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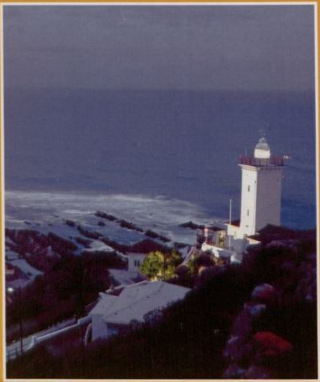
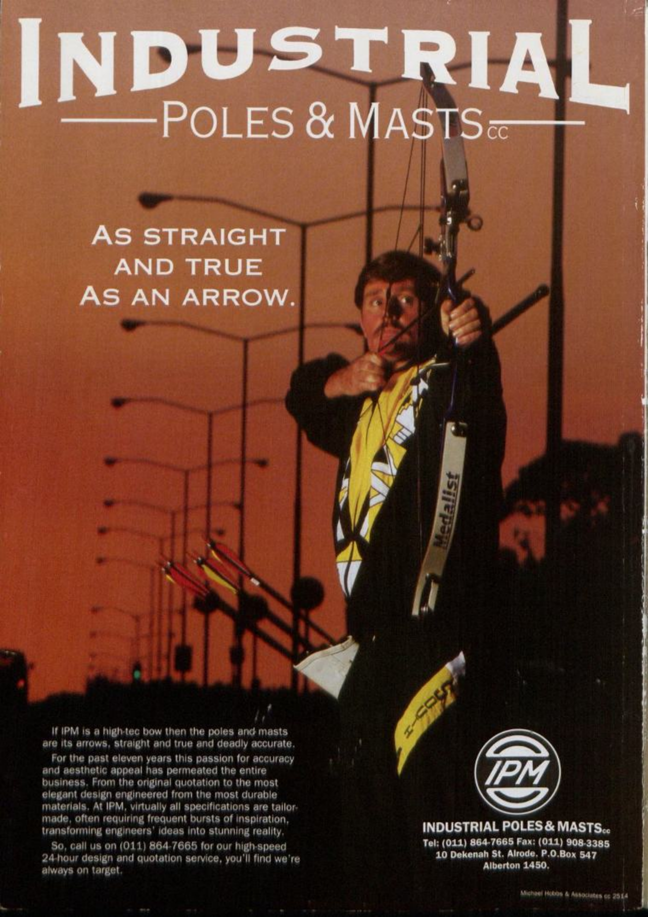


18th Technical Meeting
Mossel Bay
26 - 28 September 2000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Association of Municipal Electricity Undertakings (Southern Africa)
18th Technical Meeting - Mossel Bay
Official Proceedings
26 - 27 September 2000

Jeán Venter (General Secretary), Father Allen Kannemeyer, Mr At van der Merwe (President), Clr M Carelse (Mayor of Mossel Bay) and John Ehrich (President-Elect).

Table of attendance

Honorary Members	7	Retired Members	10
Affiliate members	180	Non-Members	31
Engineer and Councillor Members	170	Accompanying persons	140
		Total	**538**

We thank the Mayor and Council of Mossel Bay for their support as hosts of the 2000 Technical Meeting

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Delegates and exhibitions

Delegates at Mossel Bay

S Mokoena, A Nkhuhlu, At van der Merwe, Ms N Davids and H Whitehead.

At van der Merwe, Tore Horvei, EAK Kalitsi and P Shilamba.

P van den Heever, M Ellman, J Ehrich, C Burchell, H Barnard and V Matohi.

P Fowles, F Bolota, J Ehrich, D Louw and K van den Berg.

B Matangadura, Ms W Herbst, At van der Merwe, P Johnson and N Croucher.

P Viljoen, D Smart, At van der Merwe, D David and J Yuill.

X Mama, D van Wyk, At van der Merwe, R Neale, M Wilson and R Hill.

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Welcome by the President of the AMEU

At van der Merwe

It is indeed a pleasure to welcome you all on behalf of the Executive of the Association of Municipal Electricity Underta-kings of Southern Africa, at our 18th Technical Meeting. What a delight to be in the beautiful bay of Bartholomeu Dias at Mossel Bay. A special word of welcome to our foreign visitors:

Mr EAK Kalitsi: Chairman, Volta River Authority Ghana; Mr Paulinus Shilamba: Director: Energy Affairs, Namibia; Mr Boniface Matangadura: ZESA (Zimbabwe Electricity Supply Authority); Mr Dereck Hlanze: Swaziland Electricity Board; Mr Alvin Monga: Zambian Electricity Supply Corporation; Dr Alex Chiwaya: Electricity Supply Commission Malawi; Dr Terry Kahuma: Uganda Electricity Board; Mr Vika Di Panzu: Societe National D'Electricite DRC, and Mr A Chibulu: Zambia.

Mr At van der Merwe

I would also like to welcome our Honourary Members and Past Presidents:

Mr Koos Algera (Hon Member), Mr Harden Beck (Past President), Mr Max Clarke (Hon Member), Mr Al Fortman (Hon Member and Past President), Mr Brian Madeley (Hon Member), Mr Jan Malan (Hon Member and Past President), Mr Eugene Pretorius (Hon Member and Past President), Mr Bennie van der Walt (Hon Member), and Mr Howard Whitehead (Hon Member and Past President).

May we also pay tribute to those members who have passed away during the past year. They are:

Mr Richard Seymour - CEO Aberdare Cables
Mr Glyn Riley - NEI Africa
Mr JS Gamble - Retired member
Mr C Clare - Retired member
Dr Reinhard Straszacker - Honourary member
Mr CMJ van Rensburg - Engineer Vryburg
Ms Irene Browne - NEI Africa
Dr Heinie Einhorn - SANCI

In line with our theme Electrical Engineers Innovation for the African Renaissance we have tried to phase our line of events in such a way to focus on contemporary issues for both larger and smaller electricity utilities. In 2000 the debate on restructuring and transformation of utilities and engineering innovations become part of our lives. I therefore would like to invite you all to take part over the next two days in both the official deliberations and, equally important, the unofficial networking. Please visit the exhibitions of the AMEU Affiliates - they have much to offer and are ready to support you with their technical skills and expertise.

All over the world utilities are confronted with change; this is also true for Africa. Commercialisation and the transformation to competitive structures are part of this change - equally for the EDI in South Africa. Engineers through the centuries had contributed to all kinds of development, or in the almost proverbial saying of today - they acted as agents for change.

The purpose of this technical meeting is to continue with this tradition by using this meeting as a platform for exchanging technical innovations and ideas in a matter that will expedite the Africa Renaissance. Let us recognise the available engineering expertise today, as it is essential for the economic successes of tomorrow. This is what we celebrate with our theme Engineering Excellence for the African Renaissance.

In time of change it may be asked what kind of men and women are necessary for successful change? I believe that many men and women that are considered to be successful actually take much more out of life than putting back in life. Let us be measured by what we have put into life. Let it be said that we made the lights burn.

Welcome by the Mayor of Mossel Bay

Councillor M Carelse

It is a great honour that the Technical Meeting of the AMEU in the new millennium be held here, at Mossel Bay, whose recorded history goes back to beyond five centuries.

The theme of this conference is Electrical Engineers' Innovation for the African Renaissance.

Electricity is the power source to which modern man has risen to new heights from the first industrial revolution of the 1800's that was powered by steam.

Our State President, Mr Thabo Mbeki, has made a call to us all to help in the renaissance of our African continent, and electricity will be the most important catalyst for Africa's renaissance.

Councillor M Carelse

As important as electricity is for the African renaissance, so is the importance of electricity for all our councils' survival.

Electricity is one of a basket of services that is rendered by councils to its community. Electricity is the key to the upliftment of the less privileged community, as well as the key to councils' financial survival and its commitment to the RDP goals.

Electricity contributes between 40 % and 50 % of councils' cash flow and the loss of this cash flow will have a detrimental effect on councils' credit rating as well as its ability to serve its community that it governs.

Council are appointed by its people, therefore councils have a direct responsibility to govern at grassroots level and the responsibility of this governance is the protection of the people's assets such as electricity reticulation. These assets cannot be estranged without council's permission.

Consultants have been appointed by the Department of Minerals and Energy to look at the reconstruction of the electricity industry, workshops have been held around the country and it seems that the consultants have recommended six REDS for the electricity industry of South Africa.

We as councils find this difficult to understand. The six REDS model proposed will imply that the 20 councils in the Southern Cape Karoo will have less than 4 % of the shares in one of the REDS.

This will probably mean that all these 20 councils will maybe have one representative on the RED.

It must be clear that one representative with less than 4 % shares will not be able to ensure that the unique needs of our councils are met.

We as councils in this region are serious about fulfilling the commitment which it has been entrusted with in terms of the Constitution and other legislation to serve the people in its area.

Our own people have been working on an industry model for more than eight years which fulfils our needs and that of Government for restructuring. These consultants must first come and listen to us and apply strategies to meet our unique needs rather than to enforce UK practices.

We will show the rest of South Africa that Local Government in a correctly structured RED can deliver services at acceptable levels and low cost. Any alternative proposal needs to prove that it stands the test of the thorough analysis undertaken and the results achieved in this area.

We will continue to serve our people in line with the philosophy of effective democracy encapulated in our Constitution.

SESSION ONE
INDUSTRY RESTRUCTURING

Keynote address by the Minister of Minerals and Energy, Ms Phumzile Mlambo-Ngcuka

Read by Mr SS Mokoena, Deputy Director General, Department of Minerals and Energy

INTRODUCTION

I consider it a singular honour for me to be invited and be given an opportunity to deliver a keynote address here today at this 18th Technical Meeting of the Association of Municipal Electricity Undertakings (AMEU).

In recent years, electricity sectors around the world have experienced profound changes and reforms. The South African electricity supply industry (ESI) is currently enjoying low prices, is deriving no support from the fiscus and has funded an impressive electrification programme. However, we are conscious in South Africa that new challenges, opportunities and threats to the ESI mean that we need to reposition and restructure the industry in order to further pursue efficiency and social gains. In industrialised and developing countries, alike, there have been significant changes in structure, levels of competition, ownership and regulation.


Mr SS Mokoena

It is therefore in this context that I will share our experiences in those electricity and gas policy areas that we, in Government are currently working on. I will share with you our experiences and developments in the following policy areas: ESI reform, electricity distribution industry (EDI) restructuring, integrated national electrification programme (INEP), introduction of natural gas into the South African economy, and regional co-operation and integration.

I will start first by sharing with you the current status in the areas of energy scene, energy policy and status of the ESI.

ENERGY SCENE IN SOUTH AFRICA

South Africa is rich in energy resources and has a well-developed energy infrastructure. The energy sector contributes 15% of national gross domestic product and employs about 250 000 thousand people.

South African energy is dominated by coal, which accounts for 70% of total primary supply. Crude oil is next at about 16%, followed by biomass, and then small amounts of gas, hydro-power, nuclear power and renewables.

ENERGY POLICY

The most important part of South African White Paper on Energy Policy is the primary or overriding policy objectives. The following five objectives are the overriding criteria that guided the formulation of the energy policy and energy sub-sector policies. These objectives are:

- Increasing access to affordable energy services: the policy must seek to improve social equity by specifically addressing the energy requirements of the poor;
- Improving energy governance: the governance of energy institutions and consultation processes within the energy sector must clarified;
- Stimulating economic development: the policy must seek to enhance the efficiency and competitiveness of the South African economy by providing low-cost and high quality energy inputs to industrial, mining and other sectors;
- Managing energy related environmental impacts: the policy must seek to work towards environmental sus-

tainability by addressing both the short-term environmental problems, and planning for a long-term transition towards environmentally benign sources of energy; and

- Securing supply through diversity: the policy must seek to pursue energy security by encouraging a diversity of both supply sources and energy carriers.

ESI STATUS IN SOUTH AFRICA

The South African Electricity Industry is dominated by a state-owned and vertically integrated utility - Eskom. Eskom ranks among the five largest utilities in the world, in terms of both sales volume and installed capacity.

Thus in broad terms, the electricity supply industry in South Africa is currently characterised by one big player, namely, Eskom, and few small players in generation, a monopoly in transmission and a highly fragmented distribution sector consisting of Eskom's Distribution and Municipality Electricity Undertakers.

The distribution of electricity in South Africa is currently undertaken by Eskom, about 368 local municipalities and 13 other distributors. The municipalities collectively service directly about 60% of total customers by number and about 40% of total customers by sales volume. Municipal electrical departments generally supply to consumers in their local government areas. The municipal distributors differ significantly in customer density, size and type of customer base, geographic spread, financial base and effectiveness. The 12 largest municipalities account for about 75% of all sales in the municipal sector.

Municipalities in South Africa have constitutional and other legislative rights to supply electricity within their local boundaries. Eskom has legislative rights to supply throughout South Africa where municipalities, or other licensees, are not supplying.

ELECTRICITY SUPPLY INDUSTRY (ESI) REFORM

The White Paper on Energy Policy published in 1998 commits Government, amongst others, to "introduce competition to the industry, especially the generation sector", "permit open, non discriminatory access to the transmission system", and "encourage private sector participation in the industry".

Government, through its Department of Public Enterprises, is currently preparing the Eskom Conversion Bill following the passing of Eskom Amendment Act in 1998, a piece of legislation that will see Eskom being incorporated in terms of the Companies Act and start paying tax and dividends.

Furthermore, Government has also initiated investigations into the future structure of the transmission and generation sectors of the electricity supply industry (ESI).

In April 2000 my colleague, the Ministers of Public Enterprises, and I hosted an electricity supply industry reform workshop supported by the World Bank. The workshop afforded stakeholders to gain insight into the valuable experiences from various international experts on ESI reforms internationally. The valuable lessons gained from the workshop and our own local lessons and conditions are assisting us in shaping ESI reform policy. It is likely that Government will consider policy proposals on the ESI reform before the end of this year.

This will then pave the way for the necessary changes required in the generation and the transmission sub-sectors of the ESI and would also contribute towards understanding the context within which EDI restructuring is taking place.

Whatever the ESI structure is finally arrived at, the structure must assist Government in meeting the following social and economic goals:

- achieving universal access to electricity;
- promoting integrated rural development with the aid of appropriate energy provision, especially electricity provision;
- promoting industrial development through competitive electricity prices;
- reducing government debt, and meeting other public purpose objectives, through unlocking value in state assets;
- widening the participation and ownership of black South Africans in the economy through well-designed economic empowerment initiatives around state assets;
- attracting foreign direct investment;
- promoting the African Renaissance through active involvement of SA infrastructure providers; and
- ensuring security of electricity supply.

ELECTRICITY DISTRIBUTION INDUSTRY (EDI) RESTRUCTURING

In March 1997 Cabinet approved the consolidation of the electricity distribution industry into the maximum number of and yet to be determined financially viable and independent regional electricity distributors (REDs). In June 1999 Cabinet approved the transitional mechanism that would take the EDI from its current state to an end-state of viable and independent regional electricity distributors (REDs). Cabinet further approved that this process would be overseen by a Ministerial Sub-Committee (MSC), assisted by its technical arm - the Electricity Distribution Industry Restructuring Committee (EDIRC).

In March 2000 the Ministerial Sub-Committee approved the appointment of a consortium led by Price Waterhouse Coopers (PWC consortium) as technical advisor to Government of South Africa, represented by the Department of Minerals and Energy, on the restructuring process. The mandate of the PWC consortium is to advise and make recommendations in accordance with the agreed deliverables.

The PWC consortium commenced its work on 1 April 2000 and, after a number of workshops and one-to-one meetings with stakeholders, they have completed stage one report and have submitted it to the Department. After a process of consultation with stakeholders, including consultation with organised labour and business, by the Department of Minerals and Energy and processing by the EDIRC a draft Government blueprint will be prepared. Only then will the process of approval commence. Government is committed to an all-inclusive consultation process. It is expected that Cabinet will consider the recommendations on EDI restructuring blueprint before the local government elections this year.

Despite the progress achieved in the EDI restructuring process thus far, there is a number of people who raises questions on the rationale for restructuring. These queries are attributable mainly to the following reasons:

- there was a lull in the EDI restructuring process between the Cabinet decisions of 1997 and 1999, and
- there is a number of relatively new persons who have come into the process.

These queries are legitimate and they need to be responded to given the above reasons. It needs to be stated, however that there is an overwhelming consensus and compelling case for the restructuring of the EDI by the players and stakeholders. In order to remind ourselves, it is prudent to briefly reiterate the rationale for embarking on the EDI restructuring process.

The electricity distribution industry has four key objectives, namely

1. Providing low cost electricity to all consumers, with equitable tariffs; These four consumer groupings are domestic, commercial, industrial and agricultural customers.
   - For the domestic customer the key objective would be the provision of accessible, affordable and appropriate electricity services that are compatible to other sources of household energy.
   - The commercial and smaller industrial customers should have access to cost-reflectively priced electricity with an acceptable quality of supply;
   - For the larger industrial customers who beneficiate local resources should continue receiving electricity at prices that are competitive in global terms with similar industries in other parts of the world.
   - For agriculture customers prices must sustain and expand the agricultural sector and contribute towards integrated, sustainable rural economic development.
2. Meeting the country's electrification targets in the most cost-effective manner ;
3. Maintaining and improving the financial health of the industry; and
4. Improving the quality of supply and service to all customers.

However, there are a number of constraints, which limit the industry in meeting its objectives. These are -

1. High level of fragmentation of the industry exist - there are about 375 electricity distributors;
2. Wide disparity exists in the tariff structures caused by the high level of fragmentation of the industry thus resulting in large differences in tariff for the same customer group;
3. Economies of scale, skill and specialisation that are not being captured by many of the small distributors;
4. The substantial differences in financial health of municipal distributors exist;
5. Electrification needs are not evenly distributed across regions with some of the poorer regions having the greatest need and as a result the electrification delivery programme is not equally benefiting the respective areas throughout South Africa;
6. Different distributors are supplying electricity to different areas at varying prices and service standards;
7. Distributors are starting to restructure the EDI on a micro-regional basis and in an uncontrolled manner;
8. The increasing number of distributors (municipalities) which are unable to pay their bulk account to Eskom, because of the above challenges ;
9. The whole electricity industry is facing financial bankruptcy if the status quo remains;
10. Due to these challenges the South African distribution industry is loosing its attractiveness for investors; and
11. There is large amount of non-transparent cross-subsidisation in the industry, between various customer groupings, between different services within local government, and between divisions in Eskom. The restructuring process would make transparent these cross-subsidies for more equitable and easier management.

The various studies into the restructuring of the industry have demonstrated that the following benefits could be achieved, namely:

1. Rescuing a large number of (municipal) distributors from collapse;
2. Rationalising tariffs and introducing fair and equitable tariffs to all customer categories based on the principles of affordability, cost-reflectivity and transparency;
3. Accelerating the electrification programme specially in rural areas;
4. Achieving economies of scale, scope and skill from rationalising the large number of distributors into a smaller number; and

5. Enhancing the financial health of the electricity distribution industry.

It is foreseen that REDs would be established during the year 2002.

Turning briefly to the human resource issues in this industry. Given the relatively high skills levels in this industry, we have an opportunity to take advantage of this and develop a comprehensive human resource development strategy and plans that will include employment equity, retraining and succession plans. This opportunity gives us a chance to restructure the industry humanely without any loss of jobs during rationalisation of labour. One of the biggest concern of Government in this industry currently is the apparent lack of succession strategy and plans for engineers and other technical personnel in the local government electricity undertakings. It is envisaged that the EDI reform will address this problem.

NATIONAL ELECTRIFICATION PROGRAMME

The accelerated Electrification Programme under Government's Reconstruction and Development Programme (RDP) was facilitated by Eskom when a compact was reached between Government and the Electricity Supply Industry to connect 2,5 million previously disadvantaged households to the national electricity grid during the period 1994 to 1999.

This goal has in fact been exceeded by a substantial margin of 238 545 household connections. However, we still have a backlog of some 3 million households, of which 2 million are rural. This translates into 80% of households in urban areas being lelectirfied. The figure for households in rural areas with electricity is 46%.

An evaluation of this electrification programme revealed a target driven process that focussed on a number of connections made over a period of time. Consequently the majority of connections were made in the urban areas that are easiest and the cheapest to electrify due to proximity to the network, the high density of houses and relatively high consumption. The quality of some of the connections was below standard and unsafe.

Government's vision for the future Integrated National Electrification Programme (INEP) is to:

- Achieve universal to affordable and appropriate energy services by 2010;
- Integrate INEP with other social infrastructure development programmes of Government;
- Integrate the grid and off-grid technologies;
- Incorporate the clinics and schools electrification programme with the household programme;
- Contribute to sustainable development of an integrated sustainable rural development strategy, and
- Ensure appropriate quality and safe electrical installations.

Without access to electricity, human development potential is ultimately constrained. Access to a minimum electricity service is therefore, seen as an essential developmental tool.

The electrification challenge of Government is to use the capabilities in the ESI to attain the stated ideal of Universal Access to electricity and to support the development of the impoverished rural communities of the country.

To achieve this goal, and taking into account that the capital for electrification has been de facto fully subsidised as sales were just sufficient to cover operating costs, Government is now taking future responsibility by establishing a National Electrification Fund to support the future Integrated National Electrification Programme (INEP). Some of the challenges associated with funding the programme will be to what an extent are the capital costs covered by the fund and how the operational shortfalls will be subsidised. The EDI restructuring process should provide solutions for these challenges and enable Government to meet its stated objectives for the INEP.

ELECTRICITY AND GAS

South Africa has a small but rapidly growing private sector-driven gas industry. Since the release of the Energy White Paper, the objective of the Government is to implement policy to support the orderly and efficient development of the emerging gas industry. Our objective is to introduce natural gas as soon as possible and at as low a price as possible.

To this end, the South African Government is currently undertaking an integrated energy planning (IEP) process by analysing the South African demand side scenarios and evaluating the supply side options of the energy sector. This includes the introduction of natural gas into the South African economy and piloting of various renewable energy technologies.

In parallel but as part of the IEP process, a series of workshops are being run which will also feed into this process. With regard to gas, the Department of Minerals and Energy has already run three gas workshops. The idea is to develop gas markets in South Africa including electricity generation and the output of these Workshops will be an information that will assist in developing a strategy to promote the introduction of natural gas into the economy and develop a comprehensive South African gas masterplan.

The South African Government has been discussing with industry players the various options to construct a gas transmission pipeline between Mozambique and South Africa and between Namibia and South Africa.

With regard to the construction of a gas transmission pipeline from the Temane, Pande and other gas fields in Mozambique to the economic heartland of Gauteng and Mpumalanga negotiations are at an advanced stage. The possibility of constructing a gas transmission pipeline from the Kudu gas fields in Namibia will depend heavily on the outcome of the feasibility study jointly undertaken by Shell and Cape Town Metro. The results are expected before end of October 2000.

In addition to gas finds outside of our borders, Forest Oil have recently announced that by the application of modern seismics and technology to a previous gas discovery of Soekor that they are confident of a significant gas find offshore the west coast. We are still awaiting further developments on this issue.

Cabinet has recently approved the Gas Regulation Bill for wider consultation and stakeholder comments have been received, considered and, where appropriate, incorporated into the revised Bill. I will submit the Bill for tabling in Parliament shortly. The purpose of the Bill is mainly to:

- Promote the Orderly Growth of the Gas Industry;
- Promote Competition and Prevent Monopoly Abuse:

As part of the Gas Bill process Cabinet has directed the investigation on the rationalisation of the energy regulatory bodies, especially the possibility of merging the gas and the regulatory functions under a single regulatory authority.

In order to facilitate the movement of natural gas across our borders, two cross-border gas trade agreements are currently being finalised.

The Binational Gas Trade Agreement with Mozambique is currently in its approval stage in South Africa and Mozambique. It is envisaged that the agreement could be signed by the end of year 2000.

Negotiations for a similar gas trade agreement with Namibia are well advanced, with a draft Agreement having been drawn up. It is envisaged that the Agreement will be completed and finalised early in year 2001.

REGIONAL CO-OPERATION AND INTEGRATION

The successes and the developments of the Southern African Power Pool (SAPP) in promoting regional integration of electricity systems, cross-border electricity trade and integration of electricity markets, are well documented. The Motraco project involving three countries (South Africa, Swaziland and Mozambique) and their respective electricity utilities (Eskom, SEB and EdM) and two workshops on regional regulatory co-operation in the SADC region have taught us the need for regional regulatory co-operation and the harmonisation of regulatory systems.

It is in this regard that at their 25th meeting in Luanda, Angola on 31st May 2000, the Southern African Development Community (SADC) Energy Ministers noted the progress made and gave their approval in principle to the implementation of the Regional Electricity Regulatory Association (RERA). Ministers also encouraged Member States to actively participate in the association's activities and to consider the timely establishment of independent regulators in those countries where they do not exist at the moment.

It is at this same meeting that Ministers noted the invitation extended by the Government of South Africa to attend the 2nd US - Africa Energy Ministers Conference to be held in Durban, South Africa on 11 - 13 December 2000. The Women in Energy Conference to which the Ministers were also invited, will follow the Conference on 14-15 December 2000. In order to establish synergies in energy co-operation and integration in Africa, the Ministers urged the Conference organisers (South Africa), assisted by SADC TAU, to consult with other African and sub-regional energy organisations in preparation for the Conference.

CONCLUSION

There is no doubt that ESI reforms will continue unabated globally and in South Africa, in particular. It seems logical to conclude that if we do not reform our ESI willingly, we will be forced to reform the industry by circumstances as is already happening in some circumstances. Fortunately for us, South Africans are long way down the line in reforming the ESI and we need to maintain or increase the momentum. This is an industry where there is vast opportunity to do things as humanely as possible and to retain jobs in the industry given the relatively high skills levels for human resource development.

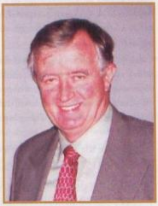
Gas markets will be developed in South Africa and in the SADC region in general. Electricity generation from gas is a big possibility in South Africa.

Finally, for any co-operation and integration to be sustainable and mutually beneficial to our countries in Africa and in the SADC region particularly, issues of capacity building, skills and technology transfer, and investment must form an important element of such co-operation and integration. Otherwise sustainable development of developing countries such as South Africa will remain a pipe dream.

Restructuring of the EDI

Howard Whitehead

MR HOWARD WHITEHEAD is the Executive Director for Durban Metro Electricity. An Honorary Member and Past President of the AMEU, he is a convenor of the SALGA Technical Working Group and acts as advisor to, and is involved in, the Department of Constitutional Development.



Mr Howard Whitehead Executive Director: Durban Metro Electricity and SALGA representative on EDIRC

The subject of restructuring is, I believe, without doubt the most sensitive in contentious issue that faces us at the moment. At van der Merwe and myself are the technical representatives of the South African Local Government Association (SALGA) on the Electricity Distribution Industry Restructuring Committee (EDIRC) and we are supported by the AMEU engineering committee and the AMEU executive. We are operating with a fairly narrow mandate from SALGA which basically stemmed from their AGM's and which, in effect, is a situation where SALGA supports the Government with regard to restructuring in April 1999 and 1997. There is an awful lot of detail around that and we are endeavoring to get mandates as we go along, both from yourselves and from SALGA.

Things are moving pretty fast, and the Department of Minerals and Energy is anxious to keep the momentum going, so that we can get this job done without undue delays. Nadia Davids referred to the recommendations that have emerged from the August report of PwC. There are 58 recommendations in the PwC report, and the comments that we have received from the AMEU representatives on the AMEU Executive Council are much appreciated.

I would also like to comment on the congruence that is emerging between the ESKOM approach to these recommendations and our own.

There are, of course, some differences but in general there are a lot a concurrences. I will be focusing on the contentious issues, which Nadia Davids has already touched upon but I will deal with them in a little more detail.

Most of the issues covered, required some political debate and decisions. Although PwC may have made recommendations, the ultimate decisions lie in the hands of the politicians both at national and local level or sphere.

Recommendation No. 1 deals with the 6 REDS that should be created with boundaries as indicated in the attached map. Some more work needs to be done on the number of REDs and PwC will have to physically demonstrate the criteria and models used as a basis for the recommendation.

All of the REDs are centered around a metro except for No 5. No 3 is centered around Durban Metro and Port Elizabeth. No 5 is centered around Pietermaritzburg, Richards Bay and the Witbank, Middelburg area. Pretoria Metro is in No 6, Johannesburg Metro is in No 4, and the East Rand Metro is in Bloemfontein and Kimberley, sitting in the middle of South Africa is in No 2.

The Durban one stretches from the Tugela River down to the Tsistikamma. We are debating where we should put our Head Office, perhaps at Jeffreys Bay.

Recommendation No 3 is of particular interest to the municipalities that are still generating a small amount of electricity. PwC has said that imbedded generation above 50MW should remain with existing owner. I am focusing on the 50 MW because that really covers the municipal sector.

We are actually saying that we should not be too firm on that. Let us say that generation about 15MW may remain with the current owner. Where generation seems to be an integral part of distribution it may be transferred to the RED as a distribution asset. There are some differing views on this subject. We felt that once you start getting into the detail of assets, one should rather take the decisions on what to do at a later stage rather than making it a firm recommendation at this now.

Recommendation No 6 deals with the golden share. You will remember that Nadia Davids commented that local government had some problems with this recommendation, and that PwC recommended that this golden share in each RED should be held by national government giving certain rights to national government. The REDS may not part with their shares without Government approval. In other words, Government could veto the sale of shares to some other organization whoever it might be.

At this stage, local government is saying that the concept of a golden share is accepted, but how this authority should be exercised has not been decided at political level. Although SALGA has not taken a firm position on this, the feeling is that they are asking why should local government not exercise the golden share option rather than national government. After all, electricity reticulation is a constitutional component of local government, hence the question.

Recommendation No 12 requires that assets should be valued upon transfer to the REDS on the basis of depreciated replacement cost. Two methods have been proposed, the discounted a cash flow method and the depreciated replacement cost method. We believe this should be tried in practice before we can examine which we have to proceed with. All municipal distributors are urged to start thinking about the value of their assets. If they have no effective asset registers that can be valued properly, they should consider doing some work on this aspect at this stage.

We have made some recommendations through SALGA, which we have urged them to pass on to their members through the provincial associations, to try and get the municipal councils to actually be working in this direction.

Recommendation No 13 says with good asset registers, depreciated replacement cost should be extracted directly from the registers, but for other cases, depreciated replacement cost should be estimated by an "approximate" approach.

What they mean by approximate approach is that you determine an empirical formula from experience to determine the value of the assets. In other words, on the basis of a value per KWh sold, and you apply that in cases where some municipalities haven't got a suitable valuation process using a DRC or a DCF method.

At this stage we have not seen PwC's detail on the recommended approximate method and we believe they need to show us some more detail on that before you can actually assess and decide whether to use the approximate method or not.

What we are actually saying, is that there is a risk that some assets may be undervalued and some may be overvalued and we need to look at the values of assets in terms of their replacement value depreciated over a time span which reflects the effective life of those assets. Of course, if an asset has been well maintained it will have a far longer life and hence be of more value than a poorly maintained asset. This is an indication to our members that with this restructuring coming down the track, we do not believe that it is in your best interest to put off maintenance at this stage.

It is, therefore, in the best interest of councils to keep those assets well maintained so that they may realize the best asset value and the best shareholding at the end of the day, because your shareholding will be reflected in terms of the value of assets less the liabilities.

Recommendation No 19 says that retail competition should be introduced as soon as possible. Initially it was indicated that this would occur within a couple of months from day one, whenever day one might be. We believe that would be far too premature as the REDS will be engrossed in restructuring and not be able to apply their minds effectively, neither would they have gained the skills to participate in a competitive or contestable market. So we are saying retail competition should be introduced as soon as possible, but REDS must be given sufficient time to acquire the skills to participate in a contestable market.

Recommendation No 22 relates to existing contracts with special terms and in particular refers to the ESKOM special contracts which have been put together for strategic reasons in the steel and aluminum industries..

We are saying, existing contract for special terms should certainly be honoured but without placing the REDS at disadvantage. We want those customers where supplied by REDs to be bound to pay the RED for the use of their wires to get the energy to these strategic customers, albeit with special contracts.

Recommendation No 24 says the future regulation of the EDI should be through a combination of local and national arrangements.

We do not have a problem with that, because of the constitutional responsibilities of local government in terms of the delivery of the electricity, there should be regulation through the local authorities in respect of certain activities and, of course, the NER will have the national interest at heart as well.

We believe the PwC have not done sufficient work in this area, and they need to really define the regulation areas of local government and NER are more clearly, we do not want overlapping of responsibilities and confusion. Dual regulation seems to operate fairly well today. If you think about it, our municipalities, our councils regulate our activities and we, in fact, seek authority for various activities from the NER, so we do not believe that it cannot happen; it is just a matter of how.

Recommendation No 30 says that prices to low-income residential customers should be kept below the cost reflective level for the foreseeable future. Of course, it should in fact increase with inflation. Our view on that is that the decision on what the lower income residential customers pay, must have political input at municipal level and will depend on conditions prevailing at that local level. Of course, ultimately this is a welfare issue and should rather form part of a National indigent policy.

The State Treasury, formerly the Department of Finance, are represented on the EDIRC and is particularly concerned about the multiplicity of cross subsidies that exist in South Africa with regard to the indigent population of South Africa.

PwC recommended that there should be no geographical differentiation of tariffs within the RED. We are saying that geographic differentiation of tariffs within the RED will in any event be subject to regulation via the municipal service delivery agreements (SDA) and the NER.

Recommendation No 34 says that the cross subsidy to cover the financial short-fall associated with the electrification should be applied as a single percentage in addition to all customers other than low income customers. Our feeling is that the consultants do not appear to have taken cognisance of the need for social equity in South Africa. Some REDS, in particular No 3, the Eastern Cape one, will have a far higher electrification burden than others and although they might start off on a viable footing today, without some cross-subsidisation in some form or other, preferably through the fiscus, will face problems in years to come.

Recommendation No 35 deals with local governments' income from electricity where PwC are suggesting that it should be from a levy. Any dividends should continue at current levels over the first five years of the life of the REDS and that the subsequent five years should be phased out so that the local government income derives from dividends alone.

That of course in itself excludes all those municipalities that are not shareholders of the RED. If you are not a shareholder you will, in fact, not earn any income from electricity. I do not think that is what local governments in rural areas want.

It is stated in the Government White Paper quite clearly so I believe that this recommendation is not quite in line with the Government White Paper policy.

Our response to that is that we advised PwC that R2.4 billion that they talk about is understated. They don't appear to have made any attempt to establish more accurately what this figure should be.

Recommendation No 36 says that the local government levy or charge should be applied as a percentage of all customers' bills with the exception of small customers and possibly large customers with an annual consumption exceeding 100 GWh.

We have argued that there is no logical reason why some customers, particularly the large customers, the 140 or so customers that use more than a 100 GWh per year, should escape this requirement to contribute to the local government levy although there is an argument that they should have some cap or limiting scale in view of their high energy usage. Some of the large users in terms of Intensive Energy Users Group have indicated that they have no problem with contributing to the municipal levy anyway. They do make use of municipal resources and facilities such as roads, drains, refuge removal, and water and waste and that sort of thing.

We, therefore, believe that the PwC recommendation is shortsighted in this respect.

Recommendation No 40 deals with the Human Resources implications of restructuring stating that the overall human resource strategy for the creation of REDS should be that people should be transferred across without any disadvantage. They should take all their own benefits with them.

We feel they should make reference to these details being developed with the unions at a joint bargaining structure. We also are of the view that generic building blocks must be included in the strategy relating to the future, because personnel cannot be transferred unless their future is clearly understood.

Clause 197 of the Labour Act enables the Government through this restructuring process to move all of us into another business. It is a very general statement in terms of what you can take with you and we believe the details of that process taking place need to be worked out in advance.

Recommendation No 42 says that upon creation, the RED should operate on the basis of all the operational process and assets currently employed.

This is such a simple statement, which however, covers an immense undertaking. We believe that PwC has done insufficient work for us to even consider such a recommendation.

If you think about it, we as municipalities are operating currently under the ordinances? After the elections we will have another batch of legislation including the structures act, a services bill and the municipal finances bill. These should all have been enacted by then, otherwise we cannot have the elections. ESKOM is operating under the ESKOM Act and the companies that are running will be operating in the Companies Act. We feel that some more work needs to be done to understand how that assortment of umbrella legislation can operate within one environment. We feel, therefore, some more work needs to be done in that area.

Recommendation No 45 says prior to RED establishment the transitional structure should undertake preparation and establishment work for the REDS establishment process for several years. Thereafter that should oversee and support the REDS and with the integration their businesses.

We do not have too much of a problem with that, but we foresee that the role of this transitional structure is likely to be limited once the REDS are in place, because the REDS will have to take on the responsibility of the activities. So we do not believe that this transitional structure would exist as long as PwC seems to think it will.

Recommendation No 56 says that the Municipal Systems

Bill should be amended.

As you may know, PwC proposes to amend the municipal systems bill to create a mandatory multi-jurisdictional municipal service district (MMSD).

They are proposing that there should be a mandatory one so that all the municipalities with a particular RED should mandate together and create one single service delivery agreement with the RED.

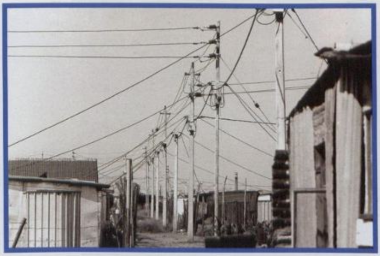
We have a problem with that because the requirements of Upington, for example, in terms of levy and service delivery, may differ markedly from Cape Town as a Metro. Would one not have a situation where the Metro in terms of its size would dominate, assuming that representation on the MMSD will have some relationship to population or whatever?

We do not believe there should be a problem with each municipality having its own SDA. If there are 20 or 25 municipalities within a RED, why can they not each establish a SDA? I understand that there are over a 1000 municipalities in France and each of them have a concession agreement with EDF, which seems to work quite well. So we have a question around that.

Recommendation No 56 deals with licenses and agreements and other legal instruments necessary for the established REDS should be drafted under the co-ordination of the transitional structure. We were under the impression that this was part of the work of the PwC, and that it was commissioned for and we need to clarify that issue.

In effect the process now is for the EDIRC to develop a composite report. The idea is that we will endeavour to reach a consensus position. If we cannot, the majority views will be expressed and that report will be taken to the ministerial sub-committee on which SALGA politicians sit.

There are still quite a few hoops to go through, but I think all of us, in spite of the difficulties that we have identified, are looking forward to this matter moving forward. I believe our affiliates are also looking forward to the uncertainty being removed from this process. Despite the fact that I have highlighted all the recommendations about which we have problems, there are a large number over which we have agreement.



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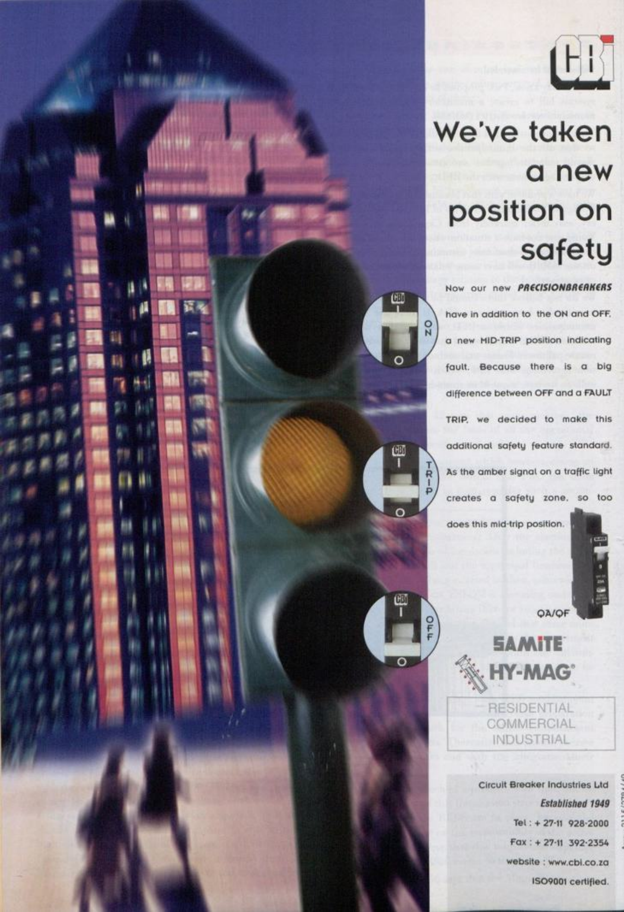
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The contribution of the Volta River Authority to the African Renaissance

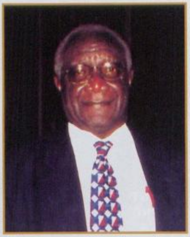
E.A.K. Kalitsi

MR E. A. K. KALITSI is Chairman of the Volta River Authority, the parasitical institution that produces all the electricity in Ghana, supplies neighbouring countries and manages the Volta Lake, the World's largest man-made lake.

Before assuming his present position in 1998, Mr. Kalitsi, who was a foundation member of the Authority when it was first established in 1961, had served in various capacities, rising through the ranks to the position of Chief Executive in January 1991.

Among important achievements of the Volta River Authority in which Mr. Kalitsi played leading roles, were the resettlement of 80,000 people flooded by the Volta Lake, development of waterborne transport system on the lake, and the inter-connection of the electrical systems of Ghana with those of neighbouring countries.

Mr. Kalitsi was appointed the Authority's Director of Finance in1966 and Deputy Chief Executive in 1971.



MR E.A.K Kalitsi

From 1987 to 1990 he was the Managing Director of the main distribution utility, the Electricity Company of Ghana.

Mr. Kalitsi has worked for the World Bank as a Financial Analyst Consultant where he focussed mainly on water and electricity sectors in the Western Africa region. In addition, for nearly five years, he was on assignment from the Commonwealth Secretariat to the National Water Commission of Jamaica where he provided technical assistance in the management of water operations.

Mr. Kalitsi was educated at the University of Ghana where he took a degree in economics in 1955. He did graduate studies in public administration at Harvard University, Cambridge, Mass. and took a Master's degree in 1961.

INTRODUCTION

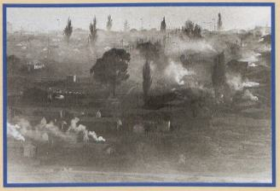
I am pleased to have an opportunity to discuss with such an august audience the contribution of the Volta River Authority to the African Renaissance.

The term Renaissance conjures up in ones mind that intellectual revolution which occurred in the middle ages and ushered in a period of a broad study of development in many spheres of human endeavour.

Immediately after the First World War African-Americans also set up what is called the Harlem Renaissance. This was a cultural revolution and a campaign for return to African roots and values and emigration to the Homeland in Africa.

Africa once had a glorious past. Some 4000 years ago the dominant civilization in the world was the Egyptian civilization, an African civilisation. The Egyptians were building massive structures such as the pyramids to elevate the vision of mankind away from the mundane to the ethereal. There had been other civilizations in Africa but of relatively limited influence even though they all are important. Among these are the Empires of Ghana, Mali, Songhay, Carthage and the Zulu Empires of Southern Africa. But for various reasons this flowering of the African spirit was extinguished one after the other. For a period, Africa fell under the domination of European influence. This influence extended to African political and economic life, trade and Industry. The impact of the slave trade and colonialism denuded Africa of all its energy and subdued the values and Institutions of African countries and African people. Even today the past weighs down the African, burdened as he is with wars, poverty

President Thabo Mbeki:
"Those who have eyes to see, let them see the African Renaissance is upon us . . . "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Mareetsane district

and disease. Critics portray Africans as lacking in self-confidence, creativity and enterprise. One reason the African empires crumbled down, slavery took root in Africa and the continent was broken into pieces by colonialism was because Africans were divided and fighting among themselves. This created the opportunity for the outsider to come in and exploit the African scene for his own advantage.

THE RE-AWAKENING

It is no wonder therefore that Africans today talk of the Renaissance as a reawakening of the African spirit, a re-awakening of the capabilities of the African for the development effort and the struggle to lift up the image of the African. The essence of the African renaissance is to quickly search for, adopt and implement strategies that will radically improve the quality of life for all Africans, and change the perception of Africans. This will happen only if the African has the will to face the challenges of the African condition.

In the case of Ghana the founding fathers considered the first critical steps to be the struggle for independence. Nkrumah approached this struggle by first asserting the African personality. He urged the study of our culture and traditions to define who we are, assert our identity and capabilities and determine our future. It was the focus on this struggle, which made Ghana the first African country south of the Sahara to gain independence from colonial rule after the Second World War. There had indeed been countries like Ethiopia and Liberia, which had been Independent for many years earlier. Those countries had in fact technically not been subject to direct colonial rule. Also, they did not use their independence to assert their leadership role for African liberation as Ghana did. This is a big contrast to what Kwame Nkrumah did with Ghana.

The South African President, Mr. Thabo Mbeki in 1998, paid tribute to African leaders for their successful struggle for change. He pointed out to a Japanese audience how "an entire epoch in human history, the epoch of colonialism and white foreign rule, progressed to its ultimate historical burial grounds because the Africans dared to stand up to say: Whatever the sacrifice we have to make, Africa must be free".

It was this same fighting spirit, so ably captured by the South African President, as expressing the spirit of the African Renaissance, that fired President Kwame Nkrumah to the determination to wage war on poverty, hunger and backwardness, and to ensure that the African will take charge of his own fate on the continent and project the interests of all Africans in the comity of nations.

MAIN CONCERN

The African Renaissance is usually looked at from several perspectives. President Mbeki has defined the political aspect by what he called "the institution of genuine freedom". The elements he identified as necessary for genuine freedom are systems of good governance without military coups, nor single party rule, elective and peaceful transfer of power, conflict prevention and resolution through collective effort, establishment of human rights and pursuits of transparency and accountability in governance, and war against corruption and abuse of power. But, it is in the economic aspect of the African

"As we peer through the looking glass darkly this may not be obvious. But it is upon us . . ."

Maphophomana

Zamekomst

Renaissance that the Volta River Project plays a role. This project was intended to solve the problem of poverty and disease, to create conditions to attract domestic and foreign investment to develop our natural and human resources, to encourage sustainable growth of the economy and establish the foundation for modernizing the economy. It was also intended to help industrial development and improvement of living conditions at home and in neighbouring countries. VRA by playing its role well and succeeding in its objectives can be said to have made a significant contribution to the African Renaissance.

ROLE OF VRA

Upon independence, Ghana made electrification the corner stone of its economic development policy. VRA was therefore born out of the quest for a rapid socio-economic development, which Ghana felt had been denied to the African. The founding fathers of Ghana considered energy as a vital infrastructure for development.

Through the Volta River development, Kwame Nkrumah hoped to provide electrical energy to fuel Ghanaian industrial development, service its commercial activities, support the health and industrial programmes for the whole of society and improve living standards in the homes of Ghanaians. The Government, accordingly, set up the Volta River Authority a river basin authority inspired by the TVA model in America to achieve these objectives. The Authority was also to address socio-economic concerns of the communities around the 8500 sq km reservoir whilst operating on sound commercial lines. That the Authority has, by and large, succeeded in fulfilling the objectives has made it serve as a model for institutions within Ghana and in the surrounding region.

Through this project, Nkrumah also introduced into Ghana, for the first time, the unique experience of implementing a major capital project. This involved construction of a massive dam 375ft high, 2100ft long impounding a reservoir of 8500 square kilometres in surface area, the largest in the world; construction, at Akosombo, of power plants which now have installed capacity of 912 MW, together with 160 MW downstream at Akuse, with a possibility of developing other hydro sites upstream, including a 400 MW capacity Bui dam on the Black Volta and a 100 MW plant at Juale on the Oti River. The planning, financing, organization and implementation of a massive development of this type exposed the country to a mega-project implementation experience, which had hitherto not existed. The fact that this massive undertaking was implemented within scheduled time and with 15% cost savings, was a remarkable achievement. It shows Africans can make it if they really want to do so.

The project also involved the flooding of some 700 communities, scatted mainly over 8500 square kilometres. The effort to manage the resettlement of 80,000 affected people without causing violent clashes nor human disasters required tremendous organizational work, which was undertaken by Ghanaians.

The operation of the hydro plant involved harnessing the efforts of Ghanaians and training them in technology newly introduced, to operate and maintain the plant and related facilities to meet prescribed standards. It is significant that two years after commissioning the plant, it was manned by local professionals and technical staff. Five years after the start of the Authority the whole of the Volta River development was placed under full manage-

" We must succeed to meet the needs of the people so as to end poverty . . . "

Crossroads

Etwatwa

ment of Ghanaians. The Volta project has since then been under Ghanaian management and professional leadership. This has served as a beacon of hope, not only for Ghanaians, but also, for our neighbours who flock in large numbers to observe the implementation and operation of such a complex and massive project, the first in Western Africa.

The fact that the project was manned almost immediately by Ghanaian technicians and managers gave confidence that, given the right environment and opportunity, the African can rise to the highest levels of technical and managerial performance. VRA's contribution to the African Renaissance can be seen, therefore, in these high standards of performance achieved.

HOW VRA APPROACHED IT'S CHALLENGE

VRA's strategic approaches can be seen in how they handled public education, social welfare and the environment and also in how the system is operated. These hold lessons for others.

PUBLIC EDUCATION

Before the construction of Akosombo dam, a massive educational campaign was undertaken among people to be affected. Road shows and public debates sensitised the whole of the Ghanaian society including, not only public officials and politicians, but also those on the ground, whose interests would be affected directly. Several seminars were held to engage Ghanaian society to face the challenges posed by the project, to exploit the positive prospects thrown up, and minimize the negative impacts.

SOCIAL CHALLENGES: MAXIMIZING SOCIAL WELFARE

The resettlement of 80,000 people within a period of about three and a half years from start of construction was considered at the time a major feat. The resettlement plans took into consideration the socio-economic characteristics of the people in their localities. The plans were based on technical studies of soils water, education and health facilities in target areas where the affected people could settle. Intensive consultations were held with the affected people in their communities on the best way and the best location to resettle them. The objective was to minimize the stress the communities would face. These consultations were held with the traditional leaders of the various communities, identifiable groups, which served as spokesmen for the people and with influential persons and public personalities related to the affected people. Their lands, economic crops and permanent trees, residential, commercial and industrial buildings, schools, clinics, and economic activities were referenced as to ownership, valued by professional Governmental agencies responsible for such valuations. A programme was implemented to compensate owners of affected properties. The compensation was partly in cash and partly through assignment of resettlement houses in 52 villages. These resettlement villages were built around the lake. Agricultural plots were assigned to each settler family. Where possible, commercial plots were added for community use through establishment of cooperatives and similar institutions. A lot has been done in the past to maximize the welfare of effected people. But up to - today pressures continue to mount on the Authority to do more.

"... and improve the quality of life by ensuring access to good education, ..."

Midrand


Orange Farm

The Authority is continuing to endeavour to meet expectation within the limits of practicality.

ENVIRONMENTAL CHALLENGES

VRA's contribution to the African Renaissance was also in the manner in which environmental and social programs were planned and undertaken.

The Volta Lake, as the largest manmade lake in the world, holds challenges - post impoundment challenges which need management.

The Authority prepares engineering models for flood forecasting and management of this vast reservoir.

Exhaustive studies were carried out on the ecology of the area upstream and downstream of the dam, before construction, during construction and after construction. The studies undertaken before construction by the Volta River Project Preparatory Commission between 1952 and 1956 were, at the time, considered to be among the most exhaustive environmental assessment for a major project. Those studies anticipated approaches, which, today, have become the order of the day. During construction The Authority, in collaboration with Universities and Scientific Institutions, and the United Nations and others, carried out basic research on the environment and the people before and after impoundment. This research covered among others microbiological study, public health study, fishery study, studies on weeds, soils, agriculture and social impact on communities to be affected. Even today we have a permanent multidisciplinary Volta Basin Research project, at the University of Ghana, which carries out studies to improve the environment and the lot of the people. This project is sponsored by the Authority, which places a high priority on it.

OPERATIONAL STANDARDS

One area in which the Authority has contributed significantly to set standards for the African environment has been how it has achieved and maintained very high standards of availability (98%) for its generating units and the transmission lines. These high levels of availability are achieved through a rigorous maintenance schedule and high quality operational measures. Expert observers pay tribute to the Authority and complement its management for achieving operating standards, which are of world level.

INITIATIVES INTO NEW DIRECTIONS

TRANSMISSION SYSTEM

In the area of transmission, VRA has already built 3874 km of 225kV, 161kV, and 66kV lines to constitute the transmission grid which criss-crosses the country and supplies power to all 110 district capitals in the 10 regions of Ghana. A spur to neighbouring countries Togo and Benin, in the east, has been operating for nearly 30 years. Another spur to Cote d'ivoire in the west has been operational for 20 years. Plans are ready for a connection to Burkina Faso in the north. The next step is to fill in with more sub-transmission and distribution lines, connecting to end - users in homes, farms, industries and businesses. Another step will be to adopt non-conventional forms of energy production such as solar energy in order to promote a more aggressive rural electrification program to extend this life-line of modernity to the 60% of our population, which still have no access to electricity.

The Authority has already set up a wholly owned limited liability company to take over and manage the transmis-

"... clean water and modern sanitation, adequate health care, decent homes ..."

Verena

Khayelitsha

sion system as an autonomous commercial entity so as to provide comfort for independent power producers wanting to establish in the country.

Communication

In the area of communication VRA has always had its own private intra-utility communication system running on the power line. This was extended to the neighboring utilities served by VRA. This power-line carrier communication system supplements the public telecom system. VRA thus avoids dependency on the unreliable public telecom service. To take advantage of the state of the art technology in communication, VRA has installed fibre optic cables on the transmission lines linking the main metropolitan centres of Ghana. A commercial subsidiary has been set up to provide back-bone facilities and services to the public. This is to accelerate access to and use of modern electronic technology and promote widespread use of the internet for electronic commerce and information.

VRA has pioneered work on the design of a shield wire system to tap the transmission line for a cheep supply to villages.

Response to Sector Changes

VRA has been able to respond to the challenge of sourcing finance from the open commercial market, instead of the traditional multi-lateral and bilateral resources. VRA is also responding to the impact of deregulation and privatization on assets which had been funded with external concessional funds. VRA is thus responding, as a useful instrument, to achieve the Governments objectives to deregulate the electricity sector and tap private sources for capital for expansion. Already VRA has formed a joint venture company with an external private investor and is in the process of negotiating other joint venture arrangements with private overseas investors, to set up additional thermal plants as well as hydro facilities. These are at different stages of development. The Authority's 330 MW thermal gas and oil fired Takoradi plant has been expanded by an increment of 220 MW with external equity funds while arrangements are being made to procure loans financing to implement the steam turbine and set up a combined cycle plant. The intention is to privatise the whole of 660 MW at Takoradi.

Regional Co-operation

The Authority pioneered interconnection with neighbouring electrical systems for exchange of power as well as for import and export of electrical energy as necessary. For nearly 30 years the Authority supplied power to neighbouring countries of Togo and Benin; for about 15 years the Authority supplied Cote d'ivoire. But, for the last 5 years the Authority has been a net importer from Cote d'ivoire. Plans are ready for the electrical system of Burkina Faso, north of Ghana, to be joined with that of Ghana. But for the vagaries of West African political changes, the Authority would by now have been connected on a 330 KV line with Nigeria.

The management of these interchanges has been carried out so successfully that the stage has been set for a West African Power Pool to be established. It is worthy of note that although political crises have flared up from time to time between Ghana and her neighbours, these crises have not in any way affected the flow of electrical energy,

"... and improve the quality of life by ensuring access to good education, ..."

Thembisa

Elandskraal

nor the commercial relations among the parties in the interconnected system. The Authority has thus had an impact on inter-regional development at a time when the neighbours had no electricity. West Africa is rather close to creating a power pool from the Cameroons all the way to Senegal.

VRA has had a tradition of sharing its knowledge with its neighbours. For example, when a Mano River Union between Sierra Leone, Guinea and Liberia was established, VRA assisted them by reviewing the scope and design proposals and implementation plans.

In the regional sphere, VRA plays other key roles. In collaboration with EECI, VRA helped set up a union of producers - Distributors of Electrical Energy in Africa (UPDEA). The Authority was able to send two of its technical directors to UPDEA to assist in developing this regional institution. The Authority also serves as the chair of a number of UPDEA committees. In the area of regional cooperation I think it is only Eskom in South Africa, which can match the contribution of VRA.

Adding value to resources

VRA, from the time it was established, made it a point to use its resources to empower the people of Ghana and neighbouring countries, to stimulate overall development by providing the energy, for industries and for social improvement of the people. Africa has been cut off the world by what has been called by some as "a knowledge curtain". Today, we also have what is called "a digital divide" separating Africa from the rest of the world. The gap between the rest of the World and Africa is getting wider. There are Africans in the diaspora, with skills which can be used to create change. VRA's role has been to identify and use such resources to demonstrate a new approach to doing things, from the African perceptive, and to provide more value in the use of these resources to create change in our environment.

In the Authority's Management style, it has always used a strict planning regime. This is not limited to physical planning and market studies only, but also to financial planning including foreign and local currency requirements. The Authority's plans are projected over a long time frame in slices of 10 years, 5 years and 2 years. It is thus possible to identify and generate policies, within the Authority, as well as within government, to ensure a continuous focus on the Authority's objectives.

WHAT ARE VRA'S SOURCES OF STRENGTH ?

Sources of VRA strength

In line with VRA's founding legislation, even though the Authority is a state enterprise, it operates as an autonomous entity in performing its technical and commercial functions. This is one area in which, we believe, VRA has made a contribution to the African environment. The manner in which the Authority has been able to protect its independence and focus should be a lesson to other entities in the African region. Structures that have been established and linkages with the Authority's financiers and major customers have made VRA robust enough to stand the buffets of short term political moods.

A significant source of the Authority's strength has been that the Board and the Chief Executives have been selected very carefully. Also the Chief Executive has been permitted to exercise overall management responsibility

"... clean water and modern sanitation, adequate health care, decent homes ..."

Nomzamu

Zwelisha

without political interferences and has enjoyed security of tenur unusual in our environment. For a period of 39 years after its establishment, the Authority had only four (4) Chief Executives. All retired, honourably, at the end of their service period. Apart from the first, a Canadian, all have been Ghanaians. They have all been groomed in the Ghana power sector. The Authority has been allowed to exercise financial autonomy, to generate and spend its own revenues, raise and disburse loan funds including foreign currency. The institution has developed a culture of technical excellence, of probity and of transparency in commercial dealings. The VRA Board and Management are thus acknowledged as having justified the trust reposed in them by the Government and other state holders.

FUTURE

In the future, VRA's experience in managing inter connection systems will be useful in setting up and managing the proposed West African power pool. VRA experience in managing a hydro reservoir with multi-storage capability, transmission infrastructure connected to neighboring countries, places the Authority in a strong position to provide leadership in this West African Power pool.

It is VRA's large thermal plant that has served to attract interest in construction of a West Africa pipeline to tap the huge resources of gas in Nigeria, to support the development effort of West Africa.

To fuifill the mission for which it was established and to enhance its contribution to the African Renaissance, VRA must now take the leadership in promoting extension of electrical supply, as rapidly as practical, to all communities, which today have no access to electricity. This has become a critical need to ensure that as many Africans as possible are able to use the information-technology, which now rules the world. We must now act aggressively and decisively to avoid the gap separating Africa from the rest of the world, as far as living standards are concerned, getting even wider. We must therefore take advantage of the information technology to access world knowledge through the Internet and participate in electronic commerce.

CONCLUSION

The VRA experience shows that Africans can develop appropriate institutions for development of our continent. These institutions can become adequate vehicles by which Africans are challenged to continuously review their vision for the continent, to harness the human and material resources, to improve the quality of life for the African and enhance his dignity.

The real nature of donor funding: Types of donor funding, consequences, and opportunities for South African entities

Tore Horvei, B Admin, MBA
Ms Jean Madzongwe

TORE HORVEI, B Admin, MBA

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Energy Economist Adviser in Angola to SADC Energy Sector's Technical & Admin Unit (TAU), included interconnection projects like: Botswana-Zimbabwe 220kV; Mozambique-Malawi 220kV & Cahora Bassa-Zimbabwe 400/330kV.

Mr Tore Horvei

SYNOPSIS

The general unavailability of finance at regional and national levels and lack of access to technology have created a heavy historical dependence on external funding sources for investment in the electricity sector in southern Africa. Electricity supply has been a major concern to the multilateral institutions such as the World Bank and bilateral development agencies, whose involvement commonly is tied to the procurement of goods and services from their home countries, thereby limiting business opportunities for local suppliers. Through their policies and practises, donors continue to influence every level of decision-making in the electricity sector by the allocation or retention of financial resources.

The 'traditional' development aid in the form of grants and concessionary loans are a decreasing source of finance, with private capital thus becoming increasingly important. The region's investment requirement in the electricity sector for the next ten years exceeds US$15bn, of which at least 60% will have to be sourced from the private sector. The reality is that there is an acute shortage of domestic finance in most of the countries in the region, primarily due to lack of well-developed capital and financial markets. The implication is that those that will provide the necessary finance will influence developments because of their strong bargaining position. In this respect the World Bank remains a key player in terms of its influence over policy and national and regional investments, with the international donor agencies increasingly taking their cue from the Bank. While it is clear that private sector involvement will increase over time, we expect the role to be played by multilateral and bilateral financing institutions to continue to set the pace for the next decade or so. For South African suppliers aiming at market opportunities in the southern African electricity sector, it will therefore become increasingly important to develop strategic alliances with suppliers from the major donor countries.

INTRODUCTION

Development assistance or aid is aimed at contributing to sustainable economic and social development of the target country. It comes in many forms: through technical assistance, grants, concessionary loans and equity investments. Aid is disbursed through multilateral or bilateral agencies. With multilateral aid, individual governments, either directly or through their development agencies, e.g. the British DFID, SIDA (Sweden), USAID, etc, transfer a portion of their annual fund allocations to multilateral organisations, e.g. the World Bank. Bilateral aid, on the other hand, is direct country to country assistance. The provider of bilateral aid is an individual country. The grant or loan is released by the donor government via its treasury, one of its ministries or its development agency. The funds are transferred to the recipient government's treasury, an appropriate ministry, or directly to a parastatal. For example, a grant by the government of Norway for an electricity sector project may be routed via NORAD to the Angolan Ministry of Energy, who may on-lend to EDEL the electricity utility in Luanda. As such, the ultimate recipient may often have to pay a quasi-commercial price for the grant, although generally avoiding foreign exchange risks.

Aid may take the form of an outright grant, but is more commonly provided as a soft loan. Important features include long maturities and grace periods as well as below-market rates of interest. It is seldom, if ever, that one encounters commercial loans as the sole source of funding in infrastructure projects in southern Africa. Commercial banks normally require more inducement in security in order to participate. The maturity of their loans is also shorter and the interest rates higher. A requirement that is usually encountered by project sponsors wishing to mobilise private sources of funding is that of a sizeable equity component, usually about 30 percent.

Development banks have for long participated in the funding of the electricity industry through planning assistance, project loans, lines of credit, sector investments, rehabilitation loans and structural adjustment facilities usually developed jointly with host governments. Multilateral aid provides project sponsors with more flexibility, being guided by international competitive tender in much the same way as development banks. Bilateral aid tends to be government-to-government assistance in which the physical project input is provided by suppliers originating from the donor country and the requisite finance is provided by the donor government.

As aid budgets are squeezed and the pressure mounts on aid ministries to justify their work, the prospect of 'tying' aid - i.e. insisting that it is spent buying goods from the donor country - becomes ever more attractive. 'Tied aid' accounts for around a quarter of the total assistance given by OECD countries to the developing world. Complex definitions for tied aid make it hard to assess exact figures. The annual "Reality of Aid" report estimates that, among the major bilateral donors to sub-Saharan Africa, the tied proportion of bilateral aid is between 13 - 50%.

Critics say it is nothing more than a subsidy for donors' export schemes, and should not be called aid at all. But defenders say tied aid is essential to maintain public and business support of development aid programmes - because it shows taxpayers in donor countries that aid brings benefits to their country as well as the recipient nation.

Much tied aid takes the form of 'technical co-operation' - salaries for expatriate experts working in the recipient country, often supplemented by consultancy support to evaluate and plan for infrastructure projects. Consultants originating in the donor country often undertake these studies. But the value of 'technical co-operation' is increasingly questioned as many observers feel it perpetuates dependence on foreign expertise, and that tying prevents aid recipients from shopping around for the best expertise and goods at the most competitive prices. Moreover, the imperatives of the project cycle produce pressures which favour the use of foreign technical assistance for its speed and high technical quality, rather than the development of local capacities. As such, tied aid promotes a dependence on expensive foreign goods and services, rather than encouraging countries to develop sustainable local solutions.

AID DEPENDENCE IN THE ELECTRICITY SECTOR

In the 1970s the world economy went through radical changes due to the oil crisis. Developing countries' governments, in need of inflows of capital and technology, were in no position to resist the direct involvement of international organisations in their economic policy-making processes. Development agencies and aid organisations assumed a significant role in the development and implementation control of policy for economic development. They emerged as the major sources of funding for development projects and programmes, procuring millions of dollars' worth of goods and services.

During the 1980s southern Africa's electricity sector developments were predominantly financed by donors1 - expansion plans were designed and defined by foreign consultants on behalf of foreign donor agencies. The southern African power sector's poor financial performance, often due to insufficient tariff levels, but also due to managerial problems, high technical and non-technical losses and sub-standard revenue collection performance, led to limited self-financing capabilities. These problems were further compounded by sub-standard macro-economic performance and lack of control on public sector spending, often resulting in rapid currency depreciation, high inflation and high interest rates. All of these negatively impacted the financial performance of power utilities, and created the heavy dependence on foreign financial assistance. In turn, this reliance led to heavy debt obligations.

It is internationally recognised that tying aid to goods and services supplied exclusively by donor country companies increases the cost of the assistance (sometimes as much as 25%) and can encourage donor-driven supply - that is, providing what the donor can supply rather than what the developing country really needs. The reality is that it is often used to promote exports and subsidise domestic industries (in the donor countries). The wide array2 of electrical plant and equipment existing in the region inhibits the sharing between utilities of technical expertise or emergency assistance with spares. Despite mountains of unused spares in one country, inter-changeability is made impossible since they are incompatible with the equipment placed in the now needy country. This is largely the legacy of chronic dependence on international donor funding and associated 'tied' aid. Since part of the funding was in the form of interest bearing loans (at least to the utilities, if not necessarily to the governments), the debt incurred for a great deal of unsuitable equipment constitutes a burden for years to come.

In addition, the conditions that accompany donor funding limit the control that a recipient country (or region such as Africa) has over its own developments. Through its role as catalyst, the World Bank has sought to influence power sector policy to a far greater extent than implied by its share in total power sector investment. This influence is generated by both direct and indirect methods. The Bank can exercise control by imposing conditions to its loans that not only regulate the project in which it is investing, but also determines the level of utilities' borrowing and investment through Debt Limitation Covenants. Bilateral agencies and commercial banks openly acknowledge that they rely heavily on the project and sector loan preparation work carried out by the World Bank, and are happy to endorse the conditions associated with World Bank loans. But, it can be argued that, by default, the World Bank also sets the intellectual agenda for the power sector in developing countries, and is the most sustained contributor to it. Furthermore, perhaps the most important source of indirect influence is the relative absence of other policy analysts who can match the Bank in terms of scale of their efforts.

THE CURRENT SITUATION

After increases during the 1980s, the real development assistance levels have stagnated during recent years. Annual aid disbursement from rich countries to poor countries peaked at US$69bn in 1991 (in constant 1995 dollars). By 1997, the figure had dropped to US$48bn. The World Bank's study "Assessing aid - what works, what doesn't and why" acknowledges that much of the trillion-plus dollars of official development assistance transferred to poor nations over the past half century has indeed been wasted. Moreover, much of the aid that remains has been redirected to other areas of the world (particularly eastern Europe and the former USSR, Latin America and Asia).

The power sector was a leading beneficiary of the boom in private financial flows to developing countries up until 1997 as shown in Figure 1 below. Power sector investments absorbed an average of 16% of all private flows to developing countries.

In addition, there have been strong regional differences both in the level of private flows to the power sector, and in their distribution between divestiture and incremental investments. This is illustrated in Figure 2 below for the period 1990-99.

The World Bank remains a key player in terms of its influence over policy and national and regional investments, including decisions around use of donor funding.

Figure 1: Private finance for power sector investments in developing countries

Figure 2: Investment in energy projects with private participation, 1990-99

The amount of private power sector investments in Africa and the Middle East has been very small compared to Latin America and East Asia who have been the largest beneficiaries (over 85% of the total between 1994-98 amounting to US$87.1). Eastern Europe and Central Asia received US$5.5 billion, while US$54 billion went to Latin America and the Caribbean, US$15.7 billion to South Asia, and just over US$3 billion to the Middle East and North Africa. The Sub-Saharan African situation contrasts sharply: the whole region attracted only US$2.3 billion in private capital for power sector investments, with the estimated power investment financing gap of more than US$15bn required for the SADC region alone during the next 10 years.

In Africa, the gap between the need and the likely availability of capital from donor agencies indicates that future infrastructure expansion and rehabilitation will require extensive participation of the private sector. The reasons are that the utilities in the region are in an uncertain financial situation, while their governments at the same time are not in a position to raise the required finance for new investments. However, for African countries, the availability of private capital for investments will depend on a number of factors:

- The degree to which countries install market fundamentals in the broader economy:
  - a sound legal framework;
  - good governance;
  - development of local capital markets; and
  - an efficient banking sector.
- The degree to which the basic criteria for a well-functioning market in the electricity sector are met is determined by:
  - sector creditworthiness;
  - independent regulation; and
  - existence of competition.

The explanations for the pressure exerted by multilateral and bilateral agencies for power sector reform include:

- Low operational efficiency, low plant availability and low customer to employee ratios (less than 50, compared to 150 in developing countries);
- Low efficiency of electricity use relative to economic output resulting in high electricity intensity of GDP (averaging 794 kWh/US$ compared to 320 kWh/US$ for EU countries - 1994 data);
- Inadequate/below LRMC electricity tariffs not sufficient to cover the cost of operation, generate new funds for investment and service new debt for future expansion and to meet financial commitments with major lenders;
- Relatively low (less than 20%) access to electricity among the population in most countries;
- Poor cost-recovery in the public power utilities due to large technical losses, high non-technical losses and poor financial management with resultant heavy subsidisation;
- Inability of some governments in the region to qualify for multilateral funding to expand their own genera-

tion capacity as a result of high debts and credit unworthiness; and

- Generally outdated legislation relating to the electricity sector, falling short of requirements to meet international practices such as unbundling, privatisation, competition, independent regulation, third party access and private sector participation.

Presently, the non-financial donor assistance involves the review of the regulatory regimes, strategies to improve private investment in the development of energy resources, and efforts to encourage countries to open up the energy sector for investment to private investors and to use outside technical expertise when necessary. The donor organisations stress on the need for sound commercial practices and arms length regulation of electricity enterprises. A further important element of the reform process has been the efforts to introduce new pricing regimes that might ensure more sustainable and cost-reflective tariffs.

FUTURE PROSPECTS?

The successful implementation of electricity sector projects and programmes is crucial to the development of the continent. To ensure that the necessary funding can be mobilised, certain ground rules will have to be observed by the host governments, the sponsors and promoters, and other participants. In particular, because the requirements of the funding of infrastructure projects tend to be complex, maximum flexibility in the selection of funding participants and funding structures will need to be retained.

If the reform of the energy sector's financial structure is to continue over the next few years, convincing institutional reforms will have to be implemented to allow a rapid shift to private participation and competition as the main drivers. Although governments are likely to remain opposed to economic pricing of electricity for reasons associated with socio-political objectives, the deregulation of prices will become more widespread. However, foreign investors will continue to have limited appetite for African risk in the foreseeable future, while the capabilities of local investors and capital markets are extremely modest compared to the needs of the sector. With the central fiscus already strained, a continued dependence on foreign aid is inevitable.

However, the deterioration of power sector performance has caused many aid agencies to examine their policies and procedures. Thus the policies which are likely to be favoured in the future will depend largely on each agency's diagnosis of the causes of the current problems. In turn, the diagnosis of the problem in itself is likely to be strongly influenced by the range of policy instruments that each will have under its control.

SUMMARY CONCLUSIONS

Although a decrease in donor disbursements to the southern African electricity sector might suggest that donor influence is decreasing, there is also the argument that the increased scarcity of development aid will continue to impart greater influence to those countries that continue to grant assistance. The link between trade and aid stays - for now.

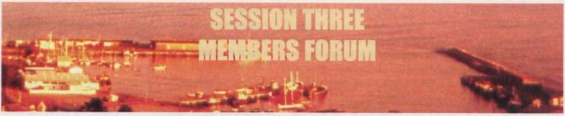
However, in seeking to ensure that aid will have positive outcomes in developing countries, agencies favour proposals that seem commercially viable - a criterion that raises an inherent contradiction, as commercially viable proposals should be self-financing. In particular, the tied aid policy sits awkwardly with broader policy on trade liberalisation and international competitiveness. If interventionism, protectionism and subsidies are generally bad economic policies, there is no reason to believe they become good policies when implemented under an aid program.

The investment needs of the electricity sector remain high - independent on how these investments will be financed. Donorship funding will certainly continue to play a major role in many countries. This is important to realise for investors, but also for the increasing number of South African consultants, equipment suppliers and contractors that these days are casting their eyes on business opportunities in the southern Africa region and beyond. While the opportunities are real, local suppliers will need to carefully develop their strategies to be able to benefit from these opportunities. In light of increasingly 'tied' aid policies, strategic alliances with companies from the major donor countries will become crucial to successfully realising African business opportunities.

Governments on their side have embarked on institutional and regulatory reforms in most countries, although these are still at a developmental stage and their application is insufficiently tested. On the one hand this period of uncertainty in southern Africa can be regarded as a constraint. Alternatively, it can be regarded as a unique opportunity for prospective investors and suppliers to exercise leverage and influence outcomes.

1 Except South Africa and Namibia, where self-financing was the norm.

2 One southern African utility is known to have more than 30 different types of distribution transformers - clearly causing major operational problems and incurring unnecessary costs for spare part management.



The South African efficient lighting initiative: Evaluation of the Hartbeespoort field study

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ABSTRACT

The South African Efficient Lighting Initiative (ELI) is a 3-year, R65 million effort jointly funded by the International Finance Corporation (IFC) - via a grant from the Global Environment Facility (GEF) - and Eskom. The ELI is a demand-side management (DSM) activity that seeks to transform South Africa's lighting market through the promotion of efficient lamps and luminaires. The initiative is set to commence in July 2000.

This paper describes the objectives and evaluation of the Hartbeespoort field study that Eskom conducted (along with four other field studies) in 1999 to guide the design and implementation of the full-scale ELI (Eskom 2000a). In Hartbeespoort, Eskom sought to determine (1) whether efficient lighting can provide benefits to distribution utilities, offsetting lost energy sales with reduced peak demand charges, and (2) whether financing for efficient lamps and distribution through utility depots was an effective means of selling the technology into the market.

The evaluation of the field study showed that the ELI would have a negative impact on South African distribution utilities' bottom lines, but that the avoided costs of peak demand could offset most of the revenue lost by reduced kWh sales. As for financing programmes, few residents of Hartbeespoort availed themselves of the lease option, preferring to buy the lamps with cash. Finally, with respect to sales through utility depots, the office hours and location of the municipal offices limited accessibility and the municipal staff voiced objection to the additional workload.

INTRODUCTION

The South Africa lighting market is dominated by inefficient incandescent lamps, with very low penetration of efficient lighting products (Eskom 1998, 2000a). To begin to remedy this situation, in May 1998, Eskom signed a contract with the International Finance Corporation (IFC) to develop a business plan for a South African Efficient Lighting Initiative (ELI). The objective of this 3-year, R65 million efficient lighting initiative is to promote the penetration of efficient lamps and luminaires into the South African market, which consists of three broad segments:

- low income and previously-disadvantaged communities that are currently being electrified at a rate of over 200 000 homes per year;
- existing and new household markets with multiple light points per dwelling; and
- commercial and institutional building markets and industrial plants.

Through this efficient lighting initiative, the IFC, the Global Environment Facility (GEF) and Eskom jointly propose to address technical, marketing and institutional barriers that have to be overcome to create a cost-effective, robust market for energy efficient lighting. The IFC/GEF contribution to the South African ELI is $2.5 million (about R17 million) over two years. Eskom's contribution is R48 million over three years. The IFC and GEF's interest in the ELI is to reduce greenhouse gas emissions from South Africa's power plants, most of which are coal-fired. Eskom's interest is to reduce its evening peak demand, which is highly coincident with household lighting use.

South Africa is one of seven countries participating in the GEF/IFC funded ELI (IFC 1999). The other countries are Argentina, the Czech Republic, Hungary, Latvia, Peru, and the Philippines.

As a first step of the South African ELI, in December 1998 Eskom initiated four "phase 1" field studies - Soweto, Kutlwanong, Albertinia/Heidelberg and Hartbeespoort-to test methods for improving the awareness, accessibility and affordability of compact fluorescent lamps (CFLs) for both low- and mid-to-high income households. These field studies ran for various durations throughout 1999, but activity on all four field studies came to a close by December 1999. This report presents the findings from one of the four field studies - Hartbeespoort - and outlines the recommendations to Eskom and the IFC for full-scale ELI program implementation that came out of Hartbeespoort. Similar, though less detailed reports, have been developed for the other field studies (IIEC 2000).

The first section provides an overview of the objectives of the Hartbeespoort field study. The second section presents the evaluation plan and criteria/matrix devised by IIEC. The third section contains the process and impact evaluations for the field study. The fourth section presents lessons learned from the field study that can be applied to full-scale ELI program implementation.

FIELD STUDY OBJECTIVES

Hartbeespoort is a small town west of Pretoria with approximately 3 000 electricity customers, mostly middle- and high-income residential customers. The field study was part of the town's larger programme to promote the wise use of energy and the conservation of natural resources. Staff from the Department of Architecture at the University of Pretoria designed this larger programme. The University also played a large role in designing and implementing the field study (Holm 1998).

As is typical in South Africa, the Hartbeespoort municipality serves as the local electricity distributor, buying electricity in bulk from Eskom and selling it on to its residents. For Hartbeespoort and many other municipalities, electricity sales are an important source of revenue. This field study was designed to show how efficient lighting can provide benefits to distribution utilities, offsetting lost energy sales with reduced peak demand charges. In addition, the field study sought to determine whether CFL financing (with loan repayment through customers' monthly electricity bills) and CFL sales at utility depots and pay points were effective means of selling the technology into the market.

After conducting a focus group to provide a baseline against which to gauge changing consumer perception, the Eskom implementation plan consisted of entering into a contract with General Electric (GE) Lighting and Osram whereby these CFL manufacturers would sell lamps to Eskom for R29. Eskom, in turn, would provide the CFLs to the municipality at the subsidized price of R25 per lamp as well as provide the municipality a R5 commission for every two lamps sold.

Customers whose accounts were paid in full would be able to buy lamps from the municipality at the price of two for R50 and would have the option of paying for the lamps through a line item on their monthly bill. The municipality would encourage customers to use the CFLs in luminaires operating at peak times, that is 18h00 to 20h00, and in luminaires operating for more than three hours per day. The town's load profile was to be monitored during and after implementation, which (similar to the Albertinia/Heidelberg field study1) would provide insights into the distributed utility benefits of residential DSM.

EVALUATION CRITERIA/PLAN

The International Institute for Energy Conservation (IIEC) conducted a process evaluation to assess the effectiveness of the planning and implementation of the field study. IIEC also conducted an impact evaluation of the Hartbeespoort field study to quantify the demand and energy savings from the field study.

IIEC carried out the process evaluation principally by interviewing individuals involved in planning and implementing the field study. The process evaluation investigated whether the field study:

- was implemented as planned;
- affected customer attitudes to CFLs; and
- provided adequate data.

IIEC's impact evaluation relied on reports provided by the Eskom staff and consultants who ran the field studies. The outputs of the impact evaluation included the:

- number of CFLs sold;
- impact of CFLs on energy sales and thus on customer savings and municipal revenue; and
- impact of the CFLs on the municipality's maximum demand and hence on the maximum demand charges the municipality pays to Eskom.

EVALUATION FINDINGS

In terms of units sold and relative smoothness of implementation, Hartbeespoort was the "model" field study. Hartbeespoort provided insights into consumer interest in leasing CFLs and data on the costs and benefits of the ELI to a distribution utility.

FIELD STUDY IMPLEMENTATION

The mayor of Hartbeespoort municipality formally launched the field study on 14 December 1998. Prior to that date, Eskom provided assistance to the municipality by (1) obtaining bids from major lighting manufacturers to supply CFLs, (2) evaluating those bids and (3) entering into contracts with two suppliers to buy lamps. Osram and GE Lighting were selected as suppliers and contracts were signed in November 1998.

Just prior to the launch, the field study coordinators conducted focus groups to gauge consumer awareness of the CFLs prior to the programme launch. The focus groups showed that there was no unaided awareness of the lamps at that time, either among end-users or among the municipal staff. The consumer reaction was overwhelmingly positive to the technology and to the proposed programme. Participants viewed CFLs as attractive, high-technology products and liked the fact that the programme would make the CFLs available to them at below-market prices.

The CFLs were sold through the Rates and Taxes counter at the municipal offices. Prior to the initiation of the field study, the team coordinating the field study redesigned the Rates and Taxes hall to serve as an "Energy and Water Efficiency Information Centre". The centre helped to create public awareness at a very appropriate moment-when customers pay their electricity and water accounts. A special exhibit demonstrated the consumption of CFLs compared with incandescent lights.

In addition to the fixed display, during the first three months of the programme, the municipality sent electricity bill inserts with information about the CFLs to all customers. Additional publicity included articles in the local newspaper, and public relations campaigns developed by the two manufacturers. Eskom also developed a public relations campaign, which municipal staff in Hartbeespoort thought was much less relevant and successful than those sponsored by the manufacturers.

The municipal staff handling the municipal accounts also handled the CFL transactions and educated potential customers on the benefits of CFLs. Municipal workers received training about two months into the field study. The delay in providing training was attributed to the Christmas holidays. The training appeared to be useful because since February, sales from the municipality's offices increased, and municipal staff resistance to the pilot program (previously perceived as additional unnecessary work) decreased.

In Hartbeespoort customers had two different options for paying for their CFLs:

1. Buy one CFL for R50 cash and get one free, with a maximum total of six; or
2. Buy up to six CFLs on credit, repaying this loan (plus a small handling fee) through a line item on their monthly electricity bills over a maximum of ten months.

Regardless of the payment method chosen, residents had to fill in a form that requested a minimum amount of information. The municipality offered five different integral CFLs ranging from a 13-watt GE to a 21-watt Osram (either in Edison screw or bayonet type), all at the R25 per lamp price. In addition, a 20-watt high-power factor CFL was available at a price of R60. Typically, CFLs sell for R40 to R60 (and sometimes for as much as R80) in South Africa.

A further condition, aimed at improving payments by low-income households, was that buyers must have their electricity account fully paid up, which was checked by the municipal clerk. However, in spite of the strained economy, Hartbeespoort residents do pay their municipal accounts, rendering the above incentive to pay one's electric account in full somewhat unnecessary.

An important component of the programme was Eskom's guarantee of the CFLs. By agreeing to replace any failed lamps within one year, Eskom's gesture raised customers' confidence in the technology and allowed the municipality to participate with less hesitation.

PROCESS EVALUATION-IMPLEMENTATION

The field study's launch in December posed some challenges. Few Eskom staff were available to provide assistance, and the municipal staff were not pleased with the idea of extra work. Time constraints on the part of Eskom staff made co-ordination among all the parties more difficult. While the CFLs were available for purchase just before Christmas, the programme did not really get started until mid-January, the middle of the South African summer.2

Moreover, the detailed monthly reports that the University requested of the municipality proved to be difficult to procure. Municipal officials stated that they were overworked and the sale of lamps constituted an additional temporary workload that might not reflect on their performance assessment. As a result, it took several months before the municipality could provide the University with data on lamp sales, returns, broken lamps, etc. The problem was compounded by the fact that the municipality only kept paper records, and did not have facilities to record the information electronically.

Nevertheless, the municipality seems to be enthusiastic about the program. The University makes a monthly report to the municipal board about the lighting and other DSM programmes, and board members have used their support of the lighting field study for positive public relations.

Ultimately, Hartbeespoort asked Eskom if it was possible to extend the field study for several months beyond its initial April end date. The University and municipality wanted to use the additional time to gauge whether consumers' interest in the lamps would continue to increase as the public education sunk in. Eskom agreed to a two-month extension.

Based on the success of the second promotional campaign, the University's research team proposed another promotional drive between the local media and the CFL firms. Although this additional activity never took place, the field study nevertheless remained active until October 1999.

The information drive had impacts beyond Hartbeespoort, with requests for information from the research team being received from as far afield as Knysna and Port Elizabeth.

PROCESS EVALUATION-CUSTOMER ATTITUDES

Most of Hartbeespoort's residents opted to purchase the CFLs outright, rather than lease them through the municipality. The most popular lamps are the integral 20-watt models from GE Lighting and Osram. Since power quality is not of direct interest to residential customers (they do not pay power quality fees), the higher priced, high-power factor models were of little interest to customers.

Overall customer awareness about CFLs has increased. In addition, some customers have expressed interest in purchasing more than the six lamps allowed under the programme at this time. The staff interviewed believes that customers are willing to pay more for the CFLs than they currently were charged during the field study. That said, customers did have a number of concerns regarding the new technology:

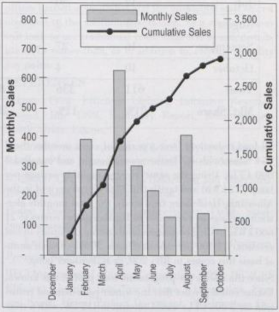
1. Exterior bulkhead lights cannot be fitted with the integral CFLs issued because the CFLs are too long.
2. Some residents wish to use dimmers on CFLs, which is technically not possible with the lamps sold through the program.3
3. Although favourably impressed with the reduced energy-related environmental impacts of CFLs (over its lifetime, a CFL in South Africa will reduce power plant water consumption by ~10,000 liters and power plant carbon dioxide emission by almost four tons), some residents questioned the environmental impact of dumping or recycling CFLs due to their mercury content.
4. The fact that few CFLs are manufactured in South Africa concerned residents worried about local job losses if locally manufactured incandescents were replaced on a massive scale by imported CFLs.

Finally, with respect to the option to lease CFLs, very few Hartbeespoort residents availed themselves of this opportunity. The programme did not capture residents' rationale for preferring cash payments over leasing, but programme staff hypothesize that Hartbeespoort's residents (who are relatively high-income) were not interested in engaging in a lease for such a small sum of money. Staff further hypothesize that the popularity of CFL leasing mechanisms could be much higher in low-income communities.

IMPACT EVALUATION - SALES

Figure 1 depicts the steady rise in sales that followed the launch of the field study in December 1999. From April (when the field study was initially envisioned to end) until July, sales fell as no new coupons were sent out and active promotion of the field study was interrupted. In August, when the programme was re-launched and advertised, sales jumped before falling again as the field study came to a close.

***Figure 1.** Monthly and Cumulative CFL Sales (Holm 2000)*



Monthly sales by product type are shown in Table 1. The GE 15-watt high-power factor CFL costing R60 each must be regarded as a special case. It cost more than double of the other lamps and buyers did not understand the benefit of a high power factor. As seen in the table, about 20% of all sales were 13-watt CFLs, about 25% were 15-watt and 16-watt lamps, with the balance (54 %) being 20-watt and 21-watt CFLs.

All CFLs that were returned by residents for whatever reasons were accepted without question and replaced with others of the residents' choice. The GE 15-watt had the highest return rate while the Osram 16-watt had the lowest. Overall, monthly CFLs return rates varied from a high of 3% in March 1999 to a low of 2% in May 1999.

IMPACT EVALUATION-DISTRIBUTION UTILITY BENEFIT

As a part of the field study, the University of Pretoria assisted the municipality in measuring the impact of the lighting programme and other DSM programmes on over-

Table 1. Monthly Sales by Model (Holm 2000)

	GE 13W	GE 15W	GE 20W	GE 15W HPF	Osram 16W	Osram 21W
December	2	14	36			
January	74	30	80		17	69
February	109	35	67		45	114
March	50	31	67		63	70
April	131	81	236	10	106	151
May	90	65	91	6	14	24
June	36	27	60		1	94
July	12	20	6		27	67
August	81	2	118		41	156
September	16	27	45		45	13
October	10	4	20	5	42	5
Total	**611**	**336**	**826**	**21**	**401**	**763**
Mkt. Share	**21%**	**11%**	**28%**	**1%**	**14%**	**26%**

all load reduction. Over a period of eight months, the 2 054 households in Hartbeespoort bought and installed 3 000 CFLs. Using the same average monthly savings per lamp (7.2 kWh) and tariffs (R0.33/kWh) as derived in the Albertinia/Heidelberg field study, the total monthly electricity savings by customers in Hartbeespoort comes to 21 600 kWh, netting customers (and costing the utility in lost revenue) R7 100 per month (Eskom 2000b). On an annual basis this comes to R85 200, or R28.40 per lamp.

Since the town's pre-programme load profile was known, Eskom could predict that the winter peak-demand reduction for 3 000 CFLs would amount to 112 kW, with a summer peak reduction of 61kW. Since the municipality pays a demand charge to Eskom of R40.2/kVA, the annual demand charge saving is R35 500 ([(9 x 61) + (3 x 112)] x 40.2). The saving by the municipality on its energy charges from Eskom comes to R19 200 per year. Together, this amounts to a saving of R18.20 per lamp per year. The net effect on the field study on the municipality is thus a loss of about R10.20 per CFL per year.

LESSONS LEARNED

In Hartbeespoort, Eskom examined a number of options designed to remove the awareness, accessibility and affordability barriers to higher levels of CFL penetration in the South African economy. (Prior to the field studies, Eskom had already found that CFLs were largely acceptable to South African consumers.) The following sections describe how the results of the field study will impact the ELI's planned activities in a variety of different programme areas. Findings from several of the other field studies conducted by Eskom are referenced in this section.

DISTRIBUTION UTILITY ACTIVITIES

The Hartbeespoort field studies showed that targeted DSM would have benefits as well as costs for distribution utilities (in this case the municipalities). The Hartbeespoort numbers are not convincing from a purely profitability perspective (as compared to the Albertinia/Heidelberg numbers that showed that the financial benefits of reduced peak demand slightly outweighed the financial costs of lost energy sales) but still show that the avoided costs of peak demand can partially make up for revenue lost by reduced kWh sales.

SALES THROUGH UTILITY PAY POINTS

To build customer interest in CFLs within a targeted area, the ELI could sell CFLs and CFL-dedicated fixtures from Eskom or municipal pay points. Eskom tested this option in Soweto (via Eskom) and Hartbeespoort (via the municipal utility). Difficulties in obtaining approval from Eskom management in Soweto resulted in that field study never getting started. In Hartbeespoort, sales through the local council were relatively brisk, but the office hours and location of the municipal offices limited accessibility and the municipal staff voiced objection to the additional workload. Despite the brisk sales at Hartbeespoort, problems in Soweto and staff complaints in Hartbeespoort suggest that the ELI pursue other potential distribution channels in the future.

TRANSACTION SUPPORT AND FINANCING

When buying lamps, most South African consumers make their purchasing decision based on the first costs rather than life-cycle costs. As a result, a relatively expensive CFL is much less attractive than its standard incandescent counterpart. To encourage consumers to base their purchasing decision on life-cycle costs, Eskom wanted to test customer acceptance of a CFL leasing programme that would remove the first-cost barrier. Establishing a leasing programme required the ELI to devise innovative methods to both extend credit and collect payment.

While Eskom planned several field studies to examine both of these aspects, only one of the planned field studies was carried out and its results were inconclusive. (As described above, few customers availed themselves of the lease option provided in the Hartbeespoort field study). As a result, the ELI will need to conduct its own research and analysis before making final decisions on which options to implement.

ESKOM INVOLVEMENT

The field studies, including Hartbeespoort, show that the ELI should avoid relying on Eskom as the primary implementor. The field studies that progressed most smoothly were those that required the least direct support from Eskom staff (e.g., Hartbeespoort and Kutlwanong). The administrative issues that stopped implementation in Soweto and slowed it in Albertinia/Heidelberg suggest that when Eskom staff involvement is required in the ELI, the involvement should be formalized. This could best be accomplished by working with Eskom to revise its Key Performance Indicators.

CONCLUSION

Eskom implemented the Hartbeespoort field study to provide data that would assist the development of a comprehensive business plan to transform the South African lighting market. In Hartbeespoort, Eskom sought to determine (1) whether efficient lighting can provide benefits to the distribution utility, offsetting lost energy sales with reduced peak demand charges, and (2) whether financing for efficient lamps and distribution through utility depots was an effective means of selling the technology into the market.

Eskom and its partners carried out the Hartbeespoort field study over a period of 10 months in 1999. To entice customers to purchase the high-efficiency lighting product, Eskom engaged in a bulk procurement with lighting manufacturers and also provided a subsidy to customers to further bring down the retail price. Eskom also provided a small (R5) handling fee to the municipality that sold the lamps. These were sold through the Rates and Taxes counter at the municipal offices.

The implementation of the field study occurred without any major difficulties, although municipal staff did express irritation with the additional workload of selling and stocking the CFLs. Ultimately, Hartbeespoort residents bought nearly 3,000 CFLs through the field study. Customers tended to prefer the higher-wattage, higher-lumen models. CFL return rates averaged roughly 2%.

The impact evaluation of the field study showed that the initiative had a negative impact on the Hartbeespoort municipality's bottom line, but that the avoided costs of peak demand could offset much of the revenue lost by reduced kWh sales. Eskom will apply this lesson to the full-scale implementation of the Efficient Lighting Initiative. The full-scale ELI will not rely on these benefits to sell the initiative to distribution utilities, but will point out that reduced demand charges from the proliferation of efficient lighting technologies can substantially off-set lost electricity sales.

As for financing programmes, although few residents of Hartbeespoort availed themselves of the lease option, the ELI is leaving open the possibility of exploring this option further. Finally, with respect to sales through utility depots, the office hours and location of the municipal offices limited accessibility and the municipal staff voiced objection to the additional workload. As a result, Eskom will look to use traditional retail channels to sell/distribute CFLs rather than, or in addition to, relying on utility pay points.

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1 *Albertinia and Heidelberg are small communities in the Western Cape with little industry and relatively high electricity tariffs. As with Hartbeespoort, the Albertinia and Heidelberg field study tested how efficient lighting can provide distributed utility benefits, off-setting lost energy sales with reduced peak demand charges.*

2 *CFL programs are usually run during winter months when lighting needs are the greatest. Eskom, however, deemed its need to start collecting data on potential ELI activities as more important than perfect timing.*

3 *Dimmable CFLs are available, but they are much more expensive than standard CFLs.*

Report on the National Electrification Co-ordination Committee (NECC)

JG Louw (City Electrical Engineer, Tygerberg)

1. INTRODUCTION

The deliberation around the unified approach on the funding of electrification has entered the second year. The past year has seen the AMEU really pulling its weight and various members have attended a large number of meetings in order to protect the rights of the AMEU and Local Government.

Since the convention of the AMEU in Bloemfontein four plenary and approximately two sets of task team meeting for every plenary session.

The following members were tasked to attend task team meetings:

1. Planning Task Team: Danie Potgieter and Deon Louw
2. Non-Grid Allocation Task Team: Peter Fowels and Tim Hill
3. National Electrification Fund & Levies Task Team: Peter Fowles and Tim Hill
4. Strategic Task Team: George Ferreira

AMEU/SALGA was ably represented by Howard Whitehead and At van der Merwe at the NECC Plenary meetings with the task team members assisting them.

A huge effort was put in to get the new electrification funding scheme going in time for the 2001 calender year but various delays were encountered. These were basically linked to three problems which are:

- Whether the source of funding would be from a levy on generation or from the fiscus.
- Ownership and control over non-grid electrification.
- Responsibility for community liaison.

2. DISCUSSION

During the past year numerous aspects of the electrification process have been deliberated and most have reached consensus.

2.1 Electrification Program

It is the National Government's intention to have universal access to electricity by the year 2010. To achieve this the backlog of electricity has to be addressed in the following way:

i. An estimated 9,5 million dwellings exist in South Africa.

ii To date 6,5 million dwellings have been electrified.

iii The remaining 3 million dwellings need to be electrified by 2010.

iv An average backlog electrification rate of 300 000 dwellings need to be achieved per annum.

The above together with new electrification equates to R1,2 billion per annum.

2.2 Funding of the Electrification Drive

Various arguments were raised for the way the electrical fund should be raised. One point of view is that the source of funding should be forthcoming from within the electricity arena. The counter argument for this approach is that the electricity industry is already heavlly burdened with loans taken up to do electrification. If in addition to this it is burdened with the uneconomical operation cost, it is feared that the industry will not survive without very high tariffs to other consumers.

The other point of view is that the source of funding should be the national fiscus. This is done to achieve a wider tax base. The counter arguments in this case are that much less control of this fund would result to those in the electricity industry.

This battle is at present being fought within cabinet.

2.3 Non- Grid Electrification

It was very quickly found that it would not be possible within the limited funding available to electrify deep rural areas. The average cost of electrification within city areas is estimated at R2 500.00 per connection whereas a cost of R20 000.00 per consumer would be the case for deep rural customers.

It was therefore necessary to look for an alternative source of electricity and photovoltaic cells were looked at and found to be an acceptable alternative and a connection at a cost of R3 500.00 per consumer.

This concept was debated at length where it was at first felt that this method cannot be considered to be electrical reticulation and would therefore not be within the responsibility of local government. It was however felt that the local government would be in a position to determine when the grid would have to be altered in the case of large industrial or commercial developments in which case grid electricity would be viable. Eskom and AMEU met on this subject and jointly agreed that the control of all forms of household electricity should be exercised by the utility of the area and SALGA has accepted this approach.

Problems within the non-grid electrification emerged. Normally a non-grid area would be allocated to a concessionaire to operate and maintain. The batteries used by a PV cell system would have to be replaced from time to time. This resulted in the necessity to charge a monthly basic fee. A monthly fee of R45.00 is estimated. This resulted in a dilemma as only the richest of the poor would be able to afford this if compared with the average cost of R12.00 for a grid consumer and the latter consumer receive considerable more power than the 100W delivered by a PV cell.

This debate is currently raging and as we speak a national workshop is being held at Midrand to look at various other forms of energy.

2.4 Electrification Modelling Tool

A software program was developed to assist the designers and management to decide whether grid or non-grid should be utilised. This GIS based program was developed by consultants using data basis from Eskom and national government. This model would predict the cost of connections at various geographic areas.

It could also be used iteratively in order to add on to the grid as it grows from year to year. By increasing the cost of the connections, areas can be determined where the grid would not be economical to extend. By starting with the maximum cost areas and progressively working to the less costly areas it would be some time before the grid and non-grid areas would meet.

The tool was tested in the Transkei and Durban Metro areas and proved to work quite well in the Transkei area but was not effective in the Durban Metro area. The consultants are busy adjusting the program to make provision for the circumstances of the Kwa-Zulu Natal area.

2.5 Community Liaison

Originally national government felt that limited negotiation with communities should take place and that it would direct the quality and quantity of electrification to be done. AMEU/SALGA felt that the requirements of the Constitution and the Municipal Systems Bill should be adhered to and in particular the Integrated Development Planning (IDP) process should be followed.

With the IDP approach the community would be thoroughly consulted through liaison processes. Not only would electricity be addressed but more importantly it would be addressed in conjunction with all the other services that local government is constitutionally responsible for.

The IDP concept was accepted and a process was developed to determine the interaction process between all the role players within the IDP communication process.

Annexure A indicates the interaction between the various role players.

2.6 National Electrification and Implementation System

The whole system is build up of various building blocks. These are made up of the following:

2.6.1 National Electrification Program Management

This building block contains the function of the two main role players namely the DME and the National Electrification Advisory Board (NEAB). The NEAB will initially be the NECC. The functions of the two role players are shown under Annexure B.

2.6.2 National Electrification Business Planning

This function is to be outsourced from the DME and it was decided that Eskom would initially assist with this task with possible help from SALGA. Discussions have started to create a national body under control of the REDs to house this and other national orientated structures. The functions of this building block is shown in Annexure C.

2.6.3 National Operations Management and Administration

This function is very much the same as 2.6.2 and it was found that not enough capacity exist outside Eskom and SALGA and it was decided to initially place this task under the control of Eskom. The detail of this function is also shown under Annexure C.

2.6.4 Database and Modelling

Again this building block under Annexure C.

2.6.5 Project Management and Administration

Similar to the above, this function will at local level be controlled by the RED but will be coordinated by a national body initially to be Eskom assisted by SALGA. Details of this building block are shown under Annexure D.

2.6.6 Treasury and Disbursement

It was originally the intention that this function be driven by the DBSA or the Central Energy Fund. These entities, however, felt that additional staff would be needed and declined to assist. Again the assistance of Eskom and later a national structure is to be used. Detail is shown in Annexure E.

2.6.7 Total Process

The structure with all the building blocks put together is shown in Annexure F &H.

2.7 Electrification Organisation

The various individual role players are shown in an organigram schedule. Annexure G shows how the various functions relate to each other.

2.8 Electrification Standard

Eskom, NER and the AMEU convened on two occasions to discuss standardised electrification designs and connection fees. A suit of supplies has been agreed upon ranging from 2,5A deepish rural consumers, 8A semi-urban to 20A urban low-income consumers have been agreed upon. It was also decided that any stronger connections will not be seen as low income. A detailed list is being put together and once completed will be distributed to members.

2.9 Interim Measures

As considerable delays have been experienced, an interim measure has been decided upon. The new electrification process will come into effect in 2002. The new electrification financial year will run from April to March. The NER claims that an amount of R100 million will be available from unspent funds of 2000. Eskom will endeavour to utilise this amount for additional electrification. The NER will still control projects and funds for the year 2001 and members are urged to urgently submit their projects for the year starting on April 2001.

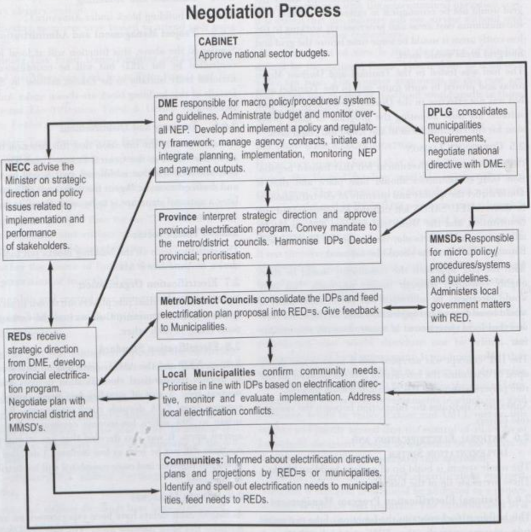
3. CONCLUSION

At present the whole process is dependant on the outcome of government's decision on the funding source. It is expected that the amalgamation of municipalities and the restructuring towards REDs will cause delays in the electrification process. Once the new municipalities are up and running it is expected that the new IDP processes will kick in and electrification will start in earnest.

Members are urged to assist with the electrification process and especially with the community liaison process.

Let us put our efforts into the process and let us have South Africa 100% electrified by 2010.

ANNEXURE A



ANNEXURE B

National Electrification Programme Management

DME

The outputs of DME in this process are to:

- Manage the National Electrification Programme, Planning and Implementation system.
- Manage the contract with the agencies (National Electrification business, Planning ,National Operations Management and Administration, Database and Modelling and Treasury and Disbursements).
- Develop macro policy/procedures/systems guidelines for the National Electrification Programme.
- Develop and administrate the National Electrification Programme budget requirements (annual, 3 years and cash flows).
- Monitor overall National Electrification Programme performance and develop corrective actions where necessary.
- Establish and maintain a communication node on the National Electrification Programme.
- Provide a secretarial function for NEAB by preparing agendas, minutes, budgets and reports.
- Receive/interpret/screen disputes and recommend on action.
- Undertake special assignments as required.
- Strategic programme monitoring, auditing and reporting.

National Electrification Advisory Board

The outputs of the NEAB are:

- To advise the Minister on:
  - Strategic direction and policy
  - Hi-level targets and objectives
  - Budget requirements
  - National Business Plan
  - Programme allocations and approval
  - Programme adjustments
  - Appointment of agencies
  - The initiation of consultations and special investiga tions
  - Communication strategy and related maters
  - Resolution of hi- level disputes
- Exercise any powers/duties as mandated by the Minister

Note 1: The NEAB in a non-statutory advisory body to the Minister with the following proposed competition:

- Chair: DME (Deputy Director-General Energy or Chief Director Electricity);
- NER(1);
- Service Providers (REDs) (2);
- SALGA (2);
- DME (2) (Additional to the Chair: Director Electrification+1);
- Department of Finance;
- Department of Provincial and Local Government; and
- Other (1),e.g. Treasury

Note 2: In order to prevent programme delays a close communication and decision making link with the Minister is advisable.

ANNEXURE D

Project Management and Administration (REDs/ Eskom/Municipalities)

- Project Planning
  - Selection
  - Design
  - IDP Harmonisation
- Project Management
- Financial admin, progress monitoring &reporting
- Payment requesting process
- Project queries & disputes

ANNEXURE C

National Electrification Business Planning

The outputs of the National Electrification Business Planning function are:

- Regular programme overview;
- Setting of purpose objectives (mission; philosophy, vision; target, market, products, growth scenarios, synergy with Government White Papers and other Government directives);
- External environmental analysis (political, economical; social; technological; environmental impact, institutional; financial);
- Internal environmental analysis (Industry strengths, weaknesses; opportunities; threats; to cover all 5 operational areas, namely, DME/Board, planning/modeling, Operations/Administration/Control, Treasury/Disbursements and project execution by the distributors);
- Scenario development (Realistic selection of optimal models);
- Setting of programme objectives and targets (test against the 3A's= Affordability, Acceptability, Availability);
- Development of a Market Plan (harmonising with regional IDPs initiation of R&D in respect of tariffs and technology, Implementation Strategy, Communication and Promotion Strategy; Financial and Numbers targets, Product range and application; Price/tariff issues Place);
- Develop a Programme Plan (approval, allocation and combination of individual regional programmes);
- Develop a Production Plan (As collated and summarized from regional plans that will address the following issues: Capacity [in-house, contracted and suppliers]; Facilities; Materials; Inventory; Methods+Standards; Quality control;
- Develop a Resource and Structure Plan (Human resources; In-house and Outsourced activities) (Note: This includes all activities from the NEAB Secretariat; Planning; Modelling; Administration; Control; Management and Treasury);
- Develop a Financial plan(Detailed budget for year 1;hi-level budget for years 2 & 3; good indication budget for years 4 B 10 ; year 1 monthly cash flow plan); and
- General programme control.

National Operations Management and Administration

The outputs of the National Operations Management and Administration function are to:

- Ensure availability of funding;
- Manage the application process;
- Manage the allocation process;
- Manage the programme database;
- Manage progress performance of the programme (Regional implementation
- Versus the approved National Business Plan);
- Assume responsibility for overall programme control and its mandated power to enforce performance;
- Manage claims process;
- Manage the auditing process on the programme;
- Assist regions with individual project auditing guidelines to support claims;
- Manage programme reporting; and
- Provide an advisory to the REDs

Note: It is recommended that this set of functions be outsourced to Eskom.

Database and Modelling

- Updated National database system which will include:
  - GIS data
  - HELP data
  - Topographical data
  - Census data
  - Cadastral data
  - Electrical data (Plant and Circuit)
- Modeling the needs and supply processes
- Development of data models
- Data acquisition
- Data management
- Data maintenance
- Data distribution
- Merging of data from various sources
- Standardization of data for ready accessibility
- Development of modeling scenarios

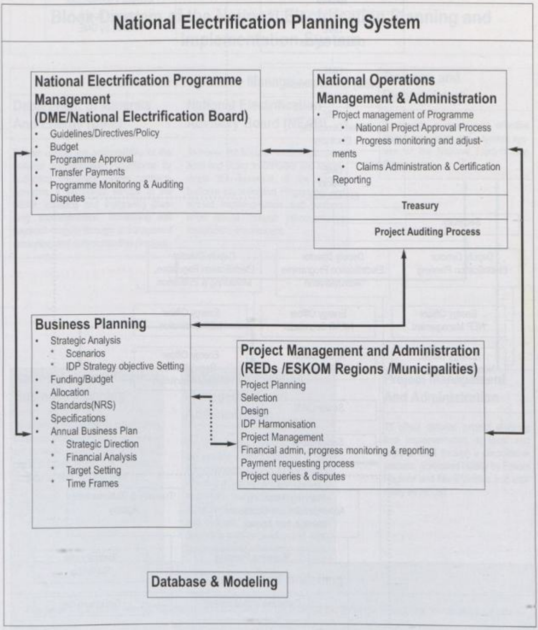
ANNEXURE E

Treasury and Disbursement

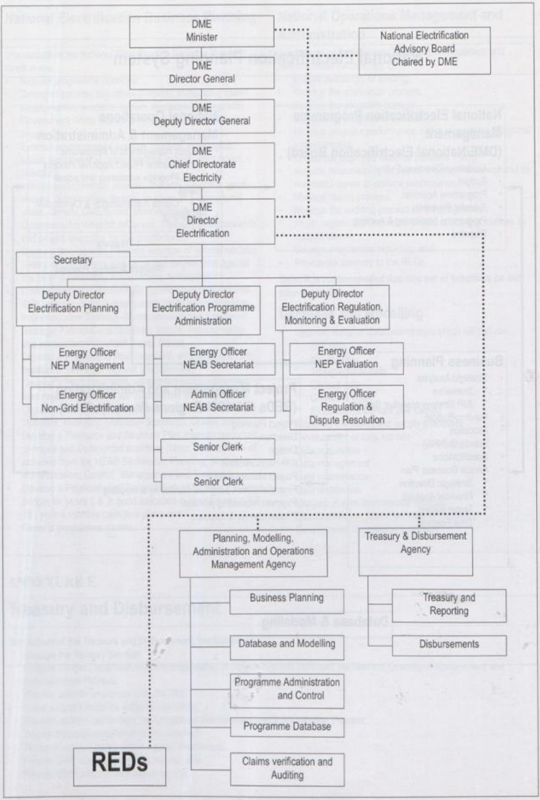
The outputs of the Treasury and Disbursement function are to:

- Manage the treasury function;
- Compile budget (Total/cash flow-monthly/weekly) in conjunction with DME and the National Operations Management and Administration Process;
- Receive transfer payments from the DME;
- Invest unspent funds on a day to day basis;
- Receive verified claims from the Operations Management and Administration Process;
- Ensure that audit requirements are satisfied;
- Disburse verified claims within agreed timeframes;
- Provide DME with reconciliation reports; and
- Provide DME with monthly status reports.

ANNEXURE F

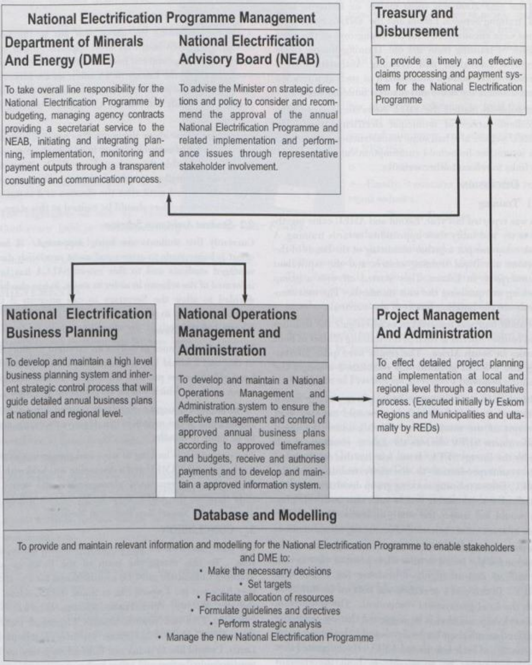

National Electrification Planning System
National Electrification Programme Management (DME/National Electrification Board)
Guidelines/Directives/Policy
Budget
Programme Approval
Transfer Payments
Programme Monitoring & Auditing
Disputes
National Operations Management & Administration
Project management of Programme
National Project Approval Process
Progress monitoring and adjustments
Claims Administration & Certification
Reporting
Treasury
Project Auditing Process
Business Planning
Strategic Analysis
Scenarios
IDP Strategy objective Setting
Funding/Budget
Allocation
Standards(NRS)
Specifications
Annual Business Plan
Strategic Direction
Financial Analysis
Target Setting
Time Frames
Project Management and Administration (REDs /ESKOM Regions /Municipalities)
Project Planning
Selection
Design
IDP Harmonisation
Project Management
Financial admin, progress monitoring & reporting
Payment requesting process
Project queries & disputes
Database & Modeling

ANNEXURE G


DME
Minister
DME
Director General
DME
Deputy Director General
DME
Chief Directorate
Electricity
DME
Director
Electrification
National Electrification
Advisory Board
Chaired by DME
Secretary
Deputy Director
Electrification Planning
Deputy Director
Electrification Programme
Administration
Deputy Director
Electrification Regulation,
Monitoring & Evaluation
Energy Officer
NEP Management
Energy Officer
Non-Grid Electrification
Energy Officer
NEAB Secretariat
Admin Officer
NEAB Secretariat
Senior Clerk
Senior Clerk
Energy Officer
NEP Evaluation
Energy Officer
Regulation &
Dispute Resolution
Planning, Modelling,
Administration and Operations
Management Agency
Treasury & Disbursement
Agency
Business Planning
Database and Modelling
Programme Administration
and Control
Programme Database
Claims verification and
Auditing
Treasury and
Reporting
Disbursements
REDs

ANNEXURE H

Block Diagram of the National Electrifcation Planning and Implementation System



Report on the proceedings of the publicity and training committee for 2000

J.G. Louw

1. INTRODUCTION

The year 2000 was spent mainly on trying to unify training between Eskom and the AMEU. Some problems were encountered with the changeover of the governance of training from the old Training Boards to the Sectoral Education and Training Authority (SETA). Various other matters were looked at such as a new student assistance scheme and capacity building seminars.

On publicity matters the AMEU News continues to be an excellent carrier of municipal electricity news. The AMEU website also had some reconstruction and now has an interactive household consumption calculator as well as links to relevant other websites.

2. DISCUSSION

2.1 Training

As was reported last year, Eskom and AMEU came together to try and unify their approaches towards training. A task team was put together consisting of the heads of the various municipal training centres and the equivalent counterparts in Eskom. They started off with a group looking at equalising the unit standards. The unit standards are the building blocks of any curricula.

An audit tour was undertaken to investigate the facilities and courses offered at each of the training centres of both parties in South Africa. The results were quite interesting and a lot of goodwill was established amongst the training centres.

With the new training system being put in place in South Africa all municipal electricity personnel together with the rest of the municipality will fall under the Local Government SETA whereas the Eskom counterpart will under the Energy SETA. It was felt that this development was counterproductive to electricity training and the AMEU/Eskom training working group decided to strive to standardise this training system such that both role players would fall under the same umbrella. Both SETAS were adamant that each would like to retain this function.

On the training board front various attempts were made to persuade the board to alter their point of view to that of unified and standardised training for Eskom and AMEU. To this end a workshop was held on 16 May 2000 with the local government component. The result from the workshop was that it be suggested that an electricity distribution sub-chamber be developed to look after training matters of both Eskom and AMEU. It is suggested that this sub-chamber be answerable to both the relevant SETAS. Once the REDs are in place one of these reporting lines could be severed and the sub-chamber could be retained to enable a much more focussed approach to electricity distribution training.

A report, explaining the above, was put to the Local Government SETA board for their approval and/or comments. Once approval has been obtained a similar report would be put to the Energy SETA and if we are successful the ball would be put into motion to follow the prescribed routes to formally established a combined training systems.

In addition to the above the committee has also looked at the retraining of municipal staff to enable them to function properly within the envisaged new REDs. A training course for councillors are also looked at. This has, however, been shelved until after the election as it is not certain which councillors should be trained at this stage.

2.2 Student Assistance Scheme

Currently five students are being supported. A huge effort is being made to attract and assist previously disadvantaged students and to this extent SALGA has been informed of the scheme in order to assist. It has also been decided to allow the Secretary to cap interests if this should be getting to be excessive.

2.3 The AMEU News

Max Clarke continues to deliver an excellent product and to this end I would like to thank him for the continued huge effort he has put into this paper. He has certainly set an example, which will be very difficult to follow.

As usual Max is urging everybody to send him as many nnews items as the members can. He says there can never be to many to handle.

The committee is looking at ways and means to enhance the image of the AMEU and a discussion was held with Mr Paul Alberts, a renowned photographer and writer. A slide show on the AMEU done by Mr Alberts will be on display at the Mossel Bay Technical Meeting.

3. CONCLUSION

The past year has been an extremely busy and restructive year. To this extent the team of the Publicity and Training Committee must be congratulated for the effort they have put in. I would like to thank the President, At van der Meerwe, Peter Fowles, George Ferreira, Neil Croucher, Paul van Niekerk, Howard Whitehead, Hannes Roos, Max Clarke and Al Fortman for their contributions. Lastly, I would like to thank our General Secretary for his massive contribution and effort he has put into this committee.

Report on the South African Revenue Protection Association (Sarpa)

Peter Fowles

Thank you very much for the opportunity to report back on the activities of the South African Revenue Protection Association (SARPA) over the past year. All of these activities took place under the very able leadership of Deon Louw, who served nearly two years as President of the Association due to the premature resignation of the previous President who left ESKOM to start his own company.


Mr Peter Fowles

CONTENTS

This report back will focus on three areas:

- Our main achievements over the past year;
- The highlights of our 4t' Annual Conference held in Pietenuaritzburg on 31 August and 1 September; and
- Some of the activities we have planned for the next year.

ACHIEVEMENTS

- **Membership**

  The first of our achievements is the slow but steady growth in our membership. We now have

  - o Utility Members
  - o Associate Members
  - o Affiliate Members

  The chairmen of our six active branches report good attendance by members, and many who are not yet members, at branch meetings.

- **Website upgrade**

  I would like to tell you the improvement to our website that has been implemented and managed by SARPA's Secretary, Jean Venter. For those of you who do not already know it, the site can be found at:

  www.sarpa.co.za

  The site is split into four areas:

- The first is 'Announcements' on which relevant notices are posted.
- The second provides a copy of the Association's Constitution, a membership application form and contact details for the members, including members of the Executive Council.
- Then there is a section called 'Resources' which is broken down into:

  - o *Revenue Protection Reference Documents* that contains papers and reports that can be of use to people operating in the revenue protection field.
  - o *The papers* presented at the last SARPA Conference.
  - o *Standards and Legal Resources*, which is a section that contains a number of notices referring to legal issues around revenue protection, legal opinion and case notes, and standards such as NRS 055.
  - o *Reference Material.*

- Finally, it contains links to other relevant websites.

- **Tamper Database**

  Under the 'Reference Material' section of the website we have established a database of some of the methods used to tamper with electricity meters. This database is obviously not comprehensive but it was created with the intention of assisting some of our members, particularly the smaller ones, to be aware of some of the common techniques used in tampering. Access is restricted to members who are provided with passwords by Jean Venter.

- The next achievement is the coming together of **NRS 055: Code of Practice for Revenue Protection**

  A few years ago the founding members of SARPA identified a need for a set of guidelines to assist organisations embarking on revenue protection programmes. The original work of ESKOM was used by the Executive Council as a basis for developing a code of practice and conduct. This draft code was referred to the Electricity Suppliers Liaison Committee who refined the contents and will shortly be issuing them as a National Specification NRS 055.

  I will not be going into any detail but for those of you who are interested, a copy of the third, and final, draft of the document can be viewed on the SARPA website as can a paper on NRS 055 presented by Martin Outram of Port Elizabeth at the recent SARPA Conference.

  Suffice to note that although the code was prepared to establish uniform best practices by electricity suppliers and their contractors, these practices could also be used by other service suppliers.

- **Standard Electricity Supply Bylaws**

  We have provided input for the formulation of the proposed standard electricity supply bylaws, particularly in the areas relevant to revenue protection.

- **Section 11 of the Electricity Act**

  You may remember the work done by SARPA, reported at the Bloemfontein Convention, in proposing amendments to Section 11 of the Electricity Act. This section requires that we give customers 14 days written notice of the disconnection of their electricity service.

  Unfortunately our attempts to amend this portion of the Act, or add regulations to the Act, that would empower electricity suppliers to disconnect an electricity supply immediately and without notice in the event of tampering being detected, have been put on hold for the moment. Whilst the NER approved of the proposed changes, the DME have been sitting on them for some time. We have been advised that the proposals will be incorporated into the new electricity regulatory act currently being drafted.

  In the meantime a warning message has been sent to all members of SARPA suggesting that they ensure that their current electricity supply bylaws allow them to disconnect an electricity service without notice if tampering is detected. Recent High Court cases have shown the value of the bylaws in this respect as Port Elizabeth's bylaws entitle them to summarily disconnect an electricity supply on prima facie evidence of tampering, while those of Durban do not.

  Further details on this matter can be found on the SARPA website.

- **Training**

  SARPA has been involved with the relevant Sector Education and Training Authorities (SETAS) on the provision and standardisation of training material for revenue protection skills.

- **STS Association**

  SARPA has also become involved with the activities of the STS Association that is tasked with the guardianship of the standard transfer specification (STS) for prepayment meter vending.

4TH ANNUAL CONFERENCE

Let me move on to the 4th Annual Conference held in Pietermaritzburg a few weeks ago, and highlight a few observations.

- The conference was attended by more than 170 delegates, which is a significant increase over the previous conference attendance.
- There were more Local Government politicians, treasury and water people than we have had before at our conferences, which could indicate an increasing awareness of the problems facing them and an encouraging interest in the activities of SARPA.
- We were treated to a very impressive keynote address by Councillor Ben Mokoena, Mayor of Middelburg. He gave us an overview of the factors in Middelburg's success in tackling their debt arrears situation and receiving the national Masakhane Award for 1999. Crucial to this success in his opinion was the acceptance by politicians that some unpopular decisions need to be taken and the close cooperation between politicians and officials. Councillor Mokoena's presentation contained some powerful messages that are deserving of a wider audience.
- A presentation by a representative from the Department of Provincial and Local Government indicated that the combined Local Government 60 day and over debt has increased to a staggering R16 billion as at June 2000. This figure of course does not include an estimate of non-technical losses.
- Conference elected a new President, Peter Fowles, and a new President-Elect, Dewalt Smit of GJMC.
- The term of office for these office bearers was extended to two years by an amendment of the Constitution.

PLANNED ACTIVITIES

- At the Executive Council meeting at Hartenbos in March we spent a few hours asking ourselves what should the mission and role of SARPA be. We have planned a one-day session for 13 October to put some meat to this work and to talk about the form that SARPA may take in a restructured electricity distribution industry.
- Over the last year, Deon Louw has presented papers at two conferences held in African countries to the north of our borders, one in Tanzania in October 1999, and the other in Kenya in June of this year. These have stimulated a lot of interest in the activities of SARPA as these countries struggle with the problem of an estimated 35% non-technical losses.

  Deon Louw was subsequently asked to assist in formulating an Affican Revenue Protection Association (ARPA), and so with SARPA, ESKOM and our own Councils' financial support, he and I will be attending the East African Power Industries Convention in Kampala, Uganda from 16-18 October 2000 and will host the inaugural meeting of ARPA on 19 October 2000.

- We hope to be holding the 5th Annual Conference in Middelburg during August 2001.

Pricing study for South Cape Karoo Electricity Distributor

Hendrik Barnard

1. INTRODUCTION

The Southern Cape Karoo Electricity Forum (SCKEF), for short the Forum, has been focussing its efforts over the past 8 years at forming a RED (Regional Electricity Distributor) which will truly fulfil the objectives set by Government in terms of:

- The Constitution which provides for Local Government (LG) to provide electricity supply.
- The Minerals and Energy Policy White Paper which calls for the maximum number of financially viable RED,s.
- Various other legislation which places various responsibilities and accountabilities on Local Government, but requires effective and viable Local Government in South Africa.

The Forum has applied to the NER for a licence to supply, which was granted conditionally. These conditions have been met as far as is possible. A RED company has been formed and various formalities are now being put in place to start taking over electricity supply in the region.

The LG's which are involved are as follows:

Nr	Existing LG's		New LG's
1	Uniondale	1	Southern Cape Distr Cnl
2	Ladismith	2	Ladismith/Calitzdorp LG
3	Calitzdorp	2	
4	Laingsburg	3	Laingsburg LG
5	Riversdale	4	Langeberg LG
6	Albertinia	4	
7	Stilbaai	4	
8	Heidelberg	4	
9	Plettenberg Bay	5	Plettenberg Bay LG
10	Beaufort West	6	Beaufort West LG
11	Knysna	7	Knysna LG
12	Sedgefield	7	
13	Oudtshoorn	8	Oudtshoorn LG
14	Deysselsdorp	8	
15	De Rust	8	
16	Mosselbaai	9	Mosselbaai LG
17	Grootbrakrivier	9	
18	George	10	George LG
19	Murraysburg	11	Central Karoo Distr Cnl
20	Prince Albert	12	Prins Albert LG

2. BACKGROUND

The Forum has set objectives to apply practices in terms of costing and pricing, which are in line with practices followed by top electricity utilities in the world.

US-AID has made funds available to support practices which will support the democratic rights and obligations of Local Government in South Africa. A project has been approved whereby such funds can be used to undertake an extensive study to complete a detailed pricing study for the region. The scope of the study is as follows:

Mr Hendrik Barnard

- Set clear pricing principles to guide the process.
- Develop accurately ringfenced statements for each electricity department.
- Develop detailed pricing policy for the region.
- Undertake detailed Cost of Supply study.
- Develop a set of regional electricity tariffs for each LG.

The objective of these analysis is to obtain a set of tariffs that can be applied in the newly formed LG's and in each LG, the moment the RED becomes operational.

The full study and details will contain a couple of hundred pages. This paper contains some of the highlights of the study as it stands at the moment. The final high level results will be made available to all members of the AMEU when completed.

3. RINGFENCING

The primary focus for ringfencing is to ensure that charges and cost allocations between the Local Government (LG) and the electricity department are fair and transparent.

Currently LG's earn a substantial part of their revenue income in electricity departments in the form of surpluses. The transparent surplus figures published, are usually far from the true surplus burden being placed on the electricity departments. If electricity is removed from LG's, its income from surpluses will be replaced with a transparent tax by way of a levy based on sales. It is therefore essential that the electricity departments be ringfenced so that:

- the true surplus burden is known,
- incorrect decisions are not made when efficiency of LG electricity departments and Eskom distribution is compared,

- tariffs are based on correct costs without surpluses.
- LG's are not affected negatively if the electricity departments are transferred out of LG's and surpluses are replaced by a transparent LG tax,
- LG's will be in a position to apply the tax selectively when drawing large enterprises to their respective area.

The exercise of ringfencing has nothing to do with questioning the current or future practice of LG's to tax electricity (generate a surplus), but to state the true surplus as accurate as possible to ensure that a breakaway from direct LG control does not effect the LG negatively.

3.1. Key focus areas

There are a number of practices which affect the accuracy of the cost and revenue of LG electricity departments. The following ones are the most important:

Services supplied by the electricity departments to the rest of the LG where no refund is made or where the refund does not cover the cost of supplying such service. The services involved here include inter alia the following: Electrical maintenance of LG facilities such as water works, sewerage works, buildings and houses.

Electricity department equipment and other resources used by the rest of the LG with no or inadequate refund. This typically includes heavy vehicles, large machinery and meter readers.

Public lighting, including streetlights, high mast lights, robots and parking lot lights. This service is considered a LG service and not part of electricity supply. The costs and charges involved are the following:

- Capital cost to erect the streetlights. In many cases this is provided by the developer involved or is actually paid for by the LG. In some cases however this is financed by the electricity department and forms part of the electricity assets. In most cases there is no charge to the LG to cover the capital costs.
- Operating costs to maintain the lights. This includes the repair and maintenance of the structures and replacement of the globes. Many electricity departments have tariffs to recover this cost from the LG, but in most cases there is an under-recovery.
- The energy supplied to the lights are usually recovered from the LG by way of an energy charge. In some cases this charge is totally inadequate and in some cases it is slightly overstated.
- The use of the electricity network. The lights use electricity and also place a burden on the network. A fair payment towards the use of the network has to be charged at cost, as calculated in the cost of supply study.

Electricity tariffs for own consumption by LG. Many LG's have a different set of tariffs for the supply of electricity for use by its own facilities, such as municipal buildings, stores, sewerage supplies, water pumping and sometimes also for staff. If these tariffs are not cost reflective it distorts the true electricity supply cost/revenue and thus surplus. In some cases an overcharge is made to the LG in the tariff and in other cases an undercharge.

Services provided to the electricity department by the LG. Typical services include the following: Meter reading and billing, revenue collection, general accounting and administration, telephones and stores. The extent to which this is done, differs significantly between various LG's. The main problem is to determine a fair means of allocation to the electricity departments:

- Administration and overheads are often allocated in terms of revenue instead of more realistic allocation factors, such as the number of staff, the own costs and area of office space. The problem with this practice is that the major portion of the revenue is received by the trading services, ie electricity and water. This revenue overstates the true share of the cost by the electricity department by more than 50%.
- Meter reading data capture and billing costs should typically be allocated according to the share of the cost of the billing system, the number of transactions or actual processing time. Using the revenue of the respective service as a basis for cost allocation, an unfair burden is placed on the electricity department which has high revenue.
- A wide range of other methods are used to allocate the other costs. There are internationally accepted methods which would result in a fair burden on the electricity department.

Use of internal LG loan funds also needs to be analysed. Specific reference is made to the "consolidated loans fund". The realities about this practice are as follows:

- These funds have been built up over a period of years from various sources generally not electricity related.
- Each department borrows money from this fund at an interest rate normally below the market rate.
- The electricity Department should borrow money at a market interest rate.
- Capital contributions made for electricity which have been allocated to the consolidated loans fund should be deducted from the other electricity department loans.

3.2. Generic methodology described

Ringfencing is a relatively new concept and therefore it is appropriate to give a quick description of what is meant by this in respect of the study for the Forum.

Ringfencing can be described as the process of determining the true costs and revenues for the electricity departments in LG's.

What this reflects is the best possible representation of what the electricity departments would have looked like if all costs and revenues in the organisation were charged out, based on actual usage by the electricity departments with provision for a fair return. If these businesses should be privatised, the ringfenced statements should represent their financial position.

The methodology to be used can be described as follows:

- Determine direct costs incurred by the electricity departments.
- Determine indirect and overhead costs applicable to the electricity departments.
- Determine possible cost allocation factors for each of the costs and revenues to be allocated.
- Assign a cost allocation factor to each indirect / overhead cost category.
- Obtain details of cost allocation factor quantities such as number of staff and computers.
- Group the basic information into usable cost categories.
- Allocate all costs and revenues based on the allocation factors.
- Adjust the surplus so that the net income of the LG remains the same.

3.3. Summary

The ringfencing methodology describes the process to be followed to obtain a true set of financial statements for the electricity departments. Various changes are made each of which will effect the cost of supply and in some cases the surplus. The adjustments to be made are summarised below:

Aspect	Treatment
• Undercharged services provided to LG.	Increased surplus.
• Undercharge on public lighting service.	Increased surplus.
• Undercharge on LG own electricity use.	Increased surplus.
• Overcharge on LG services to electricity.	Increased surplus.
• Undercharge on interest on LG internal loans.	Decreased surplus.
• Capital contribution transfers to LG funds.	Increased surplus.

The adjustments could result in an increase or decrease of the surplus depending on circumstances.

Some of the preliminary results are summarised below:

Services provided to LG.

- Most electricity departments charge for the materials used only, no allocation is made for labour and transport.
- Adjustments required range from 1% to 25% of the electricity department labour and transport budget.

Public lighting service.

- Most electricity departments charge the average purchase cost to reflect the energy cost, some does not charge out the energy.
- Some electricity departments charge for materials used but not one charges out the cost of labour and transport.
- Adjustments required range from 1% to 20% of the electricity department labour and transport budget.

LG own electricity use.

- Most electricity departments do charge out the energy used for LG departments' own use.
- Some apply a standard tariff which would require the surplus to be reduced by some 2% where others charge a very low rate, which requires the surplus to be increased by as much as 5%.

LG services to electricity.

- Many LG's apply a fair practice of admin allocation.
- The allocation to electricity as % of total admin allocation range from 5% to 65%.
- The allocation to electricity as % of sales range from 3% to 24%.
- The allocation to electricity as % of electricity department cost (excluding purchases) range from 5% to 40%.
- The allocation to electricity expressed as a cost per customer range from R3 to R18 per customer per month.

Interest on LG internal loans.

- Most LG charge an interest rate close to the market related interest minus risk.
- Capital transfers to the capital development fund was only found in one case.
- Many LG's however charge an interest rate far below the market rate.

3.4. Conclusion

By using the proposed methodology a set of ringfenced statements will be created that can be used as the basis of true cost, revenue and surplus for LG's and electricity departments which in turn can be used as the basis for undertaking a detailed Cost of Supply study and thus cost reflective tariffs for a new RED.

In general indications are that the surpluses will not increase by more than 5%. What is however of critical importance is that even if the surplus is calculated fairly, and is replaced with a transparent LG tax, LG will loose almost the full extent of the administration allocation which would add a further approximate 5% to the impact on LG if electricity is taken away from LG.

4. PRICING POLICY

The Minerals and Energy Policy White Paper clearly states the pricing policy to be applied in South Africa:

"Regional distributors will establish cost reflective tariffs for each major customer segment."

The following policy statements sets the pricing policy to be applied in the RED:

Same tariff structures. One set of tariff structures will be applicable throughout the RED area. This is required to simplify tariff making and implementation and because costs would be based on the same cost of supply methodology.

Same tariff levels. The tariff levels per customer category must eventually become the same in the RED. A phase in period will be required where tariff levels are initially set per LG area to reflect the very different standards and practices of each area.

Number of tariff categories. An adequate number of tariff categories need to be catered for to minimise the extent of cross-subsidy between different customer categories. This is required to ensure equity between customers but also to ensure that costs do not spiral upwards because of customers' behaviour to an unfair average.

National set of life line tariffs. One set of tariff structures, levels, connection fees and standards will probably be enforced for the RED to qualify for national electrification fund money.

Future electrification capital. The life line tariffs proposed for electrification customers require extensive cross-subsidy. It is proposed that the capital costs requiring subsidy be financed from a transparent mechanism outside of the RED whether it be a Government budget provision or a industry levy.

Operating shortfalls created by life line tariffs. The life line tariffs proposed do not even recover the operating costs at very low consumption levels. This shortfall will be recovered from the whole customer base in the RED and not from the residential customer base alone.

Return on assets of subsidised customers. Where any particular customer category receives a contribution, cross-subsidy from outside of the RED or from another customer category such assets should not be granted the standard Return On Asset (ROA) or depreciation allowance.

Networks financed by customers. Where customers finance networks directly or indirectly but outside of the tariff by connection fees, contributions by developers, extension charges etc, these assets will carry no depreciation or ROA. Future refurbishment cost can be provided for in future tariffs.

Past and future practices. Past and future practices must be provided for. This is to remain customer focussed thereby providing for different standards required by customers but also to cater for different financing practices.

Cost of supply methodology and studies. The RED must have a detailed cost of supply methodology approved by the NER and a system which will be used on a regular basis to determine the true cost of supply. Costs should be ringfenced per LG area.

LG tax provision. If a LG tax is to be applied it should be a separate surcharge on the tariff and should not be shown as part of the electricity supply costs or tariffs.

4.1. Cross-subsidisation.

The policy set in the White Paper clearly stipulates that cost reflective charges should be levied. It does however talk about cross-subsidisation of residential customers. It is a reality that cross-subsidisation will continue in the RED for some time. The following statements propose how these should be covered:

- Where cost of supply studies indicate that cross-subsidies exist, these should be addressed by either formulating official cross-subsidisation policies or by removing them.
- Large socio economic cross subsidies should preferably be financed by National Government. Such subsidisation should cover part or all of the capital costs.
- Cross-subsidisation of operating costs should be avoided as far as possible.
- Tariff structures should be set in a way that the cross-subsidies disappear as the need therefore disappears.
- To past electrification customers who's debt is carried by the RED will present the largest need for cross-subsidy in the RED.
- Deliberate cross-subsidies with significant impact should not be entertained between LG areas.
- Any cross-subsidy applied should be clearly shown in the COS analysis and tariff documentation.

4.2. Load profile categorisation

The way in which customers are categorised have a major impact on the extent of cross-subsidisation that takes place between different customer categories in terms of load profiles and locations on the networks specifically. Where tariffs feature TOU rates in respect of energy and demand costs, there is no need to categorise tariffs according to load profiles. Where single charges are applied for all time periods customers have to be classified in terms of load profiles. The following is therefore proposed in this respect: (See Analysis 1.)

Although the extent of load profiles available is limited, customers can be categorised into the above profiles by considering the load factors and types of business of the customer.

4.3. Supply and metering type categorisation

Further to this customers have to be categorised in terms of size of supply and type of meters. The following is proposed in this respect: (See Analysis 2 and 3.)

4.4. Tariff structures

Now that all the cost components are known and customer categories have been identified, tariffs can be developed. The key factors that have to be considered when developing tariff structures are as follows:

- The needs and ability of customers to manage and respond to more sophisticated tariffs.
- The cost, availability, manageability of metering.
- The customers' ability to understand the tariff structures.

Analysis 1

PROFILE NAME	LOAD FACTOR	APPLICATION
Night use	>105%	Significant more use in off-peak times.
Alltime	>90%	Large manufacturing 7 days, 24 hours.
All days	>70& =90%	Large industrial 7 days, 12 hours operations.
Long day	=70% >45%	Industrial/farming/commercial applications 5 days, 24 hours.
Weekday	=45%	Industrial/commercial/farming applications 5 days 9 hours.
Res/high use	=50%	High usage residential > 300 kWh/m.
Res/geyser control	=30%	High usage residential with geyser control > 600 kWh/m.
Res/TOU	=30%	High usage residential with TOU tariff > 1000 kWh/m.
Res/low use	=30%	Very low usage residential customers < 300 kWh/m.
Light/ day-night	<100%	Public lights constant load 24 hours at night.
Light/All-night	<50%	Public lights constant load 12 hours at night.

Analysis 2

CLASS	FEATURES	OTHER
Class 1	1 Ø kWh	Pre-paid
Class 1	1 Ø kWh	Conventional
Class 1	3 Ø kWh	
Class 1	3 Ø kWh	& ct's
Class 1	3 Ø MD	& ct's
Class 1	3 Ø TOU	& ct's
Class 2	Main & check	& ct's
Class 2	Metering Installation.	& ct's

Analysis 3

SIZE	KVA
Small	50 kVa
Medium	100 kVa
Large	1000 kVa
Very large	>1000 kVa

- Any other socio-political needs that have to be addressed.
- The possible impact on the utility costs.

Based on the above the following tariff structures are recommended: (See Analysis 4.)

4.5. Application of tariff structures

(See Analysis 5.)

All tariff should not be applied to all customers although theoretically it should be available to all customers. The table below recommends which tariffs should be available for different customer categories.

4.6. Public lighting tariffs

Public lighting is a public service provided to the LG or other users. It refers to supplies to applications where the consumption is for the general public generally but importantly the loads are constant during particular periods of the day. It may include the following types of applications: Streetlights, high mast lights, traffic lights, billboard lights and parking area lights.

The typical tariff for public lighting is set out in the table below. It clearly indicates the fixed charge to cover fixed costs such as capital, operating and maintenance etc. plus the cost of the energy.

(See Analysis 6.)

The load profiles have to be determined based on the system used to schedule the lights such as a remote control system, timers or light sensitive switches.

4.7. Residential tariffs

Residential tariffs are highly politically sensitive. A lot of work and debate has taken place on this issue. The White paper says the following in this respect:

"A suit of supply options with progressive capacity differentiated tariffs and connection fees are available to domestic customers"

Analysis 4

Tariff structures

TARIFF STRUCTURE NAME	FIXED Rand/ cust/m	FIXED Rand/ POD/m	ENERGY c/kWh All	ENERGY TOU c/kWh O	ENERGY TOU (Low and high season) S	ENERGY TOU P	ENERGY TOU SP	CAPACITY r/kVA All	CAPACITY P	CAPACITY S	CAPACITY O
12 Part TOU	1	1		2	2	2	1		1	1	1
8 Part TOU		1		2	2	2		1			
3 Part Demand		1	1					1			
2 Part		1	1								
1 Part energy			1								
1 Part fixed		1									

Analysis 5

Application for tariff structures

	CUSTOMER CATEGORIES				
Load profile category	All	All	All	Resident	Public light
Customer category	Not Res	Not Res	All	Resident	Public light
Metering type	TOU	MD	kWh	kWh	None
Size	>500 kVA	<500 kVA >100 kVA	<100 kVA	<13 kVA	<100 kVA
TARIFF STRUCTURE					
12 Part TOU	X				
8 Part TOU			X		
3 Part Demand		X			
2 Part			X		X
1 Part energy				X	
1 Part fixed					X

Analysis 6

Public lights

Metering type					
			Whole day	Whole night	Whole night
Energy	Measured	c/kWh	16	10	13
	Unmeasured	R/kVA/m	117	37	24
Network		r/kVA/m	12	12	12
Maintenance	Streetlight	R/light/m		10	
	High mast	R/light/m		150	
	Traffic lights	R/light/m		20	

The table below indicates the basis from where tariffs will be developed. (The rates are indicative.) (See Analysis 7.)

Analysis 7

Residential tariffs and charges

Capacity		Connection fees	R/m	c/kWh	Consumption	Typical application
				P = 40 S = 22		
1	60 A 3 phase	Full cost	R120	0 = 13	>1500 kWh/m	Upper / flexible
2	60 A 3 phase	Full cost	R120	21.5	>1500 kWh/m	Upper market
3	60 A 1 phase	Full cost	R80	21.5	>1000 kWh/m	Established high use
4	40 A 1 phase	R 1 000	R60	21.5	>600 kWh/m	Established
5	20 A 1 phase	R300	R40	21.5	>300 kWh/m	Upcoming
6	20 A 1 phase	R300		31	>300 kWh/m	Electrification / poor
7	8 A 1 phase	R50		31	>300 kWh/m	Poor / remote
8	Solar 100 W	R50	R30		>20 kWh/m	Poor / very remote

4.8. Geyser control

More innovative strategies should be applied in managing geysers:

- Some differentiation needs to be applied in the tariffs to customers who's geysers are being managed remotely by the utility as indicated in the table below.
- The price adjustments should be for one geyser being adjusted per house. A second geyser can be managed at half the discounts stated in the table.
- These indicative rates assumes the distributor will finance and manage the system.
- Customers should be allowed to select the option which will be best suit them but cannot change more than once per year.
- The distributor will manage the load according to the set limits to achieve the targeted savings.
- Any person who is found guilty of tampering his geyser control switch will at least pay the cost of a call out plus the discount granted for the last year.

The table below gives an indication of how differentiation can be done for different geysers.

GEYSER CONTROL DIFFERENTIATION (per 3 kW)

Option	Continuous control duration	Fixed charge adjustment	Energy charge discount
1	Half an hour	+R7-R10 = -R3/m	0.5 c/kWh
2	1 hour	+R7-R12 = -R5/m	1 c/kWh
3	1.5 hours	+R7-R14 = -R7/m	2 c/kWh
4	2 hours	+R7-R16 = -R9/m	3 c/kWh
5	2.5 hours	+R7-R18 = -R11/m	4 c/kWh
4	2 hours	+R7-R20 = -R13/m	5 c/kWh
5	3 hours	+R7-R22 = -R15/m	6 c/kWh

4.9. Capital charges/contributions and cost sharing

One of the subjects which are least described and understood by customers, utilities and government relate to the issue of how much of the capital costs should be paid for when a new customer is connected and how much should be covered in the tariff. This is an essential issue to address specifically, because different practices in this respect will have a major impact on creating differences in tariff levels between the different areas. The high level strategy to be applied in this respect is summarised in the Table on the next page. (This table reflecting the policy still need extensive debate.)

AREA	Increm. / Exist.	Normal residential	Electrification	Commercial / industrial	Rural
Network:					
Distribution circuits	All	Tariff	Tariff	Tariff	Tariff
Distribution/ reticulation transformation:	Existing	Previous contributions	Previous contributions	Previous contributions	Previous contributions
Distribution/ reticulation transformation:	New	Developers	Electrification fund	Contribution/ developer	Contribution
Reticulation circuits:	Existing	Previous developer	NA	Contribution/ developer	Contribution/ rental/shared
Reticulation circuits:	New	Developer	Electrification fund	Contribution/ developer	Contribution/ rental/shared
Reticulation/ LV transformation:	Existing	NA	NA	Contribution	Tariff
Reticulation/ LV transformation:	New	Developer	Electrification fund	Contribution	Tariff
LV circuit:	Existing	NA	NA	NA	Contribution
LV circuit:	New	Developer	Electrification fund	Contribution	Contribution
Service connection		Connection fee	Electrification fund & connection fee	Contribution & connection fee	Contribution & connection fee

4.10. Pricing Policy Conclusions

This policy addresses all the key issues that need to be addressed in a pricing policy of a distributor. It will form a good basis from where to start the debate with all the stakeholders.

5. COST OF SUPPLY (COS) ANALYSIS

The pricing objectives are to set costs reflective tariffs. This is only possible if costs can be analysed properly according to a standardised COS methodology.

The way in which costs of supply analysis has a major impact on understanding the profitability of different parts of the business and this will guide how tariffs are set. It is therefore essential that the methodology complies with high level principles set. The principles which should guide the key strategies are.

- The methodology must support and make it possible to apply the pricing policy that has been set for the distributor.
- The cost-of-supply methodology must ensure that there is no discrimination between customer categories by creating an appropriate number of cost and customer categories.
- The COS methodology should determine the cost per customer category, reflecting the contribution to the cost of the system.
- The calculation, allocation and apportionment of costs to different types of customers should be done on a fair and rational basis, to ensure equity in the price level between customers.
- Distribution cost pools must be created at least per Local Government (LG) area or the smallest depot in a distributor.
- Tariff categories ideally should at least cater for supply at different positions in the network, generic usage profiles and size of supply.
- Recognition must be given to past practices, including cash payments or other contributions in calculated costs.
- The total cost should be equal to those in the budget or annual financial statements plus allocated costs in both instances.

5.1. COST BASIS

The COS methodology focuses on costs as seen from a customer perspective. The methodology supports cost analysis using Long Run Marginal Costs (LRMC). The dilemma is that there are so many definitions for LRMC and they all differ to a certain extent. The definition of LRMC used in this methodology is as follows:

The LRMC of supplying electricity to a customer, is the cost of delivering one more kWh of energy or kVA of demand, or to connect and serve one more Point Of Delivery (POD) in the network. It refers to the structure and level of costs which best reflect the long term trend of these costs over the life of the assets and thereafter.

This definition could possible be too difficult to implement. This methodology proposes a practical application to achieve the same results which are intended by this definition. The statements below indicate what costs should be used as basis to approximate the LRMC:

- **Purchase costs** - Use the purchase tariff applied from the generators supplying the distributor, plus any transmission wheeling costs. This means the following:
  - At the moment it would be Megaflex for power provided by Eskom at standard tariff. Nightsave is generally be more expensive and is only applied where LG's take rural supplies.
- **Network capital costs** - The actual capital costs will not be applied but the provisions normally made in the budget for the creation of assets. This provision is referred to as the revenue requirement in respect of capital.
  - The revenue requirement replacement cost of existing assets should be used as an approximation for LRMC.
  - The revenue requirement value should be calculated by the sum of the depreciation on current cost, using the effective economic life of the asset, plus a real rate of return on assets equal to the real return required by the owner and approved by the regulator.
  - Where very large projects are being planned in the near future which will change the cost structure and level drastically, adjustments should be made to cost levels and structures to reflect this long term trend.
  - The provision for capital calculated from all the capital components of the network need to be balanced with the budget provision therefore. This will include:
    - Where fund accounting is used: the interest and redemption of loans and the capital which will be financed directly from income as are provided for in the budget.
    - Where depreciation accounting is used: the depreciation and return on assets provided in the budget.
- **Support costs** - This refers to the operations, maintenance, administration and any other costs involved in running the network and providing the required services associated therewith.
  - The best representation of LRMC is to use the costs in the current budgeted income statement. To estimate the long term trend is rather difficult and risky.
  - Where there are specific existing distortions or very large future changes such as customer mixes, these changes could be incorporated in calculating the final costs.
  - The support costs will include some small capital components, such as computers and other production equipment. As with network capital, the capital provision should be included and not the total capital cost.

5.2. Cost classification

There are various types of costs which have to be categorised and allocated in different ways. The objective is to express the costs in a way that will reflect the behaviour of the costs, so that tariffs which are based on these costs will:

- Be cost reflective in terms of reflecting the behaviour of the costs.
- Give the correct signal to the customer so that his behaviour can minimise his and the distributor's cost.

The following categories of costs which affect the costs of supplying a customer have been identified and all costs will be allocated to one of these as illustrated below:

Cost allocations

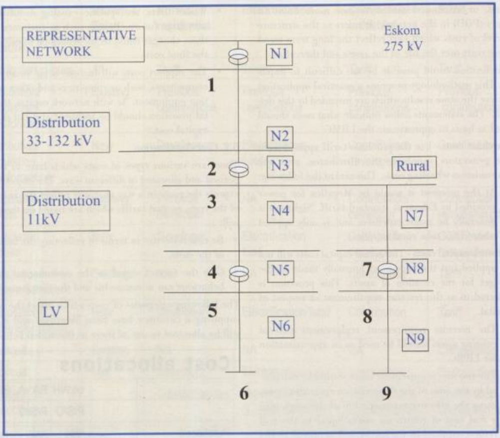
		c/kWH	R/kVA	R/cust
		P/S/O	P/S/O	
Purchases		yes	yes	no
Network costs				
	Capital	no	yes	yes
	Support	no	yes	yes
Customer services		no	no	yes

P - Peak; S - Standard; O - Off-peak.

5.3. Representative network

It is obvious that the COS cannot be calculated for every position where a customer takes supply from. The methodology proposes that the whole electrical network of the distributor/depot/LG be represented by means of a new very simplified network which will show all the generic network segments and supply positions. It is essential that this network has enough segments to allow the required differentiation in costs and in the tariffs. The less categories that are created, the more pooling and thus cross-subsidisation will occur.

The representative network has to differentiate between all the different components of network and supply positions required to set differentiated tariffs. If a simplification has been done, it will not be possible to later set different tariffs for that same category of network. The representative network diagram below will be created for every LG area.



The following should be noted in terms of assumptions used to construct this diagram:

Networks must be clearly split between circuits and transformation equipment.

- Circuits include the following:
  - All power cables and lines which include the structures plus conductors. The design, planning, materials, labour, contracts, transport and all direct costs should be included.
  - Servitudes, voltage boosters, line breakers, t-switches, line isolaters and all equipment relating to transfer of power between different points at the same voltage.
- Transformation includes the following:
  - All equipment relating to transferring power from one voltage level to the next.
  - This includes the servitudes, and sites, transformers, breakers and isolaters, switches, protection, telecommunications and wiring. Mini substations will be treated as a single unit although a T-switch also resides in the substation.

It is understood that in some cases the asset register or other registers do not split the costs exactly as is described. For example HV line equipment is usually listed together with the substations. This should not make a material difference to the cost per customer.

Networks have to be separated clearly according to different voltages for example.

- Transmission voltages: 220 kV to 765 kV.
- Sub-transmission/Distribution (HV): 33 kV to 132 kV
- Reticulation (MV): 3.3 kV to 22 kV
- Low voltage (LV): less than 1000 V

A lot of arguments were created in this respect. This methodology strongly proposes that the costs not be further differentiated and definitely that tariffs not be differentiated between voltages within a particular voltage grouping.

The representative network diagram has to show the following:

- A network element for every network component and these are to be called N(0) to N(N).
- Customer supply positions on the network where customers could possibly take a supply from have to be specified as S(0) to S(N).

What should be clear from this diagram is that despite a lot of simplification there is significant allowance for differentiation of tariffs where cost differences are significant. Unfortunately the information which is usually available does not allow distributors to have the extent of differentiation which they would typically like to apply.

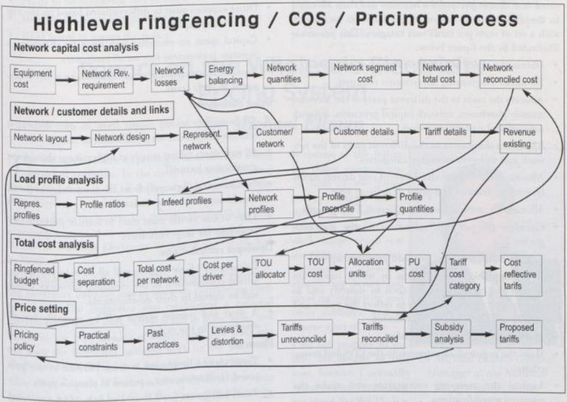
This may require distributors to do a next round of analysis after they have improved the level of detailed information recorded for all equipment and customers.

This is a very important issue that could have a major effect on the cross-subsidies which are incurred between areas and customers. Where at all possible, even more categories can be created. The differences in unit costs can then be compared and networks be re-grouped based on the size of the differences.

5.4. High level methodology

This section describes at a high level the COS process as is illustrated in the figure below.

Five main processes have been identified:



Network capital cost analysis: This is the process by which the capital provision for every component of the network and for every supply point on the network is calculated which involves the following processes:

- Identify all possible types of equipment used in the network. These are to be grouped logically.
- Determine the replacement value of each for a distributor.
- Determine the revenue requirement replacement cost per item.
- Determine the quantities of equipment for each network segment.
- Calculate the total revenue requirement replacement value for each network segment.
- Calculate the total revenue requirement costs as at every supply position.
- Normalise the estimate for capital costs to the provision in the budget.

Network layout and customer details: This is the process by which the network is transformed to a representative network and then the required details of customers have to be linked to the relevant points on this network.

- Design a representative network diagram.
- Link the groups of customers and individual large customers to every supply position on the network.
- Allocate a consumption and size classification to each customer.
- Calculate the total infeed data for every network supply point namely: kWh, kVA and POD's per load profile category.

Load flow and profile analysis: This is the process by which representative customer demand profiles are used together with customer details and network details to calculate a profile of every network to be able to know what units to use in determining unit charges.

- Obtain representative load profiles for all distributors to be involved in the study.
- Calculate the representative load profile ratios.
- Multiply the infeed quantities with the representative load profile ratio's to obtain the infeed profiles.

- Add the loads from outflow networks to the infeed quantities plus the losses to determine the load profile through each network.
- Calculate the key quantities for the load through each network segment.

Total cost analysis: This is the process by which the budget costs of the distributor are firstly ringfenced, then allocated to different parts of the business and then allocated to the different cost drivers in the business, to end up with a set of costs per tariff cost category. This process is illustrated by the figure below.

- Obtain the ringfenced budget for the distributor.
- Do minor ringfencing adjustments required.
- Allocate the costs to the different parts of the business namely purchases, network capital provision, network support and customer services.
- Apportion these costs to the different parts of the network and different customer categories.
- Allocate these costs to the different cost drivers namely; energy, demand and point of delivery type.
- Allocate the network costs to different TOU periods.
- Calculate the per unit values for all the cost categories.
- Calculate effective costs per load profile category.

Price setting: This is the process by which inputs are given into the costing process, then to simplify and to change the cost reflective tariffs to reflect the policy and constraints applicable in the distributor.

- Analyse the current pricing policy.
- Make the required adjustments to the COS and reconciliate.
- Analyse the metering constraints and make the required simplifications.
- Analyse the proposed pricing policy and make the required changes.
- Develop a full set of tariffs to represent the pricing policy.
- Analyse the current tariff and compare with the proposed cost reflective tariffs.

5.5. COS conclusions

Undertaking a COS study for a distributor is an extensive process. A lot of information and systems need to be in place for the results to be accurate enough to be able to base tariffs on these costs.

Every distributor will also have to create representative networks and depots to address the dynamics of the customers, networks and loads in its area of supply. Such a study must involve the staff throughout to obtain relevant inputs and to ensure that they will also gather value therefrom.

6. TARIFFS

The tariffs have not yet been developed for each LG area. The preliminary results from the COS analysis and the set pricing policy indicates that the following tariff changes will have to be made:

Residential tariffs:

- The single energy rate tariff without a fixed charge (life line tariff) should not be made available to any customer taking a supply above 20 Amps.
- Other supplies must be differentiated based on the circuit breaker capacity.
- Capital spent on electrification must be shown as a separate transparent levy on all customers.
- Customers with geyser control must enjoy a direct discount in their tariff.

Other customers:

- All customers taking supply from its own dedicated transformer should see a reduction in tariff.
- All customers taking supply at high voltage should see a reduction in tariff.
- Customers taking supply from the low voltage network should see an increase in tariff.
- Time of Use tariffs must start to feature prominently especially for large customers.

Developer contributions:

- Private and LG developers will all have to pay a consistant contribution to the electrical networks which will be shared by their developments.
- A clear and concise system will be available for all developers in the region.

Phase in:

- Tariff should be phased in from current to the proposed tariff levels over a period of about 5 years.
- Tariff will be set per LG area and should be targeted to be set per RED over a period of five years provided the required practices are applied.

Levies and taxes:

- LG tax will be a surcharge on the tariff to customers in its area of jurisdiction.
- Electrification and other cross-subsidies will be shown as transparent charges.

7. CONCLUSIONS

This pricing study is certainly different in approach to the one being proposed by Government Consultants. The study features the following:

- Clearly identifies surpluses & allocation impact on LG's.
- This approach is by consensus of the involved LG's.
- All LG's agree to the ringfencing statements.
- These statements used as a basis for the new RED.
- This used as basis for service agreements with each LG.
- One set of tariff structures address needs of all LG's.

- All loopholes for overcharging and unnecessary undercharging covered.
- Supports government objectives for efficiency and effectiveness.
- Supports pricing in RED's and existing suppliers.

The next steps in the process are as follows:

- Study to be completed end October.
- Individual LG's to accept their figures.
- RED board to accept the policy.
- Implementation as soon as the date of implementation of new LG's.
- Results available for other LG's.

This cryptic overview of the pricing study in the South Cape should illustrate that LG is serious about fulfilling its obligation as efficient electricity suppliers in a RED which it has full and effective control over. It plans to use their resources more effectively and to ensure that their RED will meet the needs of their people to the satisfaction of the NE

Report on the Wholesale Electricity Pricing System

Dr Michael Ellman

The wholesale electricity pricing system has had a long period of gestation. In the early 1990's the National Electricity Forum or NELF deliberated on the state of the electricity supply industry in South Africa, and amongst others came to the conclusion that the playing fields were extremely uneven. As a result of the recommendations of NELF the National Electricity Regulator was established in 1995.

The first actions of the NER were to licence all players in the electricity industry and to insist on ringfencing their businesses. The Regulator also established a national interim tariff frame work, which is still in place today and which we are busy looking at for revision, and lastly but not least the Regulator initiated work on the wholesale electricity tariff (WET) as it was called at that time.

After all these years of work, mainly by ESKOM, and some assistance we've also had from the Norwegian Electricity Regulator, we are finely reaching the stage where we are now ready to start running pilot projects.

The wholesale electricity pricing system is based on four principals.

Firstly, the principal of transparency. This tariff, or rather the components of this tariff, must be transparent to all the consumers who purchase electricity at this tariff, and that means that the components need to be unbundled, and separated from one another.

The second principal is that of cost reflectiveness. The tariff components must reflect the underline cost of supplying electricity to customers, and that includes ideographic differentiation.

The third principal is the principal of affordability. Unfortunately, cost reflectiveness and affordability work in opposite directions, and one of the major problems which we still have is that cost reflectiveness or increasing cost reflectiveness may lead to problems of affordability.

The final principal is that of customer choice.

On that basis the structure of the WETS is as follows:

Dr Michael Ellman General Manager at the National Electricity Regulator

It consist of the following major components. At time of use based energy charge, which consist of six individual tariffs, a wire or network charge, which consist of four components, customers services charge any levies and taxes on electricity and cross subsidies, and of course a set of rules.

I do not propose to go into the details of this year, because I normally spend several hours talking about the WETS. It is already a tall order to tell you about the WETS in 10 minutes, but I'd like to dwell on some of the problems that are still outstanding.

The first of these is the question of ideographic differentiation. This map shows you the present situation in South Africa - in a ring with a radius of about 300 km. The question of an ideographic differentiation this particular proposal has to be decided on as a matter of policy by Government, but if Government does accept this proposal, then we would propose to phase it in over a period of five years from the existing system to the new system.

A second area of contention has to do with levies, taxes and cross subsidies and this is been spoken about this morning, previously cross subsidies have been embedded in electricity tariffs. Nobody knows what they are, although today we have a little bit of an idea. It is the idea that the webs will be transparent. Any subsidies, any taxes and levies must be shown on the consumer's bill. I've made a list here of the various types of cross subsidies that we know about. Electrification cost subsidies from urban to rural consumers, from commercial and industry consumers to residential and agriculture consumers, ideographic cross subsidies, voltage cross subsidies, etc.

Government needs to decide to what extend it wished to balance cost reflective reflectivity of tariffs with afford ability. Studies that have been done for example on electrification customers, show that the true cost of electricity to an electrification customer is somewhere between 70 and 90 cents per kilowatt hour. Most of them pay less than 30. Obviously cross subsidies must be paid out of levies and taxes on electricity, or out of the treasury, in other words, income taxes and other taxes. The levies and taxes which might be imposed are an electrification levy and that would be primarily future electrification cappix, but there have been representations that past electrification should also be paid for, and also the refurbishment of rural electrification network and metering.

There would also be a levy for electrification operations, alternatively could be called the poverty levy. There is the municipal tax on electricity. There could also be other levies.

The next question I want to consider is that of who qualifies for the WETS. Certainly, once they are established, Regional Electricity Distributors or REDS, would qualify. We expect in the future competitive electricity market to have bulk traders and retailers and they would obviously also qualified with the WETS, and then a certain category of induce customers which we will refer to as contestable customers.

Who are contestable customers? Contestable customers are customers selected on a basis of size and they must be over 100 GIGO watt hours consumption per annum. That is the norm which was adopted, after a research project that was conducted by the NER in 1996. Sizes also been a criteriate used in other electricity markets which have been liberalized elsewhere in the world. Strictly speaking the barrier between retail tariffs and wholesale tariffs should be an economic one, and I'm sure that it will come an economic one because wholesale customers would have to install much of their own equipment at their own cost.

Now the contestable customers have been arguing that they should be exempt from levies, taxes and cross subsidies because they are extremely large users of electricity, they are important national industry, such as aluminum phero chrome, iron and steel, etc, etc., and they are industries of national importance. The refrain that these levies, taxes and cross subsidies will increase the cost of electricity and make it unvariable to continue operating in South Africa, and of cause these concerns could result in lost, tremendous loss of jobs, loss of foreign exchange and all these things, and that is of course something that we have to take seriously.

Those are three of the tricky issues, there are more of them, they will be going to the cabinet, together with the proposals in regard to the electricity distribution industry restructuring, and we hope to have clarity on these issues before the end of the year. So what are the next steps? From October to December 2000, we plan to prepare for pilots by ESKOM. The NER Board will give approval for the pilots once we have received detailed indications of the levels of the tariff components. The pilots will run from January to December 2001, and the NER obviously will oversee the implementation of those pilots.

The idea at this stage is that the pilots will be run with a very limited number of endues customers from that contestable customer group. Because the municipalities and ESKOM distribution are in any case going to be amalgamated soon into the REDS, that they should jointly oversee these pilots and pick the skills required in the process.

We expect around August 2001 that we would be ready to promulgate the WETS in the Government Gazette and even as a result of the promulgation there are any objections, there will have to be a public hearing which we expect will be around October 2001. In November 2001 there should be the final approval by the NER Board of the WETS, having sorted out the problems at the public hearing. We then anticipate final implementation of the WETS in the ESI in January 2002.

Durban: Electrical incident report

Vijay Batohi

Mr Vijay Batohi

Durban Metro Electricity (DME) has four infeed substations from ESKOM and we transform voltages down from 275 kV to 132 kV. The substation on the ward is Klower substation - a 275 to 132 kV's substation with a installed capacity of 1000 MVA. We have four 2 x 50 MVA transformers. They are situated 25 km west of the centre of Durban, close to an industrial area. The Umslanzana river runs around the substation and off to the Durban Bay.

On the night of 22nd May 1999, at about 06h45 one of the transformers exploded due to an internal fault. The explosion tore the tank and pipe work open at various points. Severe bolging on the side of the tank occurred, as well as some damage to the pipe work where a lot of oil leaked out.

On the evening when the fault occurred, staff investigating the fault, noticed oil spillage and shut off all the volts on the transformer. In the darkness of the night it was difficult to asses the full scope of the damage. The next morning a full visual inspection was carried out. The extend of the damage was clearer. It appeared that the low level pipework was severely damaged.

Approximately 70 000 of a total of 95 000 liters of oil housed in the tank, spilled within the area. The oil entrapment provision was inadequate for this massive spillage. This resulted in a large quantity of oil seeping into the ground and the surrounding area and into the Umslanzana river. As a result of this pollution, immediate action was taken to ensure containment of the oil spill in the river.

Within an hour of being contacted, an oil spillage company arrived on site, assessed the damage, and commenced with the clean-up operations.

Signs of oil contamination was visible up to 6 km downstream of the substation along the Umslanzana river.

Upon been commissioned, the clean-up company immediately erected inflatable booms at various places in the river. This was done to prevent the oil from washing further down stream and eventually entering Durban harbor.

On the surface of the water a compound was used to absorb the oil. A lot of manual work went into this process. Trenches were dug in order to create entrapment pools in which the contamination could then be treated.

Two days after the incident, DME was served a notice of contravention of the Environmental Conservation Act by Durban Metro Water. The notice stated that DME will be held responsible for the clean-up and rehabilitation of the affected area. All costs would have to be born by DME.

DME was also responsible to carry out an environmental analyses of the spill. DME had to take suitable steps to rehabilitate the area affected. We were fortunate that the oil was not contaminated with PCB's and that it had a relatively low toxic content and that oil would break down as a natural part of the bydecreation by deogration process.

The result of another assessment also revealed that DME did not have the necessary processes in place to deal which such an incident. However, one must note that this was the first incident of its nature that Durban has experienced in its history as a distributor of electricity.

In terms of pollution and has the substances organizations today have true are operate effectively with increasing legislation been applied. Legislation affecting the electricity utilities in this instances are the Environmental Act, the Water Act, the osh act and any local ordinance are may be applied where utility operates.

The financial effects of legislation on the business activities of utilities are that we have an environmental management plan for installations that hold a potential risk to the environment. Such costs are substantial. To give an example: The costs to carry out an environmental management plan for a substation, is estimated at approximately R100 000,00. DME has around 100 substations. This would place a huge financial burden on our resources and, in fact, on that of any utility.

Oil entrapment schemes, if they do exist, must cope with spillages. At old substation they are certainly not adequate. All substations being build by DME in the last few years have been designed with adequate oil traps. Utilities need to identify all sites that are not acceptable in terms of oil traps, and upgrade these sites. The cost for such an exercise would certainly be high.

In addition to implementing environmental management plans, utilities will now have to weigh up the effectiveness of these plans against the strategic principals. Furthermore, these plans will be subject to audit by an environmental authority and individual auditors would probably be commissioned. The cost in terms of clean-up in terms of requirements by legislation will have to be borne by any utility that pollutes the environment.

Legislation will affect the design of infra-structure, environmental impact analyses which used to be purely in the domain of all red line construction and planning. Now it will probably extend to substation design.

When designing substations, locality and the existence of oil trapments need to be taken in consideration. Of importance is the lesson we learnt: Do not locate a substation near a river or any ecologically sensitive area.

So, what more can we learn from this incident? Three letters - EMS: environmental management systems. Organizations now need to have an environmental policy in place and should define its environment and ensure its commitment to an environmental policy. They must develop capabilities and support mechanisms to achieve this environmental policy. Utilies must monitor, measure and evaluate its environmental performance.

This incident has made us review our existing policies with regard to pollution. In terms of stake holders, we have to identify them in our environmental management plan. We need to know who we are dealing with. We are currently evaluating and will enter into a contract with a spillage clean-up company so that we can tide them into a service agreement in terms of response times, and probably expenditure. This may increase normal expenditure in the council.

We are evaluating the purchasing of an environmental clean-up kit for use by inhouse staff. Our current substations are being evaluated and environmental plans are to be implemented. We are looking at preventative measures. These plans are currently in place but we need to focus on environmental sensitivity.

Organizations need to identify and implement emergency response plans. Utilities must identify emergency organizations and their responsibilities, for example the spill clean-up companies. The relevant water authorities must have internal and external communication plans in place, as well as what actions are to been taken in terms of emergencies. Finally, they must have training plans and these plans must be tested for effectiveness.

Emphasis should be placed on preventative measures as oppose to corrective action. In conclusion, may I point out that the incident at Klaarwater substation cost Durban Metro Council around R1.3 million for the clean-up and subsequent activities which adds a whole new dimension to the word polluted pairs.

Tzaneen incident report

Pierre van den Heever (Tzaneen Electricity) and Clive Burchell (ABB)

Our engineers visited site on two occasions to assess the situation and it seems that where the isolator drive mechanism had not been operated or maintained for a number of years, incorrect operation may result. The characteristic cannot be conclusively proven, as the final assessment has not yet been completed.

These 11kV indoor switched capacitor feeder panels have been supplied over the years by Yelland Engineering, Yelland Power Management and ABB.

As a precautionary measure, all Electricity Distributors who to our knowledge have this type of equipment installed, were informed of this incident during the month of August. A programme is in place to support those customers who require help from our service department to assess the status of their equipment.

We also suggested that the following lock out procedure, inspection and switching operations be undertaken on all panels as soon as possible to ensure that no further incidents of this nature re-occur. In addition we strongly recommend the introduction of annual routine maintenance.

1. Switch off capacitor bank manually. Check that the Var meter reads ZERO.
2. Switch off backup circuit breaker if installed.
3. Wait for 5 minutes for capacitor banks to discharge.
4. Open the isolator on the contactor panel. Before opening the panel door, check through the WINDOW on the front or back of panel to confirm that the isolator blades are fully OPEN. Check that the door interlock functions correctly i.e. the door can only be opened once the isolator is open.
5. Open panel door and check for ZERO voltage in the panel.
6. Operate the isolator a couple of times to access that it is set and operates correctly.
7. Apply portable EARTHS where necessary before working on equipment.
8. Warning : Due caution should be taken if busbars feeding the panel remain energized.

The above LOCK OUT procedure must always be adhered to when working on capacitor banks. Special note must be taken of the EARTHING OF CAPACITORS as they may not have fully discharged within 5 minutes.

To ensure continued safe operation, we recommend that the panel is maintained on at least an annual basis. During the annual maintenance the isolator should be routinely operated a number of times to check satisfactory operation. Interlocks should also be checked for correct operation.

Our service department is available to assist customers concerning maintenance aspects.

ABB will actively contribute to enhancing safety standards with regard to this equipment via various organizations such as NRS, SABS etc.

Standard Transfer Specification & beyond

Kobus van den Berg

KOBUS VAN DEN BERG

Current Position: Chairman of Bloemfontein Electricity; Chairman of Free State Branch of SARPA.

Qualifications: BSc Eng (Elect) Degree. Worked in the Biomedical Engineering field at University of Free State for nine years while acquiring degrees in BMed Sc Hons and MMedSc. Assistant City Electrical Engineer at Bloemfontein City Council (1989). Lectured Digital Systems at Technicon Free State part time.

Biography: After completing his BSc Eng (Electrical) at Pretoria University the author started his career in electrical engineering at the Eskom National Control Centre at Simmerpan on telemetry systems. He later spent about 9 years in the Biomedical Engineering field at the University of the Free State and acquired the B. Med. Sc. (Hons) and M. Med. Sc. degrees at this University. In 1989 he joined the Bloemfontein City Council as Assistant City Electrical Engineer and is responsible for training, metering, vending, telecommunications and SCADA systems. In the training field he served on the Accreditation Committee of the Local Government Education and Training Board and is a part time lecturer at the Free State Technicon in digital systems. He is a member of various NRS working groups (009, 037, 055, 057). He is the current chairman of the Free State branch of SARPA. He is currently the AMEU representative on the STS Association Board as well as the Chairman of the STS Users Group.

Mr Kobus van den Berg

1. OVERVIEW

This paper will try to give an overview of the state of development and capabilities of the STS (Standard Transfer Specification) used in pre-payment meters. It will explain the activities of the STS Association and STS User Group. It will also address the problems encountered with current vending systems and propose possible solutions for these problems.

2. INTRODUCTION

Pre-payment electricity meters made a significant contribution to the electrification in South Africa. Over the last 8 years a few million consumers have been added to the electricity grid by the use of pre-payment meters. The meter technology went through various stages of development and a number of manufacturers tried various methods of credit transfer and electronic technology. This caused confusion in a way in the sense that the meters from various manufacturers were non-compatible. This situation was addressed by the development of the STS system.

An inherent part of a pre-paid meter system is of course the vending system to sell electricity. These vending systems are compatible to meters from various manufacturers via the STS compatible tokens generated for pre-paid meters. The problem however is that many proprietary meter systems are still installed in the field and has to supported. The question that invariably comes to mind is "How do we create a vending system in a REDs (Regional Electricity Distributors) environment to cope with all the different meter systems?" as well as the large number of meters installed in many different cities and towns.

3. WHAT IS STS

Let us start by defining the STS system quickly. The STS system is a secure message system carrying information between the vending point and the meter. It is being used for electricity metering systems but can also be applied in water and other services metering devices as well as payment systems. The system ensures a high degree of security by using advanced encryption techniques as well as high security key management. Each token can only be used in a specific meter. Inter-operability is assured. Meters and vending systems from various suppliers can thus be used in the same system and a utility is thus not dependant on a specific supplier

4. WHO IS RESPONSIBLE FOR THE SYSTEM?

ESKOM initiated the system in 1993 and was the guardian of the system up to 1997. The system is specified in the NRS-009 series. The STS Association took over the technology with founder members ESKOM, Conlog, EMI. and Schlumberger. The AMEU has a non-voting member on the STS Association Board. The STS Association owns the STS Technology and licenses manufacturers to use it. Manufacturers of STS compatible equipment are all members of the Association and thus subscribes to the objectives of the Association.

5. STS-ASSOCIATION - OBJECTIVES

- STS Standardisation and enhancement
- Provide technical guides
- Accreditation testing
- Maintain an approved accreditors register

- Maintain an approved alist of STS compliant equipment
- Key management and key security and certification
- Promote and support STS as an international standard

6. STS USER'S GROUP

The STS Users Group was established in June 2000 to represent the user of STS compatible equipment on a wider front. This group consists of all electricity utilities using STS compatible systems. Any developments or problems with the STS compatible systems are channeled back to the STS Association for the necessary attention. The users Group Communicates via AMEU Branch meetings as well as via a web site where a discussion forum system exists. All STS users are urged to join this forum to ensure that user requirements are addressed by the STS Association and the manufacturing industry. A brochure on the Users Group has been attached to this paper.

7. STS 2000 - NEW TARIFF

A limitation of the original STS specification was that only one tariff structure was available namely a fixed charge per unit. This was however all that was required by the industry up to now. The STS Association is busy with a project to enhance the specification and in particular the available tariff structures. Further enhancements will be added in future. The enhancement has been described in detail in the STS 2000 specification document but can be summarized as follows:

1. One Part tariff (Straight line)
2. Stepped tariff (power or units)
3. Fixed charge (plus hourly consumption allocation)
4. Two part tariff (Step plus Straight line)
5. Combination of the above

8. VENDING SYSTEMS - IN THE REDS ENVIRONMENT

Current vending systems originated from the need to supply electricity and vending services in a confined area. A number of vending systems report back to a master station where all the data is managed. A problem arises when the number of meters supported from one master station increases significantly. A further problem in a REDS (Regional Electricity Distributors) environment is that number of different systems exist in towns and townships. These systems are not necessarily compatible and data conversion as well as communication strategies will have to be addressed. The industry will have to apply its mind to solving this problem on a national basis. Let us have a look at the problems encountered by current vendor users. These problems also correlate with problems encountered by Eskom as described by J O'Kennedy.(1)

9. TYPICAL PROBLEMS ENCOUNTERED

1. Combined STS and proprietary vending stations not universally available
2. Communication between master station and point of sale terminal not reliable
3. Data loss at sales point or during file transfer
4. Master station database cannot handle the large amounts of data effectively
5. Management of master station data base lacking
6. Reconciliation of sales vs revenue received not managed properly
7. Cash losses at private vendors (robberies and fraud)
8. Vendor contract management not effective
9. Meter maintenance not up to standard
10. Only cash transactions can be accommodated.

10. POSSIBLE SOLUTIONS

1. Privatization

This is probably one of he first solutions that comes to mind. Give the problem to somebody else with the necessary expertise (hope fully). This is certainly an option and in many cases this will solve part of the problem of revenue collection. This company however will not necessarily be responsible for the meter management. The database integrity can still be a problem. The end user is not communicating to the supplier. Any problem will have to be addressed by the utility to ensure customer satisfaction on a technical and financial level.

2. Involve financial institutions, chain stores ,etc

Many institutions will be able to accommodate electricity sales in their revenue collections systems. The supermarkets will for example be an ideal place to pay electricity and this is being done on a limited scale at this stage. The rest of the problem still remains with the utility.

To involve banking and other financial institutions will however imply that payment mechanisms need to be upgraded to new technologies in these sectors. More about this later on.

3. Redesign current systems

3.1 Master station

We need to utilize powerful industry standard database software and servers. This system will have to be a centralized system to enable a utility to manage it properly. Desktop type applications are simply not capable of handling the multi-user, large amount of data environment. Financial institutions do not use small systems to do the job. A RED with 1 000 000 customers (say 60% use prepaid systems) can easily generate 18million transactions per year. This can amount to more that R400mil per year. A daunting task to manage on current systems. We should not be playing snakes and ladders with our systems and hope that nothing will go wrong. With the current NRS047 recommendation of 2000 users per vending point, each system will comprise of at least 300 vending stations. Taking the geographical area into consideration this is a major task to ensure data communication reliability and integrity.

3.2. Communication.

To solve the data integrity and loss problem one will have to opt for an on-line system where every transaction is communicated to the master station. This also implies that the master station will do the STS encoding and the vending station will merely be a "dumb" point of sale terminal where the token is printed or generated. The advantages of this system is that all user and meter data will reside on the master database and every transaction will be added to the system as it occurs. Vendors will not be in control of transaction or user data. Any failure or fraud at the point of sale terminal will not affect the integrity of the total system. If a vendor fails to pay revenue collected for sales he can be cut of immediately.

This mechanism will however result in a major data communication structure. There are a number of ways to accomplish this but to illustrate the cost involved a service like Swiftnet is used. Swiftnet makes use of radio X25 pads which interfaces to Telkom X25 countrywide network. The location of the vending station is thus not important. Every transaction is sent to the main station for verification as well as STS token generation. If one assumes that each transaction will take 1 minute in terms of data communication than this will add 15c to the cost of that token. This implies that the total cost for data communications in a system handling 18mil transactions per year will be more or less 1% of the turnover. The current dial-up modems are probably less expensive but requires a lot of human intervention and time. It is also a lot more prone to data loss.

3.3. Data management

One of the most important issues in using computerized databases is the data management. To be of any value the integrity of data is vital. This function is more than often neglected. To ensure a reliable database YOU NEED A FULL TIME DATABASE MANAGER with the necessary INFRASTRUCTURE TO CAPTURE DATA on a daily basis. Do not underestimate the importance of this task. It is so easy to get a system corrupted. The operation of your utility depends on the correctness of your information. This data manger must see to it that all meter, sales, tampering etc data is up to date to enable you to manage with the correct information. The name of the game is effective, timeous decisions based on valid information.

3.4. Revenue Management

There is no substitute for effective management. With the right personnel and computer resources one should be able to run the operation successfully. The main issue here is not to delegate this function to some operator somewhere in a computer room. Actively engage high level personnel with the right qualifications and background to drive the process.

This process must be linked to a revenue protection programme where the technical staff is directly involved in meter inspection and cutoff functions driven by revenue collection processes.

3.5. Cash, fraud, robberies

The collection of cash and the possible robberies have not been addressed yet. All electricity transactions involve cash. One can approach this from two angles namely to protect the cash or to eliminate the use of cash for electricity purchases. To protect the cash collected by vendors can be a difficult task. Security companies can be hired to collect the money. One can ensure that the vendor has safes, alarms, banking facilities, insurance etc available. There is however always the chance that somebody can get away with the cash. Organised robberies or a fraudulent vendor can get hold of the money very easily. To eliminate the cash one will have to go to new technology and processes linked to financial institutions.

11. UPDATE PAYMENT METHODS

To accommodate the various groups of customers the payment methods will have to be updated significantly. The technology to enable the following systems exist and needs to be included in a system:

1. Cell phones (WAP enabled)
2. Smart cards
3. Internet based purchases
4. ATM / AVM card transactions
5. Financial institutions and chain stores

12. HOW DO WE SOLVE THIS PROBLEM?

The first step will have to be that the industry come together and decide what they want. Nobody will come forward with a miracle solution if the requirements have not been specified. In the previous round the NRS 009 specified what was required from vending systems.(The systems that we use now). At this stage however we do not have a new technology payment system specification or requirement. Some of the manufacturers are designing systems according to what they think the market wants. We will land up with a host of different systems if we do not act very quickly.

13. THE FOLLOWING PROCESS IS SUGGESTED TO DETERMINE

Get all the role-players together and investigate the following:

1. The current problems
2. The role of new payment methods
3. New communication methods
4. Private vending and financial institutions
5. Compile a national electricity industry payment system strategy
6. Compile standards and specifications for this system

14. Conclusion

The REDs environment will require a new vending strategy. New technology is available and we need to decide what is required. We owe our customers the most appropriate payment system.

The electrical industry is at a phase where decisions are made on a grand scale. The transition to more streamlined business entities is unavoidable. We need to take ownership of this opportunity to enter into this phase as real engineering and business innovators. How do we best serve our customers? Our success in the REDs will depend to a large extent on our ability to sell electricity efficiently.

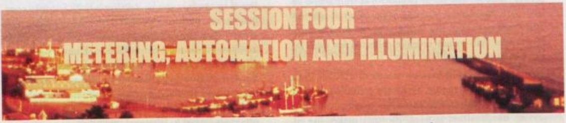
15. References

A review of Eskom's Vending strategies by J O'Kennedy

16. Web links

STS Association: www.sts.org.za

STS Users Group: www.sts.org.za/usersforum/



The future of load management systems

J. Dobberstein
(Presented by Ian Robinson)

IAN ROBINSON

Current Position: Having transferred to SA. Spent 13 years heading up L&G's operations. He left to start his own Metering company, which is now a local representation of ABB's Ripple control activities.

Qualifications: Born & Educated in the U.K. has a BSc Degree in Electrical Engineering. Graduate apprenticeship included 6 months with ASEA in Sweden. Spent 10 years at Landis & Gyr, Sweden specializing in Ripple Control.

ABSTRACT

New technology trends and developments in information and communication techniques have a strong impact on many disciplines first of all of course on high tech products and systems but beside them also conventional and since many decades well introduced systems are concerned.

Ripple systems applied as broadcast information systems within utilities, for load management and tariff control of residential, commercial and industrial customers also street lighting control etc. known as reliable and robust control technique, easy in handling and application also improves their capabilities due to new technologies and adapted their architectures and procedures.

Essential changing results from higher integrated, sophisticated micro-controllers which make it possible to distribute functionality resp. intelligence on different control levels. Furthermore drive components are base for the new transmitter generation, which are now adjustable e.g. with regard to injection level of signals and providing higher transmitter power and easier handling.

Windows NT finally as most and widely circulated operating system, can within master control systems, ensure standard MMI features according to 'windows look and feel'. Beside that due to real-time capabilities, multi tasking and multi user processing is provided and the master-system supports versatile communication links and standard protocols.

BASE SYSTEM CONCEPT RELATED TO RIPPLE APPLICATIONS

Ripple is a one-way communication technique with the advantage of covering big areas from one injection point. As higher the grid voltage level where signals are injected as less transmitter plants are required and as more final receiver points are controllable from 1 injection point.

Conventional ripple systems are strongly central oriented i.e. the master system located in the dispatching centre generates the entire activities running per day to switch on and off objects either time dependent, load forecast or event dependent and last not least also due to manual interactions (app.1).

Since applications like tariff and load control are requiring time accuracy the scheduling has to be planned according to, so that the processing of different mechanism didn't hinder each other. In case of communication outages etc. between master and substation were signals are injected, the local controller in the station is capable to overtake certain task automatically like time dependent control so that operation get no longer delay.

Load dependent control could also be executed yet needs additional data for local load forecasting.

Modern and upgraded ripple- systems have a decentralised structure with regard to executing operation. Due to powerful micro controllers used on consumer level within ripple receivers the main function of time dependent control e.g. switching of tariffs, storage heating, water boiler etc. can be executed locally.

The system get independent of the momentary grid conditions referring to signal propagation and object control is done similar switch clock operation.

To do that an essential new feature has to be provided, remote parameterisation of the distributed receivers from the master level down to the receiver level (app.2).

Comparison principle central and decentralised control:

Master system

- Time dependent control
- Event dependent
- Manual interactions
- Load forecast
- Load correction /shedding
- Duty cycle/contract supervision

DECENTRALISED CONTROL

Expanded master system

- Reduced central time dep.control
- dto.
- dto.
- dto.
- dto.
- dto.
- Synchronisation receiver clock
- Synchronisation weekday
- Remote parameterisation
- Message securing- CRC
- Status receiver scheduling

Central control

The entire activities are serving the optimisation and balancing of load within defined periods. The load resp. consumption of residential, commercial and partly of industrial customers, which is available can be used for this process and individual control par-meters like max. Off-time, min. On-time can be considered additionally (app. 3). By using time dependent control load can be disposed referred to load profile resp. load curve e.g. switching on during low consumption over the day and night and switching off during high consumption interval's. Parallel to that the momentary peak demand will be continuously supervised and in case of exceeding maximum feasible load shedding are executed.

LOAD MANAGEMENT MASTER SYSTEM LMM610

The master system LMM610 is especially tailored for load management task's and related applications. Base of LMM610 is the ABB Scada System S.P.D.E.R. MicroSCADA. This system is used in versatile automation process applications for distribution networks. Standardised Software modules for Load management facilitate simple and fast data engineering and efficient operation.

Main features are:

- Operating system Windows NT
- Ethernet- Standard as local network for interconnection of different computers
- Usage of TCP/IP as standard protocol on Ethernet networks for data communication
- Database Interface ODBC (on-line data base connectivity) for data exchange between different data base like ORACLE or ACCESS with SQL (app.4).etc.

TIME DEPENDENT CONTROL

This mechanism will be used to switch load at predetermined times. With supplementary parameters the validity range of switching directives can be varied, e.g. by declaration of special days weekend ,holidays, seasons ,also temperature ranges. The central feature of the time dependent control is the generation of the daily duty plan resp. scheduling .The time when this generation happens can be determined by the user e.g. 10 PM. Commands and directives are always processed if the entry of the execution time corresponds with the system-time.

EVENT DEPENDENT CONTROL

Due to indications over digital inputs event control can be activated. The type of processing is selectable. The moment when the event happens starts an entry into the daily duty schedule and the reaction can occur directly or delayed. Events can be used to react on disturbances as well as on special situations. An often used application is the control of street-lighting based on twilight sensor.

DUTY CYCLE CONTROL

This mechanism permits the supervision and control of objects resp. load groups referred to their ON- and OFF-switch time. Due to that without any interactions of the dispatcher the maximum off-time and minimum on-time based on contracts or agreements between utility and customer, which take into. account the load characteristic, will be guaranteed automatically.

This function is necessary e.g. in case of air conditioners or refrigerators etc. Furthermore cumulative charging of storage heaters referred to minimum on-time can be supervised and controlled.

LOAD REGULATION AND OPTIMISATION

The load dependent control is the overlaid mechanism with regard to time and event dependent control and the task is to supervise the demand within defined e.g. 15 min. Intention is to keep to the contract between supplier and consumer. The activation starts if maximum demand is exceeded. For registration of the total load, counter pulses have to be captured and converted into momentary values. The load forecast calculates on this base an average demand over the total period and a correction value to determine the final objects, which have to be switched on or off. The load data can also be provided from separated SCADA systems via LAN network. In this case the LMM610 would only select the switchable load groups.

MANUAL INTERACTIONS

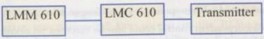
Manually at any time entries of directives or control programs into the daily working schedule can be carried out as well as changing. The whole procedures are supported by an interactive dialog, which gives also a certain protection against mal operation. The systematic leading due to the pictures and symbols is user friendly and easy for handling. After short usage the operator is capable to operate the system by himself, this concerns also data entries and changing (app.5).

LOCAL CONTROLLER LMC 610

The LMC 610 constitutes an intelligent interface between the control centre ant transmitter. In regular remote-operation mode the device receives messages from the master system and converts them into ripple telegrams. If there is a communication outage in the link, the LMC 610 assumes autonomous control from the station resp. transmitter level. Similar as the master system, time-, event- and load dependent control can be processed. The maximum of 250 programs can be used for it.

During local mode the entire actions are stored on a protocol buffer. The buffer can be called up from the master remotely or locally with a Laptop. The data entry and engineering can be done similar . The entire data resp. parameters of all components master, local controller and receivers can be stored in a central data base and must be entered only once. The operation of the device succeeds via Laptop and for the most important functions e.g. simple local manual telegram activation or switch- on Transmitter a separate, small operation console is optionally available.

The communication protocol with the master corresponds with IEC 870-5-1. The LMC 610 is available as compact device or in a modular form for rack installation. Further expansions with GPS receiver etc. are possible due to the modular system (app. 6).



TRANSMITTER UNIT

The RTS transmitter-family has been developed by ABB for feeding audio-frequency signals into medium and high voltage networks. By using converter modules taken from drive technology, incorporating second generation IGBT's and micro-processor controlled electronics favourable characteristics for ripple control operations are assured.

The transmitter is frequency stabilised, regulateable and to the greatest possible extent load independent. It covers the power required due to different grid configurations and different coupling types. The voltage regulation concept permits optimised matching to the transient response and saturation effects of different coupling types. Design, manufacturing and testing according to ISO 9002 guaranteed maximum reliability.

MAIN FEATURES

- Use of globally field-proven converter from ABB's drive systems
- Turn-off power semiconductors (IGBT's), means no commutating device required
- Output voltage steplessly parameterizable
- Wide power range (e.g. medium volt. 80..200KVA,high volt. max.6 groups a 400KVA)
- Parameterizable audio frequency
- Settable phase angle for adaptation in case of multi injection plants
- Short circuit and overload protection featuring electronic current limitation.

(app. 7)

LOAD CONTROL RECEIVER SERIES LCR

The essential impact on the new load management system concept results from the new receiver capabilities. Due to powerful and highly integrated micro-controllers much more intelligence and functionality is now available even in devices on the consumer level and autonomous operation can be carried out locally.

Time dependent control a base feature within load management systems related to tariff switching could be transferred into receivers and an internal synchronable clock in connection with switch programs resp. daily duty plans stored in the devices overtakes the entire local operation.

Referring to that receivers operate now as switch clocks, yet that would not be sufficient since changing of switch-programs are required especially event or temperature dependent. The significant feature of remote parameterization makes it feasible to activate or deactivate schedules depending on load situations and varying conditions. Furthermore existing schedules can be changed or new one added, so that a high flexibility is provided.

The local operation makes the system to the greatest possible extent independent of various disturbances especially those resulting from grid disturbances and topology changing.

The LCR receiver can process 2 types of communication protocols the conventional type and the new standardised VERSACOM protocol (app. 8). This protocol provides many new features .Function and addressing modes are strictly separated and the data transmission succeeds secured with CRC redundancy check. The addressing structure is a further important characteristic and tailored for the special broadcast communication requirements.

Area-, sub area address ranges are as well available as object type and object group selection (app.9). Additionally individual addressing is provided which is a more and more important issue to get access on single customers.

The concept means improvements in many directions since load control can be carried out immediately parallel with local time dependent control, the communication path is no more such critical even in case of higher signal attenuation or due to changing in momentary grid topology.

In spite of the named new features the system remains transparent and clear. New advanced receivers of the LCR series content supercaps to overbridge longer power outages and beside the well proven electrical interface RS232 an optical interface is provided that local parametization is possible in the same manner as used for meters.

OUTLOOK

The architecture of ripple load management systems changed in the entire participating system levels resp. components. The master systems are adapted to the windows 'look and feel' and by this easier in operation and data engineering. Standard networks are available for interconnection with external SCADA and dispatching systems.

The local control units resp. are expanded with regard to their functionality and able to execute various control mechanism comparable as the master and in case of link outages process control is maintained. The autonomous operation of the receivers is in spite of the overlaid redundancy another important factor taking into account the wide area, which has to be controlled and the dynamic topology changing, which can influence the control process.

Load management systems improve the supply and distribution economy and due to modern technologies and derived new architectures the efficiency is furthermore increasing.

Contribution

By Mark Wilson

(Transitional Local Council of Boksburg)

Load management becomes critical as surplus generation capacity starts running out.

It has become more and more difficult to build large power stations in the world due to economic pressures, environmental pressures and due to dwindling resources. Demand side management therefore becomes of critical importance to delay these capital costs.

Electrical distributors will have to implement load management schemes to lower their cost of electricity as generators, increase their demand costs to delay capital expenditure. Rising demand costs during peak load times can already be seen in Eskom's five year tariff plan.

An easy cost effective method of demand side management can be implemented with schemes as discussed in the paper.

With modern ripple systems and sophisticated software, flexible solutions, can be implemented. Individual addressable control units as well as individual addressable relays within these units will enable distributors to implement sophisticated time of use tariffs to the domestic consumer.

Given the lead time to implement load management schemes and surplus generation capacity running out in +/- 2005, time is not on our sides to implement these schemes if we have not done so already.

Mr Mark Wilson

Prepayment poverty and wealth tariffs

by Roland Hill

ROLAND HILL

A Senior Member of SAIEE and an Active member of SABS TC62, SANC of IEC TC13, SARPA and STS Association.

Qualifications: Roland has an MSc (Elect Eng) from the University of Natal and a MDP from UNISA.

He has worked for ICDC, SAMES and IST where he designed silicon chips and military video systems.

Mr Roland Hill

SYNOPSIS

Over two million prepayments have been installed that comply with the basic Standard Transfer Specification (STS) established by Eskom in 1995. This STS 1995 requirement only provides for the vending of kWH units of energy. Dramatic social, government and regulatory changes have since taken place that demand the extension of prepayment functionality for more complex tariffs, particularly those relating to poverty and indigent needs and the corresponding wealth (step) tariffs required to cross subsidise such services. It will be shown how these needs are catered for in the STS 2000 specification, which is aligned with the next release of the SABS 1524 part 1 prepayment metering specification.

This paper seeks to educate and explain the application of the new tariff features of the STS 2000 specification. Technical details of the two token definitions presently being considered by the working group of the STS association are given on the following pages. More complete and up to date information on the STS 2000 specification will be given at the time of the paper presentation. It is also intended to mention the purpose of the STS association and its fields of endeavour relating to better credit control management of vending equipment and international key management centres.

REVISION OF THE SET MAXIMUM POWER (SMP) TOKEN

Although the Eskom standard base is tested with a current of 80 Amps, proper thermal testing shows undesirable terminal temperature rise conditions occur above 60 Amps. The box terminals in all of the present bases can only accommodate 16 square mm cable rated to 60 Amps. It is thus highly inappropriate to define a SMP token capable of setting a power limit of 18.2 MW. A current of 72 Amps is more realistic. We propose that the unusable three quarters (exponents 01, 10 and 11) be remapped for Credit Control Extensions that enable the introduction of much needed Poverty Tariffs.

A report by the Helen Suzman Foundation titled "Not so close to their hearts" shows in table 46 that 46% of consumers in Gauteng are presently billed at a flat rate, and further more, that a staggering 72% agree with and support the method (re table 49 on page 70). The proposed Credit Control tariff alternatives directly support such a billing method and go further to add support for indigent subsidization policies and fixed cost recoveries from prepayment consumers.

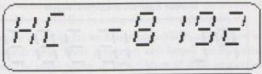
Decryption of a standard SMP token produces a 2 bit exponent and 14 bit data value.

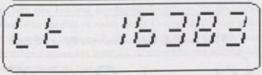
Exponent	Transfer amount	Representing
00	00 000 000 to 00 016 383	0 to 16 383 W
01	00 016 384 to 00 180 214	16 to 180 kW
10	00 180 224 to 01 818 524	0.18 to 1.82 MW
11	01 818 624 to 18 201 624	1.82 to 18.2 MW

With this method, all existing CVS vending systems will be able to vend tokens to change the poverty tariffs and earth leakage sensitivity of a meter, without being upgraded. It thus does not matter that some vending systems are no longer supported. The implementation is simple, does not require real time clocks or batteries and has no effect on the meter or vending system cost. The technology is non-proprietary and has not been patented.

Exp.	Type	Transfer amount	Representing
00	SMP	00 000 000 to 00 016 383	0 to 16 383 W
01	HCT	00 016 384 to 00 180 214	-8 192 to 8 191 Wh/h (0 = off)
10	CTT	00 180 224 to 01 818 524	0 to 16 383 kWh (0 = off)
11	ELT	01 818 624 to 18 201 624	0 to 16 383 mA (0 = off)

Table 1: Revised Set Maximum Power (SMP) token definition



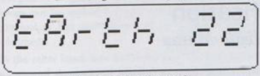


Credit control extensions are implemented in a meter with two 14bit registers. The first contains a signed value that defines the amount of automatic hourly credit transfer (HCT) that should occur. Experience shows that hourly transfers of Wh credit units are well accepted by consumers. The second register defines the credit tariff threshold (CTT) at which the poverty tariff is enabled or disabled. Combinations of HCT and CTT values enable poverty tariffs to be implemented as shown in Table 2.

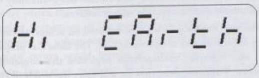
The exponent of 11 is used for a programmable earth leakage sensitivity. This enables manufacturers to supply the same product as an ECU to Eskom (an ELT of 30mA), as an ED to Municipalities (an ELT of 0mA). A meter can ignore this when earth leakage functionality is fixed or not fitted.

The safety requirements and marking of such products are being incorporated into the forthcoming SABS 1524-1 specification. Tokens attempting to set unsupported sensitivities must be rejected.

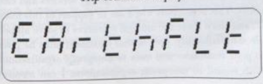
Leakage current display



Warning of imminent trip



Trip condition display



DEFINITION OF THE SET TARIFF RATE (STR) TOKEN

The STS Part 2 document (revision 3.1) currently defines this token functionality as follows:

"This is a 16 bit field indicating the tariff rate. The format is still to be defined. This token is intended for future use with currency type units. Any implementation of this token type requires STS agreement before implementation". We now propose that agreement is reached on the definition given in Table 3.

Hourly Credit Transfer (HCT)	Credit Tariff Threshold (CTT = 0)	Credit Tariff Threshold (CTT > 0)
Zero	Normal prepayment	Normal prepayment
Positive value	Flat rate electricity grants	Indigent subsidisation
Negative value	Connection fee charges	Friendly connection fees

Table 2: Credit Control tariff alternatives

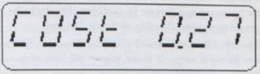
Exp.	Type	Transfer amount	Representing
00	COST	00 000 000 to 00 016 383	0.00 to 163.83 (0 = off)
01	FACT	00 016 384 to 00 180 214	0.00 to 163.83 (0 = off)
10	P1	00 180 224 to 01 818 524	0 to 16 383 W
11	P2	01 818 624 to 18 201 624	0 to 16 383 W

Table 3: Set Tariff Rate (STR) token definition

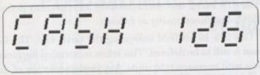
Our proposal for this token empowers two substantial features.

a) The first is a method of presenting a currency display to a consumer that is not embroiled in currency validity and date of implementation issues. This substantially enhances the consumers understanding of the "credit" in his/her meter. It is actually in the consumers interest to keep the currency conversion data up to date on the meter, however there is absolutely no penalty for not doing so. The meter remains a kWh-based meter. Because most cost changes will invariably be an increase, when a consumer enters the "tariff increase" token given to him, his amount of "cash" in the meter will increase, without the amount of kWh credit units actually changing.

A token entry setting the cost register is confirmed as



Which converts credit into

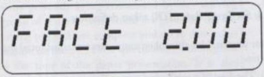


Cash between 2 and 2000 Rands can be displayed.

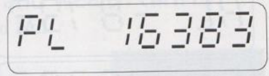
Normal kWh credit units are used when cash is out of range

b) The second feature is a means of implementing a step tariff without resorting to real time clocks and batteries. This highly important feature enables the cost of energy consumed to become progressively more expensive as more energy is consumed. This progressive (stepped) tariff thus raises additional revenue from the wealthy to enable subsidisation of the poverty tariffs described on the previous page. In operation, the amount of credit used is multiplied by the value of FACT when the consumer draws more power than the P1 threshold. The amount of credit used is multiplied by twice the value of FACT when the consumer draws more than the P2 threshold.

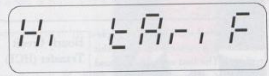
A token setting the FACT register is confirmed as



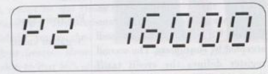
Power limit set with SMP token



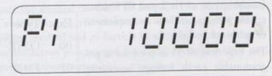
Warn user when power exceeds P1 or P2 limit



Power threshold 2 limit



Power threshold 1 limit



Traditional step tariff methods apply wealth penalisation according to periodic meter reading intervals, because that is the only data available. This is completely unnecessary in a prepayment meter because the factor can be applied instantaneously. This method is non-proprietary, not patented and does not require a real time clock or batteries. Only three 14 bit registers are required.

An edited transcript of verbatim comments on electrification

Councillor Xolisile Mama

I have observed that there are other papers that will be delivered to this 18th Technical Meeting that relate to efficient lighting. I will be talking about pre-payment systems.

Our history implies that we use our freedom to create a more human and caring society. I, therefore, request that you pardon me for talking about our history. It teaches us courage, resilience and that we embrace challenges, that we be strong and that we be confident. Poverty is the single greatest issue affecting all South Africans.

Poverty affects millions of people, the majority of whom live in rural areas. It is not merely the lack of income, which determines poverty. We must address poverty and depravation; we must attempt to eliminate hunger and provide land and housing and ensure the availability of affordable and sustainable energy sources.

The past energy policies concentrated on achieving energy self-sufficiency at enormous cost. The Moss Gas project is one example. Such policies neglected the household sector. I am confident that we will meet the needs of the poor by providing the necessary energy services and electricity. This is precisely why I am in support of this budget, and since there are enough resources to serve all people simultaneously, preferential treatment must be given to poor residences and even to non-profit organizations. With regard to non-profit organizations, I can mention that we have a debate in our council around the matter of providing subsidies to non-government organizations.

In our municipality we have a big problem with regard to unbuilt areas. These properties were largely incorporated into the municipality in 1996. Many of these properties are now new housing development projects. Tariffs are set relative to the cost of water to the Council and when water is, therefore, consumed and not paid for, either the cost for other consumers must be increased or the service will under-recover its costs.

In a way the paper that is been presented here are ways to address those issues. Take for example water tariffs. In certain instances, consideration was given in our 2000-2001 water tariff structure to the impact of funding water consumption. Under-collection takes place or tariff structure will need to be revised accordingly.

With regard to electricity cost recovery, there are no problems within our situation, as unbuild areas have prepaid meters. The introduction of the new vending system, as well as energy dispensers, have assisted our council in dealing with these challenges from the electricity point of view.

The proposed tariffs in this paper, which are designed to assist with promoting equity in terms of providing for the needs of disadvantage communities, seem to comply with the Government White Paper. This allows for the previously disadvantage communities to be subsidized as they cannot afford to pay for electricity at a higher rate.

This complies with the national government's vision of redressing the imbalances of the past, and the current discussions with regard to the reconstruction of the electricity sector in South Africa, does however require some discussion for the purpose of clarity.

Certainly, the new dispensers clearly have to be discussed in terms of the viability of the unity city in our context. This would mean that we can expect some delays for some period or it could be found to be unsuitable from region to region. The question is, therefore, whether new technology can be applied for each inner unity context. The principal to link technology and development must be welcomed.

On the other hand, how has technology been researched in terms of the national population? It seems as if the benefit in terms of poverty relief will only come from areas where the wealthy sector of the population is of a higher proportion. If the number of wealthy are used to improve an urban centre, which is large, then such an urban centre would benefit its poor. Our situation in Cape Town is an example: We have a huge urban centre with a large percentage of wealthy users. The question must, however, be asked about the smaller towns in other areas which have informals settlements that do not have a high level of more wealthy users to subsidized them.

Would they benefit from this new tariff structure? Perhaps this element might have been overlooked because the research focused on major urban centers, where the majority of the urban poor is located. This should perhaps be investigated. This would be a challenge for the new coming REDS.

Clr. Xolisile Mama

In supporting this paper, may I state that people have suffered because of crime. We, in turn, suffer at times from the culture of non-collection. I have alluded to some of the problems that we are experiencing with regard to services. I think the approach, which has been suggested at this conference, will bail out a number of municipalities. The paper at the same time refers more to the technical state of the standard transfer specification. It furthermore elaborate on poverty and wealth tariffs beyond just making provision for a single energy rate as well as increasing step-rate. I believe that the increasing step-rate tariff is not generally favorable for electricity consumers although this type of tariff is being used in certain parts in the country.

In conclusion, I think that it is obviously desirable for a metering system to be as flexible as possible in order to accommodate the future requirements. It may therefore be prudent at this stage to also make provisions for future time of metering as this is potentially the fairest and most cost effective price structure. This could only be implemented if practical metering solutions can be provided for customers with low energy consumption, as is commonly the case with residential or domestic customers.

If this system is applied in the interim, I am choosing this interim very carefully because we are undergoing a restructuring process. This will also go along to ensuring the greatest future increase in local government revenue. It will obviously also limit the possible negatives. Subsidies should as far as possible be transparent to the public. That is stated very clearly in the White Paper requirements.

I am concerned that the competition that Government wants will affect the price to be paid by consumers. Yesterday we heard from speakers from the public works department who stated categorically that the Government would like to maximize an effectiveness competition in order that prices will be determine as far possible by market forces.

This could be a contradiction. The question should be asked whether this system propose a sustainable one. I would like to thank the STC working group of AMEU for their innovative thinking. I would also like to pledge my undivided support to this document. Furthermore, I will appreciate it if the end users and members of the public could be afforded with the education that they deserve on acquainting themselves with the document itself. They are the ones that will be suffering the consequences.

Finally, I began with a reference to our history and I think I should end with history as well. We showed the world that the butterfly does not have to die so that the elephant can be saved. I am always guided by those words from Trevor Manual in his budget speech.

Holistic substation asset management

Peter M Cowan
Ray Neale

PETER COWAN Pr. Eng., M.Sc (Elec.), MSAIEE

Peter Cowan is the Managing Director of Rainbow Technologies Pty Ltd, a Specialist Electrical Engineering company.

Peter started his working life in a power station environment, moving onto substation design and ultimately specialised investigations with Eskom. He started Rainbow Technologies in 1989 in Gauteng, ultimately moving the headoffice to Durban in 1996.

Peter has a Masters Degree in Electrical Engineering and is currently studying for a Doctorate.

RAY NEALE - Margott Power Systems Management

Ray is a Director of the Marqott Holdings (Pty) Ltd group of companies and has worked in the high voltage electrical industry for 28 years. He is also the General Manager of Marqott Power Systems Management (Pty) Ltd.

Ray has a National Diploma in Electrical Engineering from Pretoria Technicon, a City & Guilds Certificate in Quality Control and a BComm degree from UNISA.

Mr Ray Neale

ABSTRACT

In an age of ever scarce capital, pressurised "bottom lines" and emphasis on improved efficiencies, the need for proper asset management in electricity utilities is paramount.

The electricity industry is a capital intensive business with low returns on investment compared to the industrial or mining sectors.

It is therefore vital that existing assets are nurtured and cared for, such that their useful life is extended as far as possible.

Condition monitoring, together with other tools, provide a holistic substation asset management system. Informed refurbishment/replacement decisions, together with incipient fault data will provide the maintenance engineer with the correct tools for the 21st century.

BACKGROUND

Condition Based Maintenance, Reliability Centred Maintenance, Predictive Maintenance, Preventative Maintenance - all similar terms and all based on the premise that equipment failures can be prevented.

Most equipment failures give some warning of the fact that they are about to occur. The trick is to be able to detect these warnings with sufficient time in hand to take preventative action.

Maintenance philosophies of the past were based on fixed time periods with maintenance/ refurbishment/ replacement scheduling purely a repetitive task. As operating capital budgets are being stretched to the limit in the new global village competitive market, new and more innovative thinking is required in asset management.

In any asset management environment, cost must be the driving factor. It makes little sense to spend R100 in annual maintenance (time, overhead, labour etc) on a piece of equipment with a replacement cost of R10.

In a well-planned maintenance system, the cost of equipment failure must be the driving force behind maintenance money spent on that equipment. In this case, cost must be all inclusive of replacement, labour, spares holding, downtime, criticality of that piece of equipment in the productive chain etc.

In an electrical environment, the subsequent costs of equipment failure can be many, many times the cost of replacement since electricity is the lifeblood of industry, commerce and domestic environments.

Only recently have more accurate consequent costs being given to loss of electricity with amounts of 0,5% of GDP (R4 billion in RSA) being typical. An optimised holistic approach to asset management will eventually lead to a maintenance system comprising:

- Condition Based Maintenance (on line and off line monitoring)

- Planned Maintenance and
- Run to Failure Maintenance (no maintenance)

CONDITION MONITORING PRINCIPLES

Goal is to identify changes in the condition of equipment that indicates some potential failure.

Condition monitoring identifies physical characteristics that collectively indicate the current condition.

Characteristics are measured, analysed and recorded so as to reveal trends.

Progress of these trends represent the deterioration of equipment conditions that will be used to determine appropriate actions.

Studies by US Navy on electrical equipment showed that monitored equipment had 16% of the catastrophic failure rate of unmonitored equipment. Probability of detecting an impending failure ranged between 92% and 95%.

TERMINOLOGY

Mean Time to Failure (MTTF)

This is defined as the time taken for the equipment to fail, normally expressed in years.

However, some care has to be taken in this definition in an electrical environment, depending on whether the failure was catastrophic, or whether it was initiated by a protection trip before damage was incurred.

From a probabilistic and reliability point of view, the finer points of definition are meaningless. However, from a maintenance point of view, the difference is substantial - implying the difference between switching the equipment back into service after proper investigation (hours), or ordering replacement equipment with subsequent lengthy delays (months).

The often quoted CIGRE surveys do not differentiate between a Buchholz trip on a transformer and a catastrophic failure, the two failures having vastly different consequences, economically as well as time to restore.

Restoration Time

This is defined as the time to restore the equipment to working order and put back into service.

It could be as little as seconds (Auto reclose of overhead lines) or months (replacement of power transformers).

It normally involves the response time (callout time after first notification), investigation time (time to investigate the fault), repair time (time to repair/refurbish damaged equipment) and re-commissioning time (time to re-commission equipment).

Realistically, this process is normally measured in hours or days or months.

In a different environment, where the investigative process is reduced to seconds, this element could be a matter of minutes. However, in an electrical environment, the safety issues predominate, and restoration time will always be measured in hours.

ELECTRICAL CONDITION MONITORING - MEASURANDS

Tan Delta: Measures the ratio of resistive current to the expected capacitive current. As insulation failure takes place, the insulation degrades with heating and decreased resistance being the order of the day. Typical Tan Delta limits are less than 1%, although some utilities "squeeze" this to 2% and even 3%. Tan Delta can be used Off - line and On - line. Power Factor measurements are similar for low power factors (power factor is the ratio of resistive current to the Total current and numerically identical to Tan Delta for values less than about 3%)

Partial Discharge: Measures the amount of electrical charge generated by voids in an electrical field. Discharge of the capacitive energy within the voids lead to tiny amounts of electrical energy being released. Discharges are measured in pico-Coulomb with typical upper limits of 10pC for paper-oil insulation. Has to be measured at nominal voltage in a laboratory environment since "noisy" electrical environments (eg substation) will contaminate the results. Research is underway to allow this measurement to be carried out in-situ.

Insulating Oil Analysis (Dissolved Gas Analysis - DGA): Measures the trapped gases in oil. During initial arcing faults, the heat creates gasses in oil. These gasses have a hundred times more affinity for absorption in oil than rising to the surface and being measured in the air above the oil, or being detected in the Buchholz. The oil has to be sampled at a point where the flow rate is high such as to ensure a homogeneous sample. Laboratory tests are then carried on the sample using gas chromatography. The makeup of the gasses is indicative of the type of fault. The amount of gassing in parts per million (ppm) gives a clue to the severity of the fault. For a power transformer, 0-500ppm is normal, 500-1000ppm shows significant decomposition (developing fault) while greater than 1000ppm is substantial decomposition and indicates an existing fault.

Insulating Oil Analysis (Contaminants): Carried out in a laboratory on oil samples taken from the equipment. Dielectric strength is measured by voltage breakdown between two metallic spheres and gives an indication of the amount of free water and dirt in the oil. Dielectric strength should be greater than 50kV. Dissolved water measurements are performed with upper levels of 30ppm. (Since cellulose insulation absorbs water up to 1000 times more than oil and insulation breakdown of cellulose will occur with greater than 30000ppm). Acid Content indicates sludge and other contaminants.

Insulation Resistance (Megger): Measures the DC resistance of the insulation. A measure of insulation integrity. Measurements are conducted Off - line.

Thermal Scanning: Measures the relative temperature (externally and internally) of components of equipment. A measure of localised hot spots and overheating. Normally carried out On - line.

Ultrasonics: Measures sound outside the human ear bandwidth. A measure of corona and tracking. Normally carried out On - line.

Frequency Response Analysis (FRA): Measures the electrical "transfer function" of an item of equipment in the frequency domain. Can be used to trend condition from an initial "new" signature. Off - line and On - line.

Vibration Analysis: Measures the level of vibration in rotating equipment. Indication of bearing failure in all motors and rotor faults in synchronous alternators. On - line.

Physical Inspection: Probably the best test available. Tell tale signs of oil leaks, low gas, overheating etc. Off - line and On - line.

ASSET MANAGEMENT - CONDITION MONITORING

Present Status

Condition Monitoring in the electrical environment varies between electricity supply utilities, depending on the degree of sophistication. This could range from daily recordings of "Maximum Demand" ammeters, to yearly dissolved gas in oil analysis (DGA) and infrared scans of equipment. All of these monitoring techniques have relevance in determining the status of electrical equipment - whether it be overloading or incipient failures.

New techniques become available over time, recent being infrared scanning, ultra-sonics, on-line transformer monitoring and on-line Tan Delta monitoring. All of these techniques have to be measured against the cost to implement and the effectiveness of monitoring. Not all techniques are cost suitable for different applications varying from high security installations to remote rural ones.

As mentioned before, cost is the driving element here.

On-Line versus Off-Line

The debate on the two techniques is varied depending on which manufacturer/supplier one speaks to. If off-line monitoring is carried out frequently enough, the difference between the two becomes minimal.

Obviously where fast changing trends need identifying, on-line monitoring is the obvious choice. However, some failures take months or years to manifest themselves, and the need to monitor more frequently than annually is unnecessary.

In most cases, on-line monitoring has proven to be far more effective than off-line monitoring due to the continual availability of data. In some cases, on-line monitoring has been essential in detecting incipient failures undetected by off-line monitoring. Again cost is the driving element with on-line being an order of magnitude more expensive than off-line.

Substation Equipment

This normally consists of the following elements:

Switchgear (Circuit Breakers and Isolators/Off load switches)

Transformers
Current and Voltage Transformers
Surge Arresters
Wall, Floor and transformer Bushings
Protection & Control equipment

Tripping Battery/s

Busbars

All of the above equipment has some form of maintenance requirement from simple cleaning and visual inspections to complex mechanical refurbishments.

Switchgear

Switchgear can account for as much as 30% of the capital outlay in a substation.

Switchgear is probably the most maintenance intensive equipment in a substation due to the moving parts (actuating mechanisms, springs, contacts etc). The mechanical moving parts require maintenance depending on number of operations and/or condition. The electrical contacts require maintenance depending on condition and the insulating medium requires maintenance depending on condition (pressure, vacuum, oil level etc)

Life expectancy (other than defective manufacture) is typically related to the number of operations and the magnitude of faults cleared.

Typical MTTF is around 42 years with a 48-hour restoration time (note that restoration time could be as low as 1 hour for metal-clad switchgear where a spare trolley is available).

Many condition monitoring systems are available, varying from mechanical characteristics alone to electrical characteristics alone.

Failing mechanisms can be detected by loss of speed, changes in travel distance, differences in pole timing, excess vibration etc. Failing contacts can be detected by micro-Ohm measurements, current clearing times and I2t measurements. Most manufacturers and/or relay suppliers now have a measure of I2t monitoring "built in" to their equipment.

Typical monitors can cost from around R1500 to R10000 per 3-phase breaker.

Transformers

Transformers are easily the largest capital outlay in a substation, accounting for more than 50% of installed assets. Depending on the type, transformers can also have a high maintenance overhead due to On Load Tap changers (OLTC's), Oil pumps and Fans, if fitted.

Typical MTTF is around 35 years with 72-hour restoration time. The standard condition monitoring is mainly off-line oil analysis (winding and insulation faults, tapchanger faults, sludging etc). Regular Infrared scans as well as in-built winding and oil temperature monitors are also useful in detecting hotspots.

Physical inspections of oil leaks (seals), oil levels, rust and other corrosion, paint flaking etc are essential on a regular basis. Ultrasonic signature analysis is a relatively new monitoring technique as well as Frequency Response Analysis. Both work on the basis of detecting changes against a "baseline" signature. On-line oil analysis is also playing a bigger part, where it can be justified.

Frequency of monitoring varies from daily (eg large transformers oil temperatures) to annually, depending on the criticality of the transformer. A recent survey by one of the UK's Area Utilities has shown that by changing DGA from 12 monthly to 3 monthly, they have reduced catastrophic failures to less than 10% of previous.

Typical costs are (excluding own manpower)

DGA	R400/sample
Infra-red scan	<R100/transformer if whole substation scanned
Ultrasonic scan	R250/transformer
FRA	R1000/transformer
On-Line DGA	R70 000/transformer

Current Transformers and Bushings

Current Transformers (CT's) and Bushings form a fraction of the capital outlay of a substation, typically less than 5%. However, in order to minimise manufacturing costs, the vast majority of high voltage CT's and Bushings are insulated with hermetically sealed paper-oil insulation. This creates an explosive situation where an internal fault will ultimately lead to a "grenade" type failure with "shrapnel" being blasted up to hundreds of metres away with consequent damage to adjacent equipment. Furthermore, since this equipment failure is almost always catastrophic and consequential damage is so much higher (eg transformer bushing failure will almost inevitably lead to catastrophic transformer failure, CT failure will normally result in a bus-zone operation), much attention has been paid to monitoring.

MTTF is typically 200 years with 24 hour restoration time.

Condition monitoring techniques are Tan Delta (Off-line and on-line), Partial Discharge, DGA (Off-line and online), infrared scans and Physical inspections. While Off-line Tan Delta monitoring has historically been the traditional method, On-line is finding more favour due to the better accuracy of early detection. Partial Discharge measurements can only currently be performed in a laboratory environment, while DGA can only detect failures sometimes after they have occurred (due to non-circulation of the oil).

Typical costs are (excluding own manpower);

DGA Off-Line	R400/sample
DGA On-Line	R70 000/device
Tan Delta Off-Line	R300/device/test
Tan Delta On-Line	R3500/device
Partial Discharge	R10 000 - R20 000 depending on transport costs

Voltage Transformers

These make up typically less than 1% of capital outlay for a substation. They do not normally result in catastrophic failure except the capacitive divider type (Capacitive Voltage Transformer or CVT) which is only used at Extra High Voltages due to cost.

Currently the only condition monitoring is physical inspections, although research is underway for On-line Tan Delta monitoring of CVT's.

Surge Arresters

These also make up less than 1% of substation capital outlay. Catastrophic failure is rare, although some utilities have had poor experience with modern Metal Oxide type surge arresters.

Condition monitoring is minimal, although some portable on-line monitors have been developed for Metal Oxide arresters (The "blocks" have a continuous leakage current at nominal voltage. By monitoring the power factor of this leakage current, incipient failure can be detected).

Tripping Batteries

The capital outlay is also low in comparison, typically less than 1%. However, this is an important element of protection and ignoring the status can lead to ultimate substation destruction, due to sustained faults not being cleared because of "flat batteries" or insufficient capacity.

Typical MTTF is 4 years and frequently less if poorly maintained. Manufacturer claims of 20 year life expectancy mean little if the battery is mistreated. Standard condition monitoring are Specific Gravity (SG) of lead acid batteries, "String" and individual Cell voltages and currents during discharges (preferably deep discharges using an artificial load), Capacity calculations from the foregoing (replace if less than 80% of nameplate) and Internal resistances of strings and cells.

Costs of automated discharging and monitoring can be fairly high and even approach the cost of the battery itself.

CONCLUSIONS

A holistic approach to substation asset management will encompass some or all of the above monitoring and maintenance techniques. In all cases, monitoring and maintenance cost must be justified against consequential costs.

Some exciting new techniques of condition monitoring have become available and are being tested against the "old way" of doing things. To measure is to know as the saying goes, and the electrical engineering community must move along in an ever more competitive world.

Condition monitoring will improve asset management in allowing equipment to be utilised to end-of-life rather than being replaced due to age, thereby deferring unnecessary expenditure.

Changes in the ESI will see competition between utilities for "contestable" customers, and the only feasible competitive parameters are cost and delivery. Only by ensuring better delivery due to managed assets, will supply utilities have a competitive edge.

Universal relay for substation automation

Marzio P. Pozzuoli
(Presented by Klaus Klingenberg)

KLAUS KLINGENBERG

Current Position: Engineering / Technical Sales & Support Manager for Drivecor. Drivecor Authorised Distributor for GE Power Management and Relay Monitoring Systems in South Africa.

Qualifications: BSc. Degree - Electrical Engineering. He spent 10 years in a power system protection environment, involved in power system protection settings, performance, test and support for transmission and distribution systems.

Utilities and manufacturers have been speculating on the feasibility of a Universal Relay(tm) for a number of years. The ultimate goal for a Universal Relay, from both a technology and economic standpoint, is a unified, modular substation solution that can be net-worked and seamlessly integrated with existing hardware and/or software regardless of the vendor or communications network.

A key driving force behind the need for the Universal Relay is implementation cost. By having a platform that is open enough to keep pace with today's technology and maintains the modularity and flexibility to allow for future upgrades, utilities can not only preserve their initial technology investment, they can substantially reduce long-term implementation costs in the substation environment. No more stranded relay investments.

Although listing the attributes of a Universal Relay in theoretical terms is a relatively easy task, for developers the challenge has been in defining the necessary logistical requirements for the ideal Universal Relay. What building blocks are needed to make it as open as possible given today's advancements in technology? How do you design a relay with the flexibility to cover every foreseeable protection application - today and in the future?

As daunting a proposal as this may seem, one need only look at the evolution of PC technology to see how this can be achieved. In just a few short years, the PC has become the general purpose or 'universal' tool and indispensable engine of the information age.

It is worthwhile to note the key concepts which have made the PC a general purpose tool - i.e. a common hard-ware and software platform, a scalable, modular and upgradable architecture, and a common human-machine-interface (HMI) - are also the key requirements for a universal relay.

However, until recently, an essential element that has been missing from the Universal Relay equation is the development of a communication standard within the utility industry. PC technology overcame that hurdle a number of years ago to the point where PCs are so open, they can function in virtually any environment, communicate with any other device on a network, and run almost any software application without the need for customized inter-faces or configurations.

The utility industry has now followed suit with the development of an international standard that is bringing the Universal Relay to the forefront as the utility's general purpose tool and indispensable engine of the substation environment.

OPEN COMMUNICATIONS PROTOCOLS

In today's open systems the ability to share data seamlessly through company-wide networks is the key to increasing efficiency and reducing costs as well as enhancing open connectivity between a company's related functional areas. This is especially true in the utility industry, where organizations have been grappling with a range of proprietary hardware and software products that can be neither integrated nor upgraded at a reasonable cost and/or effort. Special communications interfaces or gateways must be used to connect any new equipment to an existing data network if a utility wants to expand beyond its proprietary equipment.

The effort to achieve a common protocol that provides high-speed peer-to-peer communications as well as device interoperability for

substation automation is being driven in North America by a select group of international utilities as well as the manufacturers. This is being done through EPRI (Electric Power Research Institute) in conjunction with the relevant standards-related groups in the IEEE and IEC committees.

With the progress being made by EPRI in establishing open-systems communication protocols, hardware and soft-ware from different vendors can be linked and progressively integrated over time, thereby providing a means to cost-effectively upgrade as needs and technology develops.

The proposed solution for the substation is implemented based on existing standards. These standards include the Manufacturing Message Specification (MMS) and Ethernet as the data link and the physical layer. The intent is that the substation communication will be UCA (Utility Communications Architecture)-compliant in order to eliminate gateways, and allow maximum interconnectivity among devices at minimum cost.

The development and increasing application of the proposed solution has the potential for saving millions of dollars in development costs for utilities and manufacturers by eliminating the need for protocol converters (both hardware and software) when integrating devices from different manufacturers. Also because of the high-speed peer-to-peer communications LAN (local area network) a great deal of inter-device control wiring can be eliminated by performing inter-device control signaling over the LAN.

UCA VERSION 2

EPRI's UCA(tm) Version 1 protocol was introduced in 1991 and represented the first comprehensive suite of open communication protocols to meet the specific needs of the electric utility industry. In 1997, the new UCA Version 2 standard substantially expands the versatility of UCA by including internet compatibility and specifying a common interface standard for electric, gas and water utility systems.

UCA2, in being able to provide an interface to different vendors' products, ensures that equipment from multiple sources can interface. In addition, it can support existing and future network protocols.

EPRI's work to date in this area has established that an open communication protocol allows utilities to improve operating and business decisions based on real-time availability of data, combine different local and wide area media with minimal modification costs, reduce system implementation time and cost through using standardized utility devices and eliminate redundant storage, since information can be accessed wherever it resides.

With communication protocols well on their way to becoming standardized, a major stumbling block to the Universal Relay has been removed. It is now time for it to move from the drawing board into the hands of the utilities.

THE EVOLUTION OF THE RELAY

When GE Power Management embarked on an ambitious design program to develop a "next generation" family of protection relays, it relied on the same concepts and technologies that have driven the desktop personal computer (PC) market to such phenomenal heights in terms of performance and cost effectiveness to make it a general purpose or "universal" tool and the engine of the information age.

The aim of the program was to provide utilities with a common tool for protection, metering, monitoring and control across an entire power system, one that would serve as the universal engine for substation automation.

In order to understand where the technology stands today, perhaps it's best to look at the evolution and functionality of protective relays over the years.

IEEE defines a protective relay as " a relay whose function is to detect defective lines or apparatus or other power system conditions of an abnormal or dangerous nature and to initiate appropriate control circuit action" (IEEE 100-1984). This definition could best be classified as general rather than 'universal' in nature.

Traditionally, manufacturers of protective relay devices have produced different designs that are specific to the protection of generation, transmission, distribution and industrial equipment. This approach has its roots from the days of electromechanical and solid-state relay designs, where the widely varying complexities associated with each type of protection had to be implemented in proprietary hardware configurations. For example, there was a significant difference in cost and complexity between an overcurrent relay used for feeder protection and a distance relay used for protection of EHV (extreme high voltage) lines.

This leads us to an essential requirement of a Universal Relay. A Universal Relay must at minimum, be capable of providing protection for all the sectors of the power system - from simple overcurrent protection for feeders to high-speed distance protection for EHV lines. More importantly, it must offer a cost-effective solution for both.

DEVELOPMENT MILESTONES

One key contributor to the feasibility of the universal relay design has been the advancements made in digital technology and the evolution of microprocessors, as well as the proliferation of numerical/digital relays within the industry.

One only need look at the PC industry to see that the power and performance of microprocessors have increased dramatically while prices have decreased. In fact, the technology is now at the point where the performance requirements of a distance relay and the cost/performance requirements of a feeder relay can be met by the same microprocessor and digital technology.

The proliferation of numerical relays, also has allowed manufacturers to develop and perfect software for protective relaying devices across a power system. By leveraging the advancements of microprocessor and digital technology, and combining those with the array of existing and proven software developments, the 'universal relay' becomes the logical outcome.

Just as the PC is a general-purpose tool that can perform numerous tasks by running different application programs on the same platform, so can a numerical relay built on a common platform become a general purpose or 'universal' protection device by running different protection software for the apparatus being protected.

As a general purpose tool, there are a number of essential functional blocks that must be incorporated into the design of a Universal Relay.

UNIVERSAL RELAY BUILDING BLOCKS

Most modern numerical, microprocessor based relays are comprised of a core set of functional blocks:

A. Algorithmic and control logic processing, usually performed by the main 'protection' microprocessor and often referred to as the CPU (central processing unit). Most numerical relays have multiple processors for different functions.

B. Power system current and voltage acquisition, usually performed by a dedicated digital signal processor (DSP) in conjunction with an analog-to-digital data acquisition system and interposing current and voltage transformers.

C. Digital inputs and outputs for control interfaces, usually required to handle a variety of current and voltage ratings as well as actuation speed, actuation thresholds and different output types (e.g. Form-A, Form-C, Solid-State).

D. Analog inputs and outputs for interfacing to transducer and SCADA (Supervisory Control & Data Acquisition) systems, usually required to sense or output dcmA currents.

E. Communications to station computers or SCADA systems, usually requiring a variety of physical interfaces (e.g. RS485, Fiber Optical, etc.) as well as a variety of protocols (e.g. Modbus, DNP, IEC-870-5, UCA 2.0, etc.)

F. Local Human Machine Interface (HMI) for local operator control and device status annunciation.

G. Power supply circuitry for control power, usually required to support a wide range of AC and DC voltage inputs (e.g. 24-300 VDC, 20-265 VAC).

The design of a universal relay requires an architecture that can accommodate all of the above functional blocks in a modular manner and allow for scalability, flexibility, and upgradability in a cost effective manner for all applications.

The biggest challenge for relay designers is the 'cost effective manner'. The risk they have faced in the past is creating an architecture with all of the above attributes where the base cost of the platform is too high for the more cost sensitive applications such as feeder protection.

Today, this has been resolved as a result of cost reductions inherent in the production of a common platform for all applications. Like the PC industry, common components such as power supplies, network cards and disk drives continue to drop in price, while delivering ever-increasing performance levels.

While protective relay production is nowhere near the volume of PCs, a next generation relay platform based on a modular architecture which can accommodate all applications will yield significant development and manufacturing cost reductions.

THE UNIVERSAL RELAY ARCHITECTURE

In defining what a Universal Relay needs to do, it is important to understand the architectural elements that perform the above mentioned functions.

MODULARITY

On the hardware side, modularity is achieved through a plug-in card system similar to that found in programmable logic controllers (PLCs) as well as PCs. A key element in the successful performance of such a system is the high-speed parallel bus which provides the modules with a common power connection and high-speed data interface to the master processor (CPU) as well as to each other. Figure 1 shows such a system with all the core functional blocks implemented as modules.

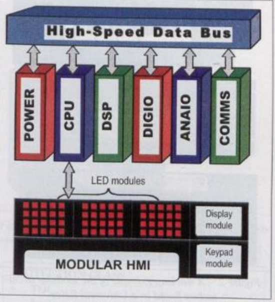


Figure 1: System configuration showing a high-speed data bus and modules with a common power connection and high-speed data interface to the zcpu.

POWER = Power Supply Mode
CPU = Main Microprocessor Module
DSP = Digital Signal Processor & Magnetics
DIGIO = Digital Input/Output Module
ANAIO = Analog I/O Module
COMMS = Communications Module

Figure 2 represents a physical realization of the modular architecture used in the design of GE Power Management's Universal Relay - a 19-inch rack-mount platform, 4 rack units in height, capable of accepting up to 16 plug-in modules.

Modules plug into a high-speed data bus capable of data transfer rates as high has 80 Mbytes/sec. The high-speed bus should be completely synchronous, thus allowing modules to transfer data at rates appropriate to their function. This is crucial in order to maintain a simple, low-cost interface for all modules. The bus should be

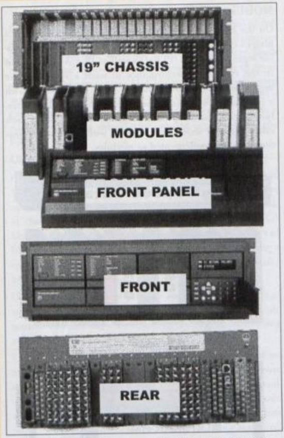


Figure 2 - A working example of the modular architecture found in a Universal Relay.

capable of supporting both parallel and serial high-speed communications simultaneously (up to 10Mbps serial) which allows those modules which must transfer data as quickly as possible to use the high-speed parallel bus (80 Mbytes/sec), while others can use the serial bus to avoid communication bottlenecks.

One of the key technical requirements of such a system for protective relaying applications is that the modules must be capable of being completely drawn out or inserted without disturbing field wiring which is terminated at the rear of the unit (see Figure 3).

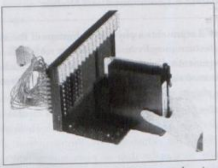


Figure 3 - Plug-in modules can be removed or inserted without disturbing wiring.

Modularity can also be applied at the sub-module level (Figure 4). Configurable input/output (I/O) combinations can accept plug-in sub-modules, which means that each sub-module can be configured for virtually any type of I/O interface desired, to meet both present and future demands. This gives the relay a 'universal' inter-face capability.

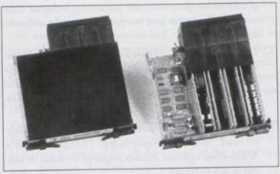


Figure 4 - Configurability at a sub-module level.

SCALABILITY AND FLEXIBILITY

A modular architecture of this type allows for both scalability and flexibility. In particular, scalability is found in the ability to configure the relay from minimum to maximum I/O capability according to the particular requirements. The flexibility lies in the ability to add modules con-figured with the desired sub-module I/O. This allows for maximum flexibility when interfacing to the variety of control and protection applications in the power system (Figure 5).

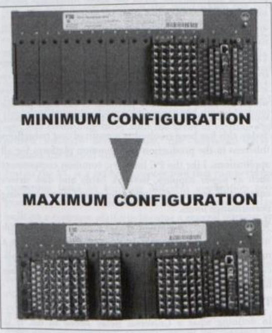


Figure 5 - An example showing minimum and maximum module I/O capability.

UPGRADABILITY AND ENHANCEMENTS

Another obvious benefit of this architecture is the ability of users to upgrade or enhance their relay simply by replacing or adding modules. For example:

- Upgrading from a twisted pair copper wire communications interface to high-speed fiber optics communications.
- Enhancing a transformer protection application by adding an Analog I/O (ANIO) module with the submodules to detect geomagnetic induced currents, sense and adapt to tap-position, perform on-load tap-changer control, or detect partial discharge activity.
- Upgrading the CPU module for more powerful microprocessor technology allowing for more sophisticated and protection algorithms (e.g. "Fuzzy Logic", "Neural Networks", "Adaptive").
- Enhancing the metering capability of the relay by adding a second DSP module with current and voltage transformer sub-modules capable of revenue class metering accuracy.
- Enhancing the control capabilities by adding a Digital I/O (DIGIO) module with customized labeling to customize the reporting of events.
- Enhancing the HMI capabilities by adding an LED module with customized labeling to customize event reporting.

MODULAR SOFTWARE

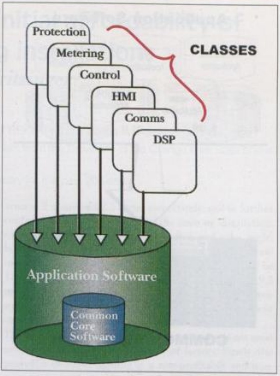
Scalability and flexibility issues are not exclusive to hardware.

Software must be able to support the same features. In fact, the software has its own form of modularity based on functionality. These include:

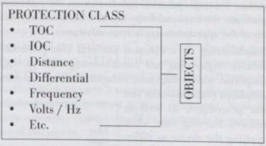
- Protection elements
- Programmable logic and I/O control
- Metering
- Data and Event capture/storage
- Digital signal processing
- HMI control
- Communications

The key advancement in software engineering that has come to dominate the software industry is Object Oriented Programming and Design (OOP/OOD). This involves the use of 'objects' and 'classes'. By using this concept one can create a protection class and objects of the class such as Time Overcurrent (TOC), Instantaneous Overcurrent (IOC), Current Differential, Under Voltage, Over Voltage, Under Frequency, Distance Mho, Distance Quadrilateral, etc. These represent software modules that are completely self-contained or 'encapsulated' (Figures 6a and 6b).

The same can be done for metering, programmable logic and I/O control functions, HMI and communications or, for that matter, any functional entity in the system.



Figures 6a and 6b - The OOP/OOD concept uses objects and classes to create self-contained software modules.



Therefore, the software architecture is able to offer scalability and flexibility: scalability in that the number of objects in an application are scalable (e.g. multiple IOC elements); flexibility in that objects can be combined to create custom combinations to suit the application (e.g. TOC, IOC, Distance Underfrequency and Directional IOC). In combining these attributes - modularity, scalability, flexibility, upgradability and modular software - the capability is there to run a wide variety of applications on a common platform. Figure 7 shows the concept of a common platform Universal Relay capable of running multiple applications.

THE BENEFITS

Overall, the ability to standardize on one hard-ware configuration that can address the majority of specific appli-

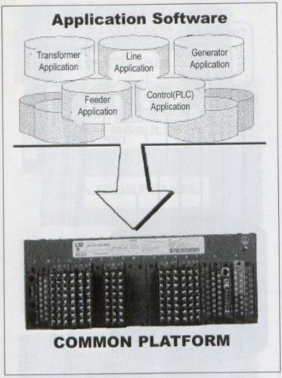


Figure 7 - The elements of the Universal Relay platform.

cations is a major potential benefit to users. As a common platform, the Universal Relay can be used to run any variety of the appropriate application soft-ware.

Standardizing on a common platform also potentially reduces engineering and commissioning costs through simplified wiring diagrams, reduced drafting expenses, simplified commissioning and test procedures, as well as reduced learning time when applying the device to different applications.

The key element, which results from a common platform approach in simple terms is that of a 'common look and feel' across the entire family of applications - the ideal scenario for substation automation.

THE UNIVERSAL RELAY'S ROLE IN SUBSTATION AUTOMATION

As mentioned earlier, utilities worldwide have been clamoring for a standard that will allow different devices from different manufacturers to communicate with a common protocol and to interoperate. Now that the standard issue is being resolved, one can look to add value by net-working protective relaying devices. This is achieved by leveraging their ability to communicate among themselves (i.e. peer-to-peer) and to the station interface.

Since the Universal Relay offers a modular hardware and software architecture that is scalable, flexible, and upgradable, as well as advanced peer-to-peer communications, it can accommodate the requirements of any substation automation proposal.

In addition, the configurable object oriented software can handle both new and legacy communications proto-cols, which means a Univeral Relay can coexist in today's environments, as well as handle any future migration to Ethernet or other future technology without incurring the significant investments normally associated with system conversions or upgrades.

As performance and functional requirements evolve to take advantage of the new possibilities brought about by high-speed peer-to-peer communications the Universal Relay can just as easily evolve to remain in-step with users' requirements and budgets.

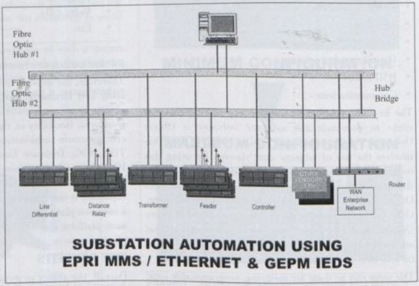


Figure 8 - Schematic of entire Universal Relay setup, from workstation to relays.

Lifecycle cost versus initial affordability of street lighting installations

Gustav Kritzinger

GUSTAV KRITZINGER

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Qualifications: Gustav has a degree in business management from the University of the Orange Free State and is an associate member of SANCI.

He has been involved in construction and the lighting industry for the past 20 years.

The Green Paper on Public Sector Procurement Reform in South Africa has stated clearly that the prime objective of public sector procurement is to achieve best value for money. Best value for money in the context of a technical component in procurement is the optimum combination of whole life cost and quality to meet a user department's requirements and not the lowest short term cost. Whole life cost takes into account all aspects of cost over the lifetime of the asset, including capital, maintenance, management and operating costs.

In engineering and construction projects like street lighting, life cycle costs are most important and are highly dependent on product design quality. Design quality is about providing, within the available resources, added value over and above the merely adequate. Procurement systems need to be structured in such a way that quality designs, and not lowest cost designs, are procured, as the work of the designer has a significant impact on lifecycle costing.

This paper takes an in-depth look at the current standards, methods and procedures, applied by the electrical distribution industry, for the provision of street lighting installations, a non-profitable and non-core service, and proposes a new approach to procurement standards, based upon lifecycle costing. This should provide new insights into the actual costs of street lighting services, especially when viewed in the light of the ever-increasing pressures to privatise these services.

1. CURRENT STANDARDS

The current standards of street lighting within many municipalities of South Africa are unfortunately based upon other considerations than what is inherently the most economical, both in terms of initial price and life cycle cost. In order to substantiate this, one merely has to refer to the practices of decision-makers within the electrical industry relating to which poles and luminaires they procure and the reasoning behind it. How often do we find that procurement of poles and luminaires for street lighting is limited to two types of poles and two types of streetlight luminaires? Here the most common are the typical 9.5 metre pole for use in residential areas and the typical 11.5 metre pole for use on main roads. To complete the picture, both are equipped with outreach arms of 2 metre and 2.5 metre respectively, and to further confuse and lend "character" to the town or installation, each municipality adds his own radius and rake angle, borne from years of painstaking refinement in their drawing office! Of course, the streetlight luminaire shall be 125 Watt mercury vapour side entry for use with the 9.5 metre pole in residential areas and 250 Watt high pressure sodium side entry for use with the 11.5 metre pole on main roads.

The reasons for these costly stereotype standards are most probably to be found in a number of factors. Firstly, the provision of street lighting is a non-profitable and non-core service to the public. As such, both in terms of capital and expertise, it has for many years been the stepchild of the electrical distribution industry. This has led partly to the fact that decision-makers have had themselves guided by convention ("it has always been done this way"), or put up resistance to change ("this is our standard, keep to it or we will not maintain it"). Some have also cited personal preferences ("I like it that way") or non-standard stock ("it is not on our annual tender and will result in another stock number") as reasons for not adopting new standards related to street lighting equipment. None of these subjective reasons should be acceptable to overburdened ratepayers.

Fortunately, a great number of progressive municipalities in South Africa have adopted new concepts for both their residential and main road lighting, which have led to substantial savings in both initial cost and life cycle cost. In this regard, I wish to refer firstly to the change from poles equipped with outreach arms to a straight pole / bottom entry luminaire concept. This can be attributed to a better understanding on the part of municipal engineers and designers of the luminous intensity distribution of modern streetlight luminaires equipped with sophisticated reflector systems. The luminous intensity distribution of these sophisticated reflector systems projects the main beam, also called the area of peak intensity, into the road at angle relative to a line parallel to the road. This angle, popularly referred to as the "toe-in" angle, makes the use of outreach arms on streetlight poles, used in a residential lighting application, an obsolete idea, and in many cases, when used in conjunction with an outreach arm, renders a street lighting installation to non-compliance with SABS 098. Secondly, investigations by municipal engineers involved with street lighting, have led to successful conversions from 125 Watt mercury vapour to 70 Watt high pressure sodium lamps, as well as the introduction of other wattage lamps like the 100 Watt super and 150 Watt high pressure sodium lamps. Investigations by these pioneers of the street lighting industry into the use of lower wattage tubular high-pressure sodium lamps and metal halide lamps are being conducted on a continuous basis.

A factor of major concern for the future RED environment is the virtually unlimited individual standards and variations of poles relating to their length, dimensions, outreach arm radius and rake angle. Combined with a magnitude of luminaire and lamp variations, the consolidated procurement of such a range of products will prove to be a very difficult exercise.

2. CURRENT SPECIFICATIONS

Almost 90% of South Africa's 375 local authorities, licensed to administer electrical reticulation in terms of section 156 (1) of the constitution, do not have any specifications relating to streetlight poles and luminaires. These municipalities do their procurement of whatever street lighting poles and luminaires on an "as and when" required basis. Sometimes they issue an official enquiry, mostly without reference to any specification and/or minimum SABS mark specifications. A further problem with smaller municipalities is that orders are usually generated via their stores to replenish minimum stock levels. This often takes place without the knowledge and/or involvement of the responsible person from the electrical department. The storeman or buyer would also not necessarily have the technical expertise to differentiate between what is value for money, or which products are bearing the relevant SABS mark - he will buy anything as long as it is the cheapest! Or, even worse still, he could have an outdated stock description on his computer, and put out an enquiry for the replenishment of something totally outdated and unsuitable!

It is in this grey area where the street lighting requirements of smaller municipalities are often left in the doubtful hands of electrical wholesalers and contractors, who in general are not equipped to offer sound advice on street lighting, based upon the latest technologies and standards. In such a situation, the advice of a professional and reputable streetlight pole and luminaire manufacturer is crucial. Such a manufacturer should be up to date with all aspects of streetlight pole and luminaire manufacturing and specifications, their relevant SABS marks, and their mechanical, electrical and photometric performance, culminating in the submission of street lighting designs in accordance with SABS 098.

Only 40 municipalities in South Africa do their procurement of streetlight poles and luminaires on an annual basis and in accordance with a tender specification. Most of these are currently grade 9 or higher. These tender specifications vary from the most primitive item description to detailed quality specifications, but they are mostly based on initial purchase cost. It is a known fact that a lack of detailed quality specifications mostly leads to the adjudication of a tender based purely on initial price and not on the value for money that the product offers. This usually results in a product soon requiring a higher maintenance expense than anticipated, thus ruining the initially perceived savings in purchase cost.

Several larger municipalities have introduced the so-called scheme price cost into their tender documents, whereby streetlight luminaires are evaluated in terms of their photometric performance, thus requiring less luminaires per kilometre. This results in fewer poles, excavations, cable terminations, installations, luminaires, lamps and subsequent lower energy costs per kilometre of installed street lighting. Refer to table 1.

The argument has been brought that most streetlight poles and luminaires are purchased for the replacement of those damaged in vehicle accidents, or for the replacement of existing streetlight poles and luminaires which are beyond economical repair, and is thus locked into a fixed spacing. Superior photometric performance can thus not lead to an increase in spacing, but it still leads to a justifiable improvement in the lighting levels of the streets in general. Furthermore, the scheme price system usually leads to the superior-performing product being offered at the lowest price, ensuring a rapid adjudication and acceptance by the council.

Scheme price applicable to Item 1 - 4

$$\text{Scheme price} = \frac{1\,000}{\text{Spacing [m]}} \times (\text{R}1500 + \text{Unit price [excluding VAT]})$$

3. REQUIREMENTS AND MATERIALS OF STREETLIGHT POLES

A streetlight pole has several requirements:

- It should hold a streetlight luminaire reliably in position, and therefore be manufactured in an ISO 9002 accredited factory and bearing the relevant SABS mark
- It should be easy to transport and install, saving on vehicle requirements, handling and installation
- It should be properly insulated, offering protection against electrocution by faulty wiring
- It should be maintenance free and corrosion proof both above and below ground
- It should have a lifespan of at least 50 years in a harsh and corrosive environment
- It should provide safety to road users and the community by being highly visible and prevent serious damage to vehicles and loss of life

TABLE 1: Design criteria, design results and price schedule: Group A street lighting

Type of luminaire and lamp	Unit	Item 1 250W HPSE /SE	Item 2 250W HPSE /MCB/SE	Item 3 250W HPSE /BE	Item 4 250W HPSE /MCB/BE
Design criteria					
Arrangement		Single sided left			
Lanes per carriageway		2	2	2	2
Width of each lane	m	3.7	3.7	3.7	3.7
Mounting height	m	10	10	10	10
Overhang of left hand side	m	1	-0.5	-0.5	-0.5
Angle of tilt	degrees	15	15	15	15
Lamp lumen	lm	25000	25000	25000	25000
Ballast factor	%	98	98	98	98
Maintenance factor 0.83*0.90 = 0.75 for IP 6* 0.76*0.90 = 0.68 for IP 5*					
Lighting Category		A3	A3	A3	A3
Traffic volume for road without median		300	300	300	300
Luminance	cd/m2	0.6	0.6	0.6	0.6
Overall Uniformity	UO	0.4	0.4	0.4	0.4
Longitudinal Uniformity	UL	0.5	0.5	0.5	0.5
Threshold Increment	%	20	20	20	20
Design results					
Pole Spacing	m				
Luminance	cd/m2				
Overall Uniformity					
Longitudinal Uniformity					
Threshold Increment	%				
Price Schedule					
Unit Price	R				
Scheme Price as per formula	R				

- It should be aesthetically pleasing and not be an eye-sore in our environment
- It should offer the most cost-efficient solution

There are a number of materials suitable for the manufacture of street lighting poles, and the material chosen is usually based upon criteria relating to cost, handling, corrosion resistance and strength. The four types of materials that are currently used for the manufacture of streetlight poles are glass fibre reinforced polyester (GRP), steel, concrete and wood, which will each be discussed briefly below:

3.1 Glass fibre reinforced polyester (GRP)

GRP streetlight poles have become extremely popular due to their ability to fulfill all the requirements as detailed above. These poles must be manufactured in accordance with SABS 1749. Due to both the low initial purchase cost and the fact that it is maintenance free, it is now the preferred choice of material of most municipalities for streetlight poles of up to 11.5 metre in length. As this material is extremely lightweight (approximately 20% of steel and 5% of concrete), it is also suitable for labour based construction programmes and allows for cheap and easy replacement in the case of damage by vehicle accidents. Furthermore, the use of GRP poles reflects the responsibility of the municipality towards community safety, as loss of life can never be compared to the cost of a streetlight pole. Once a GRP pole is hit by a vehicle, it will tear off at ground level, with the top half 100% intact. These damaged poles can then be reclaimed as a shorter pole by providing a new access door and cable entry, resulting in major savings to municipalities.

3.2 Steel

For streetlight poles above 11.5 metre in length, steel is still the preferred material. This due to the fact that poles manufactured from other materials are usually more expensive or it is either impractical to manufacture or difficult to find. All steel streetlight poles must be hot-dipped galvanised in accordance with SABS 763 to give it some form of protection against corrosion, and it is often fitted with an expensive additional corrosion sleeve. Especially in coastal environments, steel streetlight poles require repainting at regular intervals of approximately every 5 years at a substantial additional cost, but this does not prevent the interior of the pole to continue corroding until failure. Steel poles have also been responsible for countless deaths on South Africa's roads, and is also usually deformed beyond re-use once hit by an out of control vehicle. The practice of using a buried stub with a bolted shear flange, in order to re-use the buried portion, adopted by some users, have also failed due to the buried stub either deforming or disintegrating upon impact.

3.3 Concrete

Spun reinforced concrete poles have been popular due to its low initial purchase cost and the fact that it does not require painting at regular intervals like steel. It is, however, not the most aesthetically pleasing piece of street furniture ever designed! They must be manufactured in accordance with SABS 470. However, due to its extremely difficult transport and handling, as well as premature fracturing during transport and installation, it has lost a great deal of its popularity. Concrete poles installed in coastal environments have also failed prematurely due to corrosion of the interior steel reinforcing. Concrete poles are also as deadly as steel, and the structure is fractured and damaged beyond repair upon vehicular impact. Their handling and installation is also extremely complicated and time consuming.

3.4 Wood

Although wooden poles are used mainly for overhead power distribution and telephone networks, some municipalities also use them in conjunction with a conventional underground street lighting system. Hot dipped galvanised outreach brackets are clamped to these poles to allow for the mounting of side entry streetlight luminaires. Wooden poles may have a useful life of 40 years, but this is subject to them receiving remedial treatment within 10 years of installation, and at increasingly frequent intervals thereafter, in order to control decay. SABS 754 covers wooden poles manufactured from eucalyptus trees and SABS 753 covers those of pine, but these specifications refer mainly to grading and physical defects, rather than the moisture content. Research by Eskom has found that fungal attack begins when the moisture content of a wooden pole is above 20%, which can even happen in very dry areas which had been without rain for several months.

4. REQUIREMENTS AND MATERIALS OF STREETLIGHT LUMINAIRES

The requirements for streetlight luminaires are addressed in SABS ARP 035: 1993 - GUIDELINES FOR THE INSTALLATION AND MAINTENANCE OF STREET LIGHTING (under revision). This document should form part of the library of each and every person responsible for street lighting in a municipality, as it covers all aspects of this discipline in the electrical distribution industry and gives all the necessary guidelines to those not comfortable in the environment of street lighting.

Luminaires should bear the SABS 1277 mark and SABS 1464 safety mark and be of the totally enclosed type. Luminaires should incorporate a positive and substantial means of fixing to the pole or bracket, designed to allow adjustment and to ensure that once set to the required position, the luminaires remain locked in that position. Luminaire spigot entries should comply with SABS 1088 - Table 1, with a side entry having a diameter of 42 mm x 125 mm and a bottom entry having a diameter of 76mm x 75mm.

Luminaires should be designed to inhibit the ingress of dirt and moisture and should have a degree of protection certified in terms of SABS 1222 and SABS 098: Part1 - 1990, Code of Practice, Table B-1. The minimum IP rating of both the lamp and control gear compartment should be IP65, i.e. dustproof and protected against water jets, thus reducing maintenance and running costs. Luminaires with an ingress protection rating of IP 66 on both the lamp and control gear compartment, offering the ultimate solution to corrosion problems and premature failure of control gear components, are also available on the market. IP ratings should be certified by SABS test reports.

The housing should be robustly constructed, weatherproof, hail proof, corrosion proof and vandal resistant. An exterior lip should be provided on the housing to ensure that there is no direct rainwater contact with the gasket between the housing and the diffuser, thus ensuring that no moisture is sucked into the diffuser when the luminaire is switched off and cools down.

The enclosing diffuser bowl should not have any external prisms that could accumulate dirt and thus reduce the light output of the luminaire. The diffuser should be held to the housing by at least three clips, thus ensuring that it remains closed in the event of the failure of one clip. The diffuser should also remain attached to the housing when hinged open for maintenance or lamp replacement. This hinge mechanism should be incorporated into the housing to ensure that it protected against damage during transport, installation and maintenance.

Gaskets should be used to seal the lamp compartment. The gasket should be fitted into a groove in the housing and should be kept in place by a tongue provided on the diffuser, thus ensuring the integrity of the IP rating. The gasket should be screened against harmful radiation from the lamp source.

The optical system should consist of reflectors and should not be subject to accidental misalignment. All luminaires should be of the semi cut-off distribution, but where the design requires a cut-off distribution, the luminaire should be marked as having such a type of light distribution. Should a luminaire have an adjustable light distribution, either where adjustment markings are included on the luminaire body for setting of the optical system, or orientation of reflectors or of the lampholder, they, like the light distribution classification marking, should be made in a clear and preferably indelible manner. The lampholder should comply with VC 8011, should be rated for 240∞ C and should prevent possible loosening of the lamp caused by vibrations.

All control gear should be housed fully within the body of the luminaire in a separate gear compartment and sealed by a hinged, non-corrosive lid. Access to the gear compartment should not be possible without the use of a tool or key, thus protecting unqualified staff, doing lamp replacement, against electric shock. Covers and other parts that provide protection against electric shock should have adequate mechanical strength and should be reliably secured so that they will not work loose whilst in service. For ease of maintenance, access to the gear compartment should be gained from underneath and all the control gear components should be mounted on a removable gear tray. The control gear should be suitable for operation with the specified rating of the lamp on a 230V+3%/-10% 50 Hz single-phase system. All control gear components should be removable and bear the relevant SABS mark. All internal wiring should be Teflon coated with protective sleeving to prevent damage by possible abrasion. All screws, bolts and metal parts should be of stainless steel or non-corrosive materials. Ignitors, where applicable, should be of the superposed pulse type. Luminaires should be power factor corrected to a minimum of 0,85. Where optional integrally mounted MCB's are required, they should be mounted on the control gear tray, with the lever of the circuit breaker accessible from the outside of the luminaire.

Luminaires with a separate spigot compartment, suitable for both side entry and bottom entry versions, are also available on the market. These luminaires offer the added advantages that the control gear is not subjected to possible damage during installation or by moisture rising up a pole when heated by the sun during the day. The spigot compartment would also house a screw terminal block and wire clamp, as well as an optional downfacing miniature daylight switch, giving it protection against UV and ensuring extended service. Otherwise, daylight switches suitable for Nema type base sockets should be plugged into a base mounted above the gear compartment, so as not to expose the daylight switch to overheating.

Self-adhesive labels should be applied to the underside of the luminaire housing which should be visible when the luminaire is mounted on a pole. This label should indicate the type and Wattage of the lamp, as well as the letters CO in the case of a luminaire with a cut-off distribution. Luminaires suitable for use with tubular lamps should be indicated as such with the letter T after the Wattage. Letters should be at least 40mm in height and be black against the following background colours:

- High pressure sodium vapour - Light orange B26
- High pressure mercury vapour - Strong blue F11

The materials currently used in the manufacture of streetlight luminaire housings are mainly engineering polymer, dough moulding compound (DMC), cold pressed glass reinforced plasic (GRP) and aluminium, each of which will be briefly discussed below:

4.1 Engineering polymer

Over the past ten years, engineering polymer, like reinforced polypropylene homopolymer, has become the most popular material for the manufacture of streetlight luminaire housings. This material is UV stabilised, provides a good surface finish, rigidity and toughness. It has a good heat distortion resistance and can be used continuously at 100 - 110∞ C for years. Further tests have shown that this material will not lose its tensile strength even if exposed to 140∞ C for 600 hours. Due to the fact that this material is injection moulded, it can be produced in high quantities with excellent consistency.

4.2 Dough moulding compound (DMC)

This is a dough-like mixture of reinforcing fibre, with a length of 3-12 mm, and a polyester resin, that has been used for many years in the manufacture of general-purpose outdoor enclosures via a hot press moulding technique. This material does not have the high mechanical strength or heat resistance than that of engineering polymer, and care should be taken that no glass fibres are exposed, as it will draw moisture and further reduce its mechanical strength properties.

4.3 Glass reinforced plastic (GRP)

This material, utilising the cold press moulding technique, used to be popular up to the eighties due to its low tooling cost and low-pressure presses required. The glass used is in the form of a chopped strand mat, offering excellent mechanical strength. Unfortunately, due to the low pressure and simple tooling, this process cannot be applied to high technology streetlight luminaire housings where there are high requirements on tolerances and design details. The long cycle times also do not allow for high volume production.

4.4 Aluminium

Aluminium, either in the form of high-pressure die cast, gravity cast or extrusion, is still one of the best materials for the manufacture of streetlight luminaire housings. It offers excellent heat dissipation and mechanical strength, as well as good resistance to corrosion. Unfortunately, the high tooling and material cost has limited the use of this material.

Diffusers should be manufactured from injection moulded high impact acrylic, which does not yellow, or otherwise toughened heat and impact resistant glass. Polycarbonate should not be used, as it discolours and rapidly loses its impact resistance when subjected to the UV emitted by the sun or lamp source. Gaskets should be manufactured from silicon sponge, as it is an intelligent material that does not deteriorate, with clips being manufactured from an appropriate grade of stainless steel. Reflectors should be manufactured from 99.98% super pure deep anodised aluminium, ensuring a consistently high efficiency.

5. THE COST OF OWNERSHIP OF A STREET LIGHTING INSTALLATION

Capital assets like a street lighting installation, incur the greater part of their whole life cost after purchase, with the purchase price frequently being as little as 20% of the total cost. This is reflected in most of the capital and maintenance budgets of some of South Africa's major municipalities, which were researched for this paper. Table 1 has indicated clearly the comparative cost per kilometre of street lighting, based upon the photometric performance of a streetlight luminaire and the installed cost of the streetlight pole. What this table does not take into consideration though, is the comparative cost of ownership of the installation over a 10 to 50 year period.

With reference firstly to a streetlight pole, it becomes important to determine the following parameters before a decision is made based upon the initial purchase price per unit:

1. What is the cost of installation of each type of material of pole, based upon its weight and ease of handling, transportation and erection?
2. What is the premium on labour and transport applicable to each type of material in the event of replacement, based upon the number of staff and type of vehicle required to transport, remove, reinstall and erect the pole?
3. What is the life expectancy of the various types of streetlight pole materials?
4. Does it require any preventative treatment, like painting, during its expected life, and if so, at what interval and at what cost?
5. Is it possible to reclaim poles damaged by vehicles by cutting new access doors and cable entries and re-using it as a shorter pole?

Once these parameters have been evaluated in a comparative cost of ownership table, the cost of ownership can be determined. Please refer to table 2.

As far as the streetlight luminaires are concerned, the main factors that should be taken into consideration are as follows:

1. The photometric performance of the luminaire, determining the spacing of poles at a pre-calculated installed cost.
2. The mechanical properties and design of the product, relating to the durability and life expectancy of the materials used in the manufacture of the housing, gasket system, reflector system and diffuser.
3. Design details relating to the speed and ease of maintenance and replacement of components and control gear.
4. The IP rating and its integrity.
5. The actual rise of high-pressure sodium lamp voltage due to poor reflector system design and small volume of the lamp compartment, which has a direct influence on expected lamp life. Currently, the SABS merely states a compliance or non-compliance to the maximum stated rise in lamp voltage, as determined by paragraph 3.5.7 and Table 2 of SABS 1277. As a high pressure sodium lamp ages, the lamp voltage increases until the voltage needed to sustain the arc has reached the level of the supply voltage (+- 130V), which is indicated by "cycling" and effectively indicates end of life. The relationship between lamp voltage rise and life expectancy can be seen in graph 1.

Lamp replacement makes up by far the biggest part of streetlight maintenance tasks. It can be done according to two different strategies: by replacing a lamp when it fails, or by planned group lamp replacement. The former makes no provision for lumen depreciation, with the result that, at time of failure, the designed lighting levels will not have been met. This could result in a probable

GRAPH 1: Relationship between lamp voltage rise and life expectancy

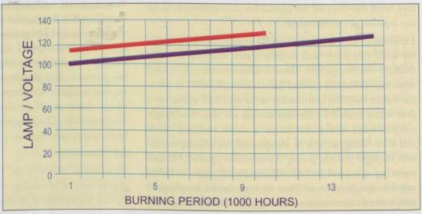

TABLE 2: Comparative cost of ownership of GRP vs steel street lighting poles

			GRP	STEEL
	BASE QUANTITY	10000		
QUANTITY OF	9.5M POLE	8000		
QUANTITY OF	11.5M POLE	2000		
PRICE OF	9.5M POLE		R 1,000.00	R 1,200.00
PRICE OF	11.5M POLE		R 1,600.00	R 1,400.00
ANNUAL GROWTH, %			2%	2%
ANNUAL REPLACEMENT, %			2%	4%
REPLACEMENT PREMIUM, %			10%	50%
TREATMENT AFTER YEAR			50	5
LIFE EXPECTANCY, YEARS			50	25
COST OF TREATMENT	9.5M POLE		0	200
COST OF TREATMENT	11.5M POLE		0	300
COST OF OWNERSHIP - 10 YEARS			R 2,506,698	R 3,107,378
COST OF OWNERSHIP - 20 YEARS			R 5,562,348	R 7,147,504
COST OF OWNERSHIP - 30 YEARS			R 9,287,169	R 13,496,656
COST OF OWNERSHIP - 40 YEARS			R 14,333,187	R 23,845,461
COST OF OWNERSHIP - 50 YEARS			R 19,362,593	R 34,159,598

increase in road accidents and night crime. Also, the high labour and vehicle operating cost to replace individual lamps, makes it an extremely expensive option.

Planned lighting maintenance, or otherwise known as planned group lamp replacement, is a philosophy agreed to by most major municipalities in South Africa as being the only practical and most economical strategy to manage lamp replacement. Group lamp replacement is an efficient system of maintenance whereby every lamp in a predetermined area is changed in one operation at a fixed interval, irrespective of whether a lamp has failed or is still operating. The interval chosen is based on the most economical burning period for the lamps according to their lumen depreciation and the mortality curve of the particular lamp. Based upon the high ingress protection ratings of IP 65 and IP 66 of streetlight luminaires nowadays available on the market, in conjunction with the reliability of lamps and control gear, this interval is suggested as 36 months. Lamps that fail between group lamp replacement intervals are replaced individually on a spot replacement basis.

Planned group lamp replacement can be carried out during normal daylight working hours, which considerably reduces the cost of staff and vehicles required to replace individual lamps. The problem of lack of staff within municipalities to drive a planned group lamp replacement programme, can be solved by this work being put out to contract. Specialist street lighting maintenance contractors are not bound to restrictions on overtime or working at night, and produce extremely high productivity levels due to their philosophy of payment per job done. These specialist contractors should also be given the task of simultaneously providing a cleaning and preventative maintenance service.

Notwithstanding all the advantages of planned group lamp replacement, during a survey conducted on the actual costs of owning and operating a street lighting installation, not one municipality could be found which still has it as their lamp replacement strategy. Maintenance has degraded to a find and fix basis, where fortunes are lost in monies spent on operating costs relating to staff and vehicles, without providing the level of service which ratepayers are paying for. In many cases, the amount of money spent on the procurement of lamps and materials required for maintenance, represented less than 20% of the maintenance budget, with 80% disappearing into a bottomless pit of operating costs. As a street lighting service is also an entity that is still not ringfenced within the electrical distribution industry, actual operating costs could make up an even higher percentage of maintenance expenses.

6. A PROPOSED MODEL FOR PROCUREMENT BASED UPON LIFE CYCLE COSTING

TABLE 3: Installed pole cost comparison

	A	B
	BASE QUANTITY	**10000**
UNIT PRICE	R 1,600.00	R 1,400.00
WEIGHT IN KG	50	250
LABOUR RATE PER HOUR - R10		
VEHICLE RATE PER HOUR PER 50KG - R30		
HANDLING & TRANSPORT, 10 POLES PER HOUR		
LABOUR (weight (25 x rate x duration)	R 2,000.00	R 10,000.00
VEHICLE (weight (50 x rate x duration)	R 3,000.00	R 15,000.00
INSTALLATION, 1 POLE PER HOUR		
LABOUR (weight (25 x rate x duration)	R 20,000.00	R 100,000.00
VEHICLE (weight (50 x rate x duration)	-	R 150,000.00
TOTAL	**R 25,000.00**	**R 275,000.00**
HANDLING, TRANSPORT & INSTALLATION COST PER POLE	**R 25.00**	**R 275.00**
INSTALLED COST (unit price plus handling, transport and installation)	**R 1,625.00**	**R 1,675.00**

A model for the procurement of pole and luminaires for street lighting installations should take cognisance of the fact that what you pay is not necessarily what it costs. The system of scheme price evaluation of streetlight luminaires, as introduced by several larger municipalities and referred to in table 1, is proposed as the model to be adopted in all tender documents relating to the procurement of streetlight luminaires. With regard to the procurement of poles, factors like the weight, life expectancy and cost of treatment of streetlight poles should be determined to form part of its installed cost. It is therefor proposed that the future tender specifications of local government or REDS for streetlight poles, to be used in new capital projects, do not refer to material specifications, but to performance specifications, bearing the relevant SABS mark.

It is further proposed that the handling of a streetlight pole becomes a cost, based upon the ability of a person to handle a weight of say 25 kilograms, as well as the cost to lease capital equipment, like vehicles and cranes, required to transport and install the pole. These factors would provide a much more accurate picture of the installed cost of a streetlight pole. The cost of ownership, as depicted in table 2 above, which takes care of the other aspects like replacement premiums, life expectancy and cost of treatment, which is of significant proportions in coastal environments, can also be included in the tender document.

CONCLUSIONS

Many municipalities have based their standards, specifications and methods of procurement of street lighting on reasons other than those borne from sound engineering and financial concerns. This can be attributed to factors that have found their way into the day to day activities of local government over a length of time, with most of them being based on subjective reasons. It is appreciated that electrical distribution engineers are involved with so much more than a non-profitable and non-core service like street lighting to ratepayers. However, as ratepayers, it should not be acceptable that this service is provided without an up to date set of standards and specifications or that the procurement of the items required for the provision of street lighting is based only upon initial unit price. Tender documents should be drawn up in such a way that the life cycle cost of street lighting is taken into account before a tender is adjudicated.

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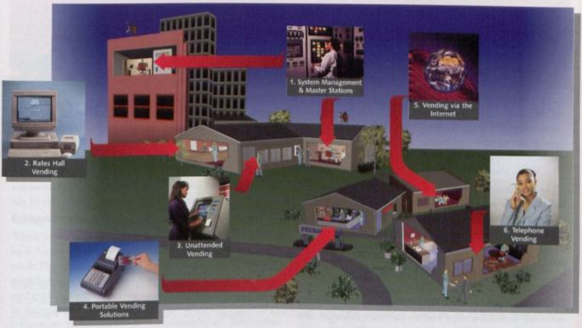

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PV renewable energy: A non-grid technology in transition

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INTRODUCTION

There is no doubt that the use of new and renewable energy sources should be supported in building a sustainable energy sector world-wide. However, some technical assistance agencies' and developing countries government's strict policies of dealing exclusively with renewable energy technologies have resulted in renewables being chosen for projects in which they were clearly inappropriate and considerably more expensive than conventional options. The incremental costs born by the African continent due to these experiments have been very high in the 70s and 80s.

This is not to say that new renewable energy technologies should not be applied. On the contrary, more knowledge of the conditions under which these technologies are the most suitable is needed. But renewables should be subject to the same technical, financial and social analysis as the commercial options are being subjected to. Only in this way can a commercial market and trust in the new technologies be attained. [Levine M, 1993]

THE NEED FOR ENERGY TECHNOLOGY R&D

Throughout the world, access to energy services and the development of modern energy forms have been major driving forces for economic growth, social security and technological progress. In fact, efficient energy use plays an important role in the social and economic development. It contributes, for example, to slow down population growth, and reduces pollution and environmental pressures.

Electric power has largely supplanted oil as the most controversial energy issue of the 1980's. Souring costs, high interest rates and environmental damage caused by large power plants have wreaked havoc on the once booming industry. In most countries, electric prices have risen faster than the general rate of inflation since the mid 1970's. In this regard electricity generation have been mostly that of coal fired power plants. These are a major cause of air pollution, and are implicated in the predominant environmental issue of the time, namely acid rain and global warming.

Although there is still a considerable uncertainty about the exact degree of global warming expected over the next few decades, the greenhouse warming is real. Water vapour, carbon dioxide and other naturally occurring gasses trap heat in the earth's atmosphere. This energy drives atmospheric and oceanic circulation, redistributes energy more evenly across the planet, raises the average surface temperature to about 33OC, and makes the earth a pleasant place to live. Most climate scientists now agree that doubling the concentration of CO_2 from pre-industrial levels to the present level will increase the surface temperature by about 1 to 3.5OC by 2100.

About 70% of the increase in CO_2 concentrations however have occurred in the last 50 years, and have been attributed to coal and other fossil fuel burning for energy generation [Intergoverment report:1996][Morgan MG, 1995] Even with the introduction of stringent policies, the world's energy systems will continue to add CO_2 to the atmosphere. Once released the CO_2 remains in the atmosphere for about a century. Given the dependency of the world's economies on energy and the growing aspirations of the people of Africa, China and India, the introduction of a draconian 60% less CO_2 emissions is simply not going to happen. More and more people are going to want large homes with good heating and air conditioning, a wide range of electrical consumer products, and a varied diet that includes some meat. All these things require energy.

The only plausible technique by which we can reduce CO_2 emission is new energy technology. New energy should be able to provide people with the goods and services they demand as well as using far less energy, and it should be able to produce that energy with fewer environmental consequences. Figure 1 shows the carbon dioxide levels in countries that are industrialised.

Energy cost-effectiveness of PV

When introducing modern energy services one has to look further than the energy source and the technology used. The whole fuel chain from source and generation to distribution should be seen as a package with technical and regulatory mechanisms, and institutional frameworks as integral components. The success stories of rural electrification co-operatives is an example of innovative approaches when addressing small and fragmented markets, while also recognising the need to mobilise citizens to fully participate in the implementation of programs.

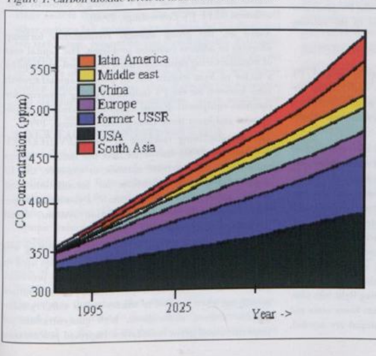
Historically, fundamental changes in the infrastructure for producing, distributing, and consuming energy have taken 50 to 100 years to complete. The development of clean-energy alternatives to fossil fuels, including photovoltaics, wind turbines, and fuel cells, seems no exception. Worldwide sales of PV systems reached 150 MW in 1998, after a decade of growth at 15÷30 percent per year. Extrapolating to 2023-half a century from the 1973 oil crisis and postulating steady annual growth of 25 percent, photovoltaics will add a total of 40 GW of new generating capacity by that year [Morris E 1996]. That estimate derives from a recent effort by the PV industry in the United States to develop a technology roadmap for sustained long-term growth, similar to those drawn up in the semiconductor industry. As detailed in the conclusion, the industry's roadmap anticipates that in the United States photovoltaics will cover about 15 percent of the added capacity needed each year in the early 2020s.

Where governments are subsidising the installation of PV arrays, growth may be even faster. Japan, above all, has maintained a large and steady R&D effort for decades, and recently also begun an initiative to install 5 GW of PV by 2010. The program as a whole is funded at 16 billion Yen annually. In the United States, Federal, state, and local governments encourage installation of building-integrated, grid-connected systems. There are local subsidies for systems purchase [Thomas E, 1999], federal/state tax and regulatory incentives, and state mandates that utilities include PV power in their generation portfolio.

Consider an electricity co-operative serving 2100 members in a closed system far from the grid supply. A study found that upgrading a feeder line to the tune of R8 million could not be justified in terms of the fees to be anticipated from members. But it also determined that an on-site power system would pay for itself over time if growth in demand were met by a combination of residential efficiency improvements, PV cells, and gas-fired co-generation. Balancing the PV and co-generation outputs proved important to the economics: turbines would produce more electricity in the winter for space- and water-heating, but in the summer their output could be reduced, and the greater PV output would match the remaining load.

Demand for electricity often is highest just when the sun is at its brightest, during the hottest parts of the hottest summer days. Thus, if the United States is mapped to determine where PV output is best matched to the demand profile, some areas not thought of for PV applications may be more viable than say the Kalahari desert! And when relative electricity prices are put into the equation, the advantage of the more industrialised and built-up locations is even greater [IEEE PV proceedings, 1998]. In Africa sunshine is abundant.

Figure 1: Carbon dioxide levels in industrialised countries.



One can therefore say that even without subsidies, PVs are economically attractive in many applications. Take the choices that face a homeowner located about a kilometer from the closest grid connection. Assume this consumer will demand 300 kWh per month with a load peak of 4 kW. The consumer could extend a connection to the grid, install a small diesel generator, or install a PV system.

A typical PV system for this load would include PV modules rated for peak output of 2 kW, twenty 6-V batteries rated at 300 Ah, and an inverter rated at 4 kW. Such a system will probably cost R50 000 installed, or about as much as most utilities charge to extend a power line to the house. Including this initial investment into the mortgage would boost monthly payments by R200 at current rates. The batteries will probably need replacing every four to five years, creating an operating and maintenance cost for the PV system that is comparable to the monthly charge to the homeowner for electricity drawn from the grid.

The diesel generator would be sized at 4 kW, costing R18 000 or so, much cheaper than the PV setup or new utility line. But running continuously, it will consume 20 to 30 liters of diesel a day and require an engine overhaul every two years and an engine replacement every seven to 10 years, so that the low initial cost is offset by nearly R600-per-month fuel and maintenance costs. Over a period of 10÷20 years, the PV system, which has no moving parts, no fuel needs, and little maintenance expense, will prove cheaper [IEEE PV proceedings, 1998].

Modularity is another PV advantage over conventional sources of power, in that PV systems can be expanded as the demand at a site increases. For example, in a closed system referred to above, the output of the PV generator could be expanded by adding modules to the existing array.

MATERIAL CONCERNS

To build the current-voltage characteristic desired, PV cells are connected into series strings and parallel circuits, which are then encapsulated, typically between a glass cover and polymeric sheets for pottant and a back skin, to form a durable module.

The materials used in these PV cells and arrays must meet the most challenging demands, in terms of not only durability and reliability but also efficient performance and low manufacturing costs. An IC company may produce thousands of Rands of product starting out from a 150-mm silicon wafer, but in PV module manufacturing, a similar wafer of the same size generates only about R50 in sales. It is of the utmost importance, therefore, to develop materials for cells that can be manufactured at relatively low cost from a smaller volume of material thanks to higher efficiencies in converting light into electricity. Note that higher efficiency means lower costs not only because smaller quantities of material are needed, but also because systems components like encapsulation, support structures, field wiring, and installation are smaller.

Before turning to the details of how research on the major categories of PV materials has been progressing, it may be appropriate to explain just how the PV cell differs from the integrated circuit in operation. That should also provide a better grasp on the pros and cons of bulk versus thin-film silicon, of the various copper ternaries, and of the III-V elements in a photovoltaic cell.

A ROADMAP FOR THE PV INDUSTRY

The PV industry must sustain a rapid growth rate for many more years to make a sizeable contribution to the world's supply of electricity. Such growth will match the industry goal of achieving a thriving business and national program goals to meet future energy needs for the country. Hence, the idea of developing a technology roadmap for the next decade is promising to the PV industry [Yeager KE, 1992: Morris E, 1996].

The United States National Centre for Photo-Voltaics group identified four task areas

- marketing and applications;
- systems,
- components,
- integration;
- manufacturing;
- basic research

Clearly, a major challenge for the industry is technical:

How to reduce the cost of hardware at a pace consistent with the anticipated entry into broader markets.

Nevertheless, the tone of some of he highest-priority actions identified by the NCPV meeting is distinctly non-technical [IEEE PV Proceedings, 1998].

Above all, the group strongly recommends forming alliances to address common problems. The capital cost of manufacturing equipment must be slashed–perhaps by a factor of 5–to sustain the 25 percent annual growth rates foreseen for the PV industry. Pooling resources for common equipment designs could both accelerate development and lower those costs [Siemens Review, 1999].

The manufacturing taskforce of the NCPV [IEEE PV Proceedings, 1998] discovered that the industry orders materials in an expensive manner. or example, the 12 slightly different specifications for formulations and dimensions of ethylene vinyl acetate, a common component of most module encapsulation systems, could undoubtedly be streamlined.

Scientific and engineering issues in manufacturing will also need sustained commitment. Many processes used in PV manufacture are poorly understood. Even processes drawn from the microelectronics industry become rather mystifying when applied to silicon wafers with crystallographic defects, dislocations, high concentrations of impurities, and grain boundaries. Improved process controls and in situ diagnostics are needed for all of the technologies.

Manufacture of thin-film PV is especially baffling because in most cases these processes are unique to PV. The design of deposition reactors and tools to form these large-area electronic devices into effective products in high-volume production will challenge the best minds. Non hardware costs must come down, too. Photovoltaic systems are not easy to install. Standards for interconnecting with the local utility vary widely. The industry suffers from a focus on selling technology, whereas a focus on the general consumer should yield plug-and-play PV products and complete service solutions. It cannot thrive by catering to consumers who are already sold on solar energy!

Support for the work of IEEE standards committees and adoption of their output as national interconnection standards will be instrumental in lowering the cost and speeding up the deployment of PV systems. These advances must be matched by educating and training the people needed to support wide use of PV—not only system installers, property appraisers, and insurance professionals.

Popular support for solar energy is strong, as most public opinion polls confirm. Yet few people are aware of the technology's economically viable applications. In partnership with groups having related interests, PV professionals can aid in developing curricula and setting educational standards, reaching into even primary schools. While photovoltaics get good exposure through events like solar-powered car races [Yeager KE, 1992], the PV community must learn to translate this exposure into improved understanding of how the technology is best applied.

Many factors that influence the value of PV relative to other options fall outside normal financial calculations (see Technology, Innovation and Development). Rationally quantifying some of those factors is an ideal challenge for an alliance of users and suppliers of PVs and similar generation options. The social value of distributed resources, grid stability, and CO2-emission-free energy sources are three that come to mind.

A NEW FACE FOR PHOTOVOLTAICS

Photovoltaics technology is well established as a reliable and economical source of electricity in small, scattered applications, far from urban centres. Today however, it has the potential for applications that is larger in size and public awareness. Huge solar roofs were built for the Olympic swimming pool in Atlanta, Georgia., and for a convention centre in Munich, Germany. In initial experiments solar panels have been installed to adorn the upper walls of a skyscrapers erected in New York City's Times Square [Hoff et al, 1999].

The point is that when photovoltaic (PV) arrays are integrated into a building's design and the system is interconnected to the grid so that electricity can be traded both ways, PV can save peak demands on the transmission grid.

It can also lessen the need for new central generation equipment and new transmission and distribution lines, sections of which are often already operating at peak capacity.

Because rights-of-way limit the expansion of transmission and distribution systems, and because populations grow in awkward locations, more and more opportunities arise for consumer-sited electric generation systems. This is especially true when PV arrays are combined with other power sources in hybrid setups.

CONCLUSION

Having reached about $1 billion in annual global sales [Siemens Review:1997], the photovoltaics industry has a track record of reducing costs, entering markets, and demonstrating reliable performance. At this stage, the industry is entering a new operating mode: it is no longer a question of the struggle to survive, but of seeking new ways to thrive.

Forming partnerships within the industry to develop common specifications of materials, equipment definition, and standards can accelerate growth. Developing alliances with producers of other distributed resources will be another big step to expanding general awareness of electricity options and the understanding needed to evaluate the most effective application designs. Design of PV panels that can be integrated into aesthetics of skyscrapers and modern buildings in place of decorative window panes (obviously where light is not a requirement), and the ancillary electronics associated with it must be considered as a serious contender for future PV applications. This is especially so now that electricity deregulation is occurring more and more and independent electricity generation is becoming more viable.

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Fuel cells: Electricity of the future!

Wilma S Herbst

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Ms Wilma Herbst

SYNOPSES

Due to the impact of conventional Power Generation on the environment and the decrease in conventional power sources, new sources of energy conversion, with increased efficiency, should be explored. The changing of the Power Generation Industry opens the door for smaller decentralised power plants. It is in this field that the fuel cell finds an application for generation of electricity, heating and cooling. The history, the working principle, development and application of the fuel cell, focusing on the Proton Exchange Membrane (PEM) technology, will be discussed in this paper.

INTRODUCTION

As a developing country, South Africa needs to realise that we must keep abreast of the latest technology developments. This paper attempts to inspire Electrical Engineers to broaden their view on New Generation methods and to equip themselves with the knowledge to realise "Innovations for the African Renaissance".

Keeping up to date with the latest technology developments Electrical Engineers can structure networks in such a manner as to incorporate this technology, as well as learn from the mistakes of developed countries.

With the changing Electricity Distribution sector the quality of power and service will be very important and by being aware of technology advances will enable us to provide the best service to the customer enabling them to realise the African Renaissance in their specific field.

What are Fuel Cells?

A fuel cell is an electrochemical device - it converts the chemical energy of a fuel directly and efficiently into direct-current electricity and heat. It does this in a continuous manner (much like a battery) but for a longer time because it is continuously supplied with fuel.

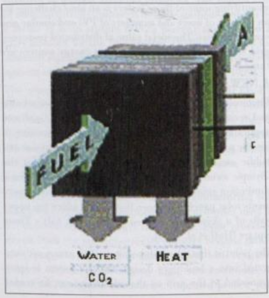
The structure of a fuel cell resembles that of a battery. Each cell of the fuel-cell system has a matching pair of electrodes, the anode supplying electrons and the cathode absorbing electrons. The electrodes are separated by electrolyte but they are also immersed in the electrolyte. The electrolyte can be a liquid or a solid but it must conduct ions between the electrodes in order to complete the chemistry of the system.

The history of Fuel Cells

Sir William Grove discovered the principle of the Fuel Cell in 1839. He used hydrogen and oxygen to produce electricity, essentially by reversing the process of water electrolysis. In 1866 Werner von Siemens discovered the dynamo electric effect. This launched the development of generators and pushed the theoretical considerations of Fuel Cell technology to the sideline.

However, in the 1880's, Ludwig Mond and Carl Langer, employed a porous non-conductor to hold the electrolyte and realised a longer service life for fuel cells. From this date there were several developments with the focus on producing practical hydrogen-oxygen fuel cells. Research continued but it was not until the need for high-efficiency stable power supplies for space satellites and manned spacecraft that created exciting new opportunities for fuel cell development from 1960.

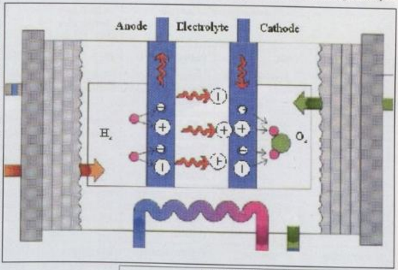
Figure 1: The Fuel Cell Structure



Many technological advances, including the development of new materials, played a crucial role in the emergence of today's practical fuel cells. Further improvements in electrode materials and construction, combined with rising fuel costs and environmental impact on current generation methods, are expected to make fuel cells an increasingly attractive alternative power source.

Based on the type of electrolyte there are currently five different types of Fuel Cells (Table 1). The following Working principle is based on the Proton Exchange Membrane Fuel Cell (PEMFC) technology. The electrolyte consists of a very thin plastic film and the high power-to-weight ratio and low operating temperature (80-90∞C) make it ideal for mobile as well as stationary applications.

Figure 2: Proton Exchange Membrane Working Principle



PEM Fuel Cell

$$H_2 \rightarrow 2H^+ + 2e^-$$
$$^1/_2O_2 + 2H^+2e^- \rightarrow H_2O$$
$$H_2 + ^1/_2O_2 \rightarrow H_2O$$

Working Principles

The PEMFC uses hydrogen as a fuel. The fuel is supplied to the anode where it is oxidised ("burned"), producing hydrogen ions and electrons. An oxidiser, oxygen, is supplied to the cathode where the hydrogen ions from the anode absorb electrons from the oxidiser and react with the oxygen to produce water. This reaction is illustrated in figure 2.

The difference between the respective energy levels at the electrodes is the voltage per unit cell. The amount of current available to external circuit depends on the chemical activity and amount of the substances supplied as fuels. The current-producing process continues for as long as there is a supply of reactants to the fuel cell. The electrodes and the electrolyte are designed to remain unchanged by the chemical reaction and the fuel must be supplied from an external source.

Practical fuel cells are complex because they need additional peripheral equipment to supply the fuel - pumps, blowers, fuel-storage containers and a variety of sophisticated sensors and controls to monitor and adjust the operation of the system. These system design features have an operating capability and lifetime that could limit the performance of the fuel cell.

Because fuel cell operation is an electrochemical system, the operation depends on the temperature. Low temperatures reduce the chemical activity of the fuels and catalysts. Very high temperatures, though, improve the activity factors but may reduce the functioning lifetime of the electrodes, blowers, construction materials and sensors. Each type of fuel cell thus has an operating-temperature design range. That explains the different temperature ranges in Table 1.

A fuel cell is inherently a high-efficiency device, which converts chemical energy directly into electrical energy. This fundamental characteristic allows fuel cells to convert fuels to useful energy at efficiencies as high as 60 %, compared to internal-combustion engines that are limited to <40%. Being more efficient results in much less fuel and smaller fuel storage containers being required for a

Figure 3: Elements of a Fuel Cell Power Plant

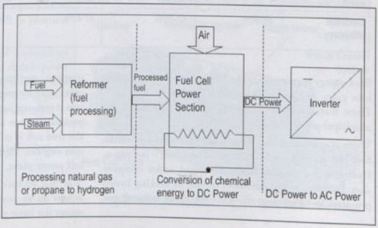


Table 1

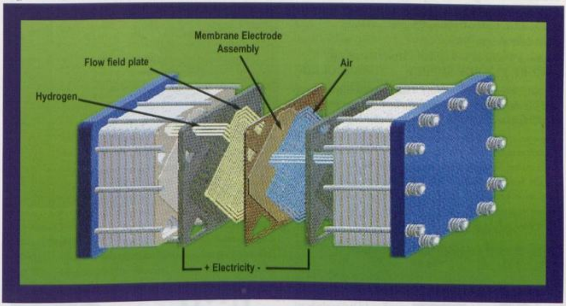
	Low-temperature Fuel Cells (60 - 120 deg C)		Medium-temperature (160 - 220 deg C)	High-temperature (600 - 1000 deg C)	
Type	AFC (Alcaline fuel cell)	PEMFC or SPFC (Proton Exchange Membrane or Soldi Polymer Fuel Cell)	PAFC (Phosphoric Acid) Fuel Cell)	MCFC Molten Carbonate Fuel Cell)	SOFC Solid Oxide Fuel Cell)
Application	Space flight, defence, naval	Cars, buses, note-book computers, domestic heating, submarines, cogeneration plants	Cogeneration plants	Combined heat and power, power stations, ships, rail vehicles	Power station, domestic power supplies, transport
Status of development	Have been used in space flight	Domestic power projects, cars, buses, cogeneration (pilot projects)	Industrial use 200kW power ±160 plants	Test plant with 280kW and 2 MW Output	Test plant with 100 kW Output
Characteristics	No pollution emissions	Pollution emission between 0 and low	Low pollution emissions	Efficient use of energy	Efficient use of energy
	High level of electrical efficiency	Low noise emission	Low noise level	Low noise emission	Low noise emission
	Very expensive manufacture	Solid electrolyte suitable mass production	Three times as expensive cogeneration plants	No external gas preparation	No external gas preparation
	Not for industrial application	Expensive compared conventional technologies	Electrical efficiency reduce with sustained operation	Aggressive electrolyte	Aggressive electrolyte
	Low service live				Exact requirements on materials
Electrolyte	Potassium hydroxide solution	Proton-permeable membrane	Phosphoric acid	Lithium and potassium carbonate	Solid ceramic body
Fuel	Pure Hydrogen	Hydrogen, Methanol Natural gas	Hydrogen, Natural gas	Natural gas, coal gas, biogas	Natural gas coal gas, biogas
Oxidation agent	Pure oxygen	Atmospheric oxygen	Atmospheric oxygen	Atmospheric oxygen	Atmospheric oxygen
Electrical efficiency	60-90%	43-58%	37-42%	>50%	50-65%

fixed energy requirement. The fuel cell does not emit noxious gases and has a low noise level during operation. These features make fuel cells definite contenders for municipal power stations.

There is another factor influencing the efficiency of the fuel cell and this is the nature of the fuel - hydrogen. Hydrogen is a gas that has to be stored under compression. Enabling a safer means of storing or making hydrogen lead to sacrificing efficiency by using natural gas, propane, methanol and petrol. With the use of a fuel other than hydrogen, the net efficiency of the fuel cell system is reduced because the gas needs to be altered in composition for use in the fuel cell. Despite this draw back, the fuel cell is still more efficient than internal combustion engines. Figure 3 shows the basic elements of a fuel cell power plant.

Now that we have the elements of a fuel cell the question is how do we practically design and produce it. Figure 4 shows the basic construction of a practical fuel cell.

Figure 4: Practical Fuel Cell Construction



DEVELOPMENT AND APPLICATION

The basic development of fuel cells has been realised and practical fuel cells are being manufactured at present! The price of fuel cells is still very high and is a barrier to introducing this technology on a large scale. The future development of fuel cells will concentrate on making fuel cells affordable and adaptable to all forms of energy requirements.

Additional development focuses on the fuel. A team of researchers at the University of California Berkeley and the National Renewable Energy Laboratory, in the USA, discovered a renewable hydrogen production technique. Cultures of tiny algae can be conditioned through a microbial switch to produce plant matter (photosynthesis) producing oxygen in the process. When the switch is triggered the algae produces hydrogen renewably (through sunlight and water). This process is called NOR. After generating hydrogen for several days, the gas can be drawn off and the molecular switch can be reversed again, allowing the algae to recover and return to its normal state. This technology is not used in practical fuel cells ...yet!

Fuel cell systems have a large number of applications such as in motor vehicles, stationary and mobile power supplies (portable personal computers, mobile telephones). For the purpose of this paper the applications of stationary power supplies will be discussed.

Stationary Power Supply Application

Fuel cells find the an application in the following:

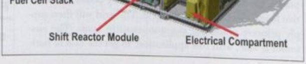
- Co generation plants
- Stand-by power plants
- Premium power
- Home use

Co-generation plants

In many European Union (EU) member countries the combined Heat and Power capacity is increasing. The high overall efficiency compared to 'traditional' generation brings a significant reduction in carbon dioxide (CO2) emission and a more efficient use of fuel. With the current concern with the global environment, the change of climates and air pollution, the lower emissions from this form of power supply offers a solution. Also the increase in efficiency reduces the demand on declining resources - fossil fuels.

This specific application might not look as favourable for South African conditions because of our superb climate. The fuel cell power plant should be seen as an electricity source, which can be used for co-generation applications. The co-generation plant will be effective in dispersed and decentralised power supplies for demands from 1kW to 10 MW.

Figure 5: The 250 kW PEM Unit from Alstom/Ballard



Evaluation of co-generation plants:

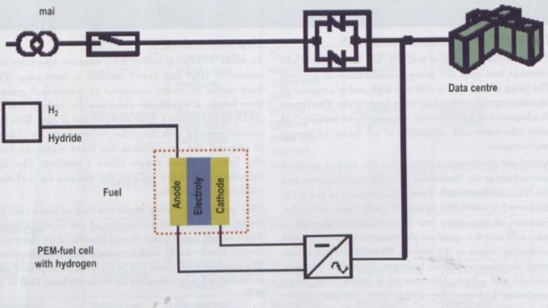
- 250 kW PEM Natural Gas Fuel (Cell USA and Canada). Figure 5 shows the practical unit.
- 11 MW unit in Tokyo
- 250 kW unit in Bewag and Partner (Germany)

SECURE ENERGY SUPPLY

Electricity consumers require a high availability of power and to comply with this demand a fuel cell can provide an ideal stand-by function in case of conventional power failure.

Conventionally the components of stand-by power are an Un-interruptable Power Supply (UPS) and an Emergency Generating Set (EGS). If the grid fails the UPS will pick up the load until the EGS comes on line. The EGS consists of a generator set and thus requires a fixed time before it can supply power. A future solution using the PEM fuel cell is shown in figure 6.

Figure 6: PEM Fuel Cell back-up Solution



Combining the stored hydrogen with metal hydrides for on-site hydrogen generation provide a great benefit to the consumer as far as power reliability is concerned, no pollution from exhaust systems as well as safe operation. The Fuel Cell provides a one-element stand-by power system that will supply power immediately.

PREMIUM POWER SUPPLY

Power quality is an issue that is receiving world-wide attention and many utilities are seeking solutions to improve the quality of power supply to customers. With the Premium Power installation using fuel cell power plants, the fuel cell will provide primary power for sensitive loads - backed up by the grid. The grid will then supply primary power for the non-sensitive loads. The customer is able, with this application, to get the best of both worlds - Grid and Distributed generation. Figure 7 shows a block diagram illustrating the Premium Power Supply.

HOME USE

This is the ultimate application, but the cost of fuel cells is still prohibitive, no doubt there will be a future market. Limited development has been carried out in this regard and trial units have been manufactured. An example is shown in figure 8.

TIME FRAME OF DEVELOPMENT

Manufacturers are still in the trial phase of prototypes, but commercial production is expected from 2002/2003.

Table 2 shows the development steps of Alstom/Ballard's PEM fuel cell business. In 1997 Ballard Generation Systems started with the first large PEM fuel cell unit ever built. This was a full-scale system demonstrator operated at the Ballard Burnaby site and was connected to the grid. Commercial introduction is expected to start in 2004 after testing several trial units in the field.

Figure 7: Block diagram of Premium Power Supply

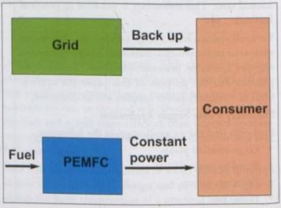


Figure 8: Home Use Fuel Cell developed by Plug Power

CONCLUSION

A Fuel Cell is an electrochemical device that converts chemical energy directly and efficiently into direct current. The efficiency of the process is very high depending on the fuel used, and is at a maximum if hydrogen gas is used. Due to the nature of hydrogen (difficult to store) the use of other fuels from which hydrogen can be produced is a better option, but affects the efficiency of the fuel cell.

Practical fuel cell power plants are being manufactured and although the manufacturing cost is still high, this will no doubt be the electricity source of the future. With further developments to produce renewable hydrogen, this could result in a renewable energy source with reduced pollution.

With the restructuring of the South African Electricity distribution industry these technology developments should be recognised and should be explored.

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Table 2

1997	1999	2000
210 kW Testing unit	220 kW Field trial unit	220 kW Field trial unit
• Since 08/97 to be operated for tests	• End of '99: Delivery of one unit to Bewag and Partner (EdF, HEW, Preussen Elektra, Veag)	05/2000: Delivery of one unit to EBM, CH. • Enf of 2000: Delivery of one unit to Promocell and Partner (SO CO LIE, SRIW, ALE, ALG, Universié de Liége), B. • End of 2000: Delivery of one unit to ENW, NL.
2001/2002	**2003**	**2004**
230 kW Prototypes	Commercial introduction (pre-commercial)	~ 250 kW Commercial series
• Every year approx. 5 units with improvements in performance data and reliability / availability.	• > 10 unit	• In advanced applications for markets like: • Premium Power • Back-up

Piping gas from the Kudu gas fields to Cape Town for electricity generation

Neil Croucher

NEIL CROUCHER

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Qualifications: Pr.Eng. B.Sc. (Elec. Eng.) FSAIEE GCC

He previously served as Generation & Transmission Engineering Manager with the National Electricity Regulator (NER). He was also responsible for running the NER's Electrification Fund project during the last 8 months at the NER.

Mr Neil Croucher

INTRODUCTION

This paper sets the background against which the Kudu Gas: Cape Power Project has been undertaken both from an electricity as well as from a gas perspective. Unfortunately, at the time of writing this paper, the results of the Technical and Economic Impact studies were not yet finally available. The paper therefore focuses on the background, the challenges and the process followed to date. In conclusion, the way forward is provided which hopefully will ultimately lead to the commissioning of a CCGT power station in the Cape area which will provide benefits on a wide front from a local as well as a national perspective.

The Cape Town Electricity Undertaking's (CTEU) Athlone Power Station (APS) was commissioned in 1960 and has successfully been operating for the past 40 years with great benefit to the local consumers and ratepayers. However, with the changing circumstances in the electricity supply industry, with Eskom having surplus generating capacity and with high transport costs for coal from the Mpumalanga area, the station has become less profitable in its role of performing peak lopping whereby the cost of bulk purchases from Eskom is reduced. As a result of this, the CTEU began exploring future options for APS. One such option was the conversion/replacement of the station with a Combined Cycle Gas Turbine (CCGT) station. A preliminary pre-investment study was therefore commissioned towards the end of 1998 to determine whether there was a prima facie case for such a power station. The results of the study were positive and established, that for a CCGT plant to be viable in the Cape, the plant would have to be sized between 1000 and 2000MW.

CAMALA AND SHELL

At the same time as the CTEU was contemplating these possibilities, Eskom's Memorandum of Understanding with Shell to examine the possibility of a CCGT power station in Namibia had lapsed. It was an opportune time for Cape Town and Shell to enter into a partnership to examine the possibilities of such a power station development in the Cape area.

Given the required size of the power station to make such a project viable, it was clear that the project was too large for the CTEU alone. In addition, it was also known that the establishment of the Unicity was scheduled for November 2000. As a result of the foregoing, the 6 local authorities in the Cape Metropolitan area, along with the Cape Metropolitan Council (CMC), formed a voluntary association called CAMALA (Cape Metropolitan Area Local Authorities). Governance for this project is therefore by way of a committee of 14, being 2 councillors from each local authority and the CMC, and is supported by a technical body of officials.

Whilst the replacement/conversion of the Athlone Power Station was initially the prime motivation for this project it is clear that there are potentially many other important benefits from a local as well as a national perspective including:

- Increased security and quality of supply in the Cape area
- Lower electricity prices
- Avoided transmission costs
- Introduction of natural gas to the Western Cape will provide a massive stimulus to the economy through industrial development
- Establishment of a gas industry
- New technology
- Diversity of energy source and diversity of generation
- Opportunities for black empowerment in the Electricity sector
- Ideal opportunity to establish first Independent Power Producer (IPP) as suggested in the Energy White Paper
- Local and national environmental benefits

COMBINED CYCLE GAS TURBINE (CCGT) TECHNOLOGY

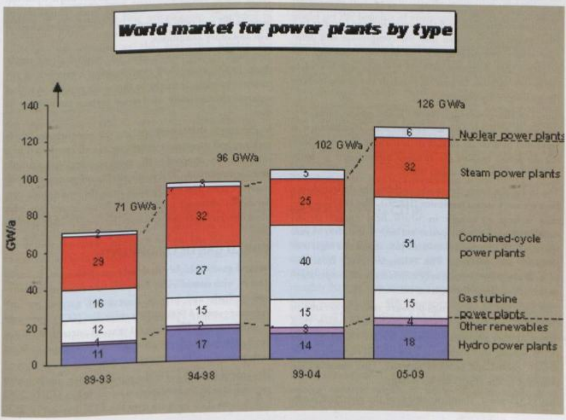
Before going into detail on how this project has been undertaken to date, it is worth spending some time on developing a very basic understanding of the Combined Cycle Gas Turbine (CCGT) technology and the extent to which it has literally taken the generation sector by storm over the past 10 years.

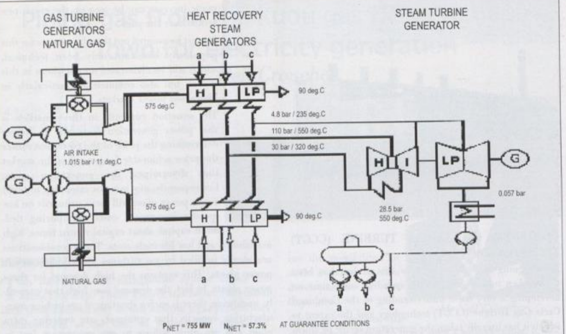
CCGT generating plant first entered the scene in the early 1980's and since that time has developed a market share of almost 40% of all generating plant worldwide. This dramatic increase can be seen on the graph presented over the page.

It must be pointed out that the reasons for this popularity have not only been technical, which will be elaborated on elsewhere in this report, but also commercial, particularly in liberalised power markets.

The situation currently in these markets is that power generation costs are no longer determining the price of the power but rather the price achievable for power on the market that determines the generation costs. Consequently, any investor intending to build a new power plant will focus primarily on low specific investment costs, minimizing tied-down capital, short capital return times, high availability, and low life-cycle costs. These considerations are ideally fulfilled by gas turbines and combined-cycle power plants. This explains the high demand for these power plants. In fact, the demand is so high that currently, worldwide, there is such a shortage of gas turbine manufacturing capacity that customers are ordering extra plant and are quite willing to pay reservation fees in advance. This is resulting in rising prices for gas turbines.

A CCGT power station comprises 2 components, namely the gas turbine and the steam turbine.





Schematic diagram of a typical CCGT Power Station

As can be seen on the diagram on the next page, the gas turbine has 3 components. These are the compressor, the combustion chamber and the power turbine (similar to a jet engine). Air is drawn into the compressor and delivered under pressure to the combustion chamber. The resulting high temperature high pressure is delivered to the power turbine. In passing through the power turbine the gases give up energy.

Some of the power developed in the power turbine is employed to drive the air compressor. The balance is employed to drive an electricity generator. The gases leaving the power turbine are at about atmospheric pressure and a temperature of about 600(C.

The hot gases from the power turbine are delivered to a heat recovery steam generator (HRSG). The HRSG is basically a heat exchanger in which heat energy in the exhaust gases from the power turbine is transferred into water, which in turn is converted into steam at a high temperature and pressure. The exhausted gases from this process are delivered at a very much-reduced temperature to the atmosphere through an exhaust stack.

The high temperature high-pressure steam generated in the HSRG is delivered to a steam turbine which then drives another generator to produce more electricity. The steam leaving this turbine is then passed through a condenser, cooled and reduced to water. This water is then returned to the HSRG for recycling.

In a CCGT plant, about two-thirds of the electrical power is derived from the gas turbine and one-third from the steam turbine. The efficiency of such plants range between 50 and 60% depending on the actual configuration and other conditions.

Two basic configurations exist i.e. multi-shaft or single shaft. In the multi shaft configuration a number of gas turbines (usually 2) would be thermally combined with a separate appropriately sized steam turbine running on its own.

In the single shaft configuration the gas turbine, steam turbine, and a common generator are all connected to a single shaft as opposed to the more conventional multiple shaft arrangement. The single shaft configuration is generally cheaper but less flexible than the multi-shaft configuration although a number of factors come into play when determining the optimum for a particular application.

WORLD GAS DEVELOPMENTS

Natural gas is a highly desirable energy source. It burns cleanly, with considerably less pollution than other hydrocarbon fuels and proven reserves of natural gas are immense - some 4 900 trillion cubic feet (TCF) at the end of 1995, enough for about 60 years at current world gas production rates. These proven reserves are also growing each year as new discoveries are made.

The role of natural gas in the world's energy supply is also growing rapidly and is expected to reach 145 TCF by 2015 which is an 85% increase over the 1995 level of 78 TCF.

Over the next two decades, gas use is projected to rise at more than 3 times the rate for oil use. Resource availability, cost, and environmental considerations all favour growing reliance on gas in industrial applications and electricity generation.

Another factor that is likely to accelerate the move towards the substitution by gas is a possible increase in policing of carbon emissions by the government's of the world. For an equivalent energy output, burning natural gas saves 50% of carbon emissions relative to coal and 30% relative to oil.

THE LOCAL NATURAL GAS INDUSTRY

With the exception of offshore gas reserves in Mossel Bay, South Africa has been slow to develop its reserves of conventional oil and natural gas.

South Africa has a highly developed synthetic fuels industry, which takes advantage of the country's abundant coal resources and offshore natural gas and condensate production in Mossel Bay. The two major players are Sasol (coal-to-oil/chemicals) and Mossgas (natural gas-to-petroleum products). Sasol has the capacity to produce 150,000 barrels per day (bbl/d), and Mossgas 45,000 bbl/d. The Mossgas plant receives natural gas and condensate from the F-A gas field in Mossel Bay through a 90-kilometer (54-mile) pipeline. It converts the gas into a variety of liquid fuels including motor gasoline, distillates, kerosene, and LPG.

There has, however, been renewed interest in the distribution of gas with the first privatisation completed in December 1999, when a consortium led by the U.S.-based CINergy was chosen as the preferred bidder for Johannesburg's Metro Gas Company. CINergy, one of six firms to qualify for the bidding process, recently completed the purchase of Johannesburg Metro Gas.

In order to ensure that there is good order in this emerging gas industry the Government's Department of Minerals and Energy has prepared a Gas Regulation Bill which is currently being work-shopped with stakeholders. Government is clearly keen to promote the development of the gas sector and have to date shown much enthusiasm for the Kudu Gas: Cape Power Project.

The Kudu gas field is situated in Namibian waters approximately 170 kilometres West of the mouth of the Orange River, near the border of South Africa. The Kudu licence comprises an area of some 4000 square kilometres. The gas reservoir is at an average depth of 4300 metres below sea level in a mean water depth of 170 metres.

The Kudu field was discovered in 1974. Subsequently, Shell (75%) as the operator, and Energy Africa (25%) were awarded an exploration licence in 1993. The partnership was expanded in 1996 when Texaco acquired 15% from Energy Africa.

To date the partnership has spent in excess of R500m on seismic work, drilling and market development for the project. The work to date indicates a gas reserve potential for Kudu in excess of 20 trillion cubic feet (TCF) which approximates 3.5 billion barrels of oil in energy content. Put in context, 20TCF could fulfil the current electricity demand of the Cape Metropolitan Area for more than 200 years.

A number of other gas fields have also been discovered or are being explored off the coast of South Africa and in Mozambique which are in various stages of development. A number of these are in reasonably close proximity to Cape Town and therefore offer the potential of competition in terms of the gas supply.

The map at the end of this paper shows the extent to which this exploration and development is currently taking place.

ELECTRICITY SUPPLY INDUSTRY EVOLUTION

South Africa was one of the first countries in the world to see the commercial use of electricity in 1890. Over the next 30 years a number of isolated electricity suppliers were formed. These comprised local government undertakings, privately owned electricity supply companies, privately owned mining companies and the railways.

By 1920 it became apparent that electricity supply was too fragmented and a consulting engineer from London, Charles Merz, was commissioned to conduct an investigation. He found that the majority of power producers in the country were too small and inefficient and therefore suggested that the country focus on larger power plants. He believed that, by centralizing generation, the industry would get the benefits of economies of scale and be more efficient. He also recommended that an Act be passed which would establish government control over the industry. This led to the Electricity Act of 1922 and the establishment of the Electricity Supply Commission, Escom.

Over the next 30 years there was a dramatic increase in the demand for electricity and, in 1948, Escom acquired the Victoria Falls and Transvaal Power Company which was the countries biggest merger at the time. Thus, whilst there were still some municipalities generating their own electricity, Eskom emerged as the dominating supplier. This dominance was increased when in the 1950's Eskom decided to establish a national transmission grid.

GENERATION SECTOR

It is against this background that Eskom has emerged as the national utility which generates some 96% of the countries electricity, owns and operates the extensive national transmission network and distributes directly to roughly half of the country's customers (the other half being supplied by ~400 municipalities). Eskom has also, whilst not being obligated to do so, become the de facto National Generator of last resort thereby planning and installing generating capacity to meet the countries needs. It is also against this background that the current situation exists where there is a significant surplus of generating capacity which is likely to exist until about 2007/8. Current generating capacity is some ~39000 MW whilst the system peak for 1999 was ~29 000 MW.

Eskom therefore currently operates the sector as a virtual monopoly with municipal generation largely restricted to performing a load management type function in order to minimise the cost of bulk purchases from Eskom. Until some 3 or 4 years ago Eskom's generation was dispatched on a least-cost basis using a merit order system. This was then replaced by a power pool system which was to be operated internally by Eskom on a trial basis. This has proved to be very successful within Eskom and is currently still in operation. In fact, Eskom is currently encouraging wider participation in the pool by willing municipal generators.

In December 1998, the Government adopted the White Paper on Energy policy which envisages a move to competition and private investment in the Generation sector. It also envisages a transmission sector which operates as a natural monopoly and offers non-discriminatory access to the transmission network. It is important to note that Eskom's current transmission license from the National Electricity Regulator (NER) includes such a requirement.

In terms of the Electricity Act of 1987, any Generator that generates and sells more than 5 GWh of energy per annum is required to obtain a Generation Licence from the NER. No clear framework however exists by which such licences are granted other than the Energy White Paper and the limited guidelines of the Electricity Act.

Recently the Department of Minerals and Energy commenced the debate regarding the restructuring of the Generation and Transmission sectors of the Electricity Supply Industry (ESI). During these debates Government once again made their intentions clear that they wish to restructure the industry into one where competition, customer choice and private investment are facilitated. Given this background, a motivation for the Kudu Power Project will have the extreme challenge of needing to satisfy opponents to the project who will argue from the current central planning, monopolistic viewpoint as well as having to satisfy the opposing views of those who support a liberalised power market. This clearly represents a significant challenge.

THE PROJECT TO DATE

Given the background sketched above, it was clear that, for the project to be successful in mobilising the necessary support and overcoming the many natural barriers to entry, it would be necessary to follow a very carefully planned and thorough strategy. In following this strategy the following steps have been undertaken to date or a still in progress:

- Pre-investment study
- Formation of CAMALA
- Signing of Letter of Intent to conduct a technical study
- Technical Study
- Empowerment Studies
- Economic Impact Assessment
- Consultations
  - o NER
  - o Eskom
  - o Government - Departments of Minerals and Energy, Finance, Trade and Industries, and Local Government
  - o Provincial Government
  - o Other stakeholders e.g. Environmental Groups, WESGRO.
  - o Nampower and the Namibian Government
  - o Other potential Gas suppliers

Unfortunately the final results are not yet available from the technical studies and it would be inappropriate to disclose too many details from the preliminary results at this stage before the results have been formally presented to the CAMALA political body and CAMALA's partners in the study, SHELL. It is however expected that the results of the Technical Study and the Economic Impact Assessment should be completed and delivered to the Council by the end of October 2000.

Significant and encouraging progress has been achieved in many of the areas mentioned above. As mentioned previously, the pre-investment study identified *"that a prima facie case existed for a viable project which holds significant potential for delivering benefits to all the major stakeholders"*.

Flowing from the recommendations of the above study CAMALA was formed and a detailed technical study was commissioned in partnership with SHELL.

This technical study was awarded to a consortium led by PB Power in December 1999. The main focus of the study was in the following 4 areas:

- **Site Selection and CCGT Technology Studies**

  The site selection study was designed to demonstrate that a site or sites could be found, suitable for a CCGT power station of 1000 MW capacity, and preferably capable of accepting an ultimate capacity of 2000 MW. The site selection process comprised a comprehensive public participation process, identification of potential sites and an environmental study of a shortlist of suitable sites. Environmental scans were conducted on the five shortlisted sites one of which was the existing Athlone Power Station site. One of the 5 sites was then used for modelling purposes.

  The CCGT technology studies were designed to discuss the available technologies, to propose a configuration for the Kudu plant, to set out performance characteristics for the chosen configuration and to estimate associated capital and (non-fuel) operating costs. As mentioned earlier the basic configurations are single or multi-shaft. For base load operation the single shaft configuration is generally adopted nowadays.

- **Demand Side Study**

The studies were required to conduct electrical demand forecasting for the CMA area, Western Cape, South Africa and neighbouring Southern African countries, together with an assessment of the impact on national electricity demand developments. First, a 'Base Case' forecast was developed which was then supplemented by 'High Growth' and 'Low Growth' scenarios. The results of these studies were then used as an input in the Supply Side and Transmission Studies. The current load (1999) in the CMA is 1833 MW and in the Western Cape is 2935 MW.

The two key explanatory factors in developing and analysing demand forecasts are the future growth in gross domestic product (GDP) and electricity and energy prices. The impact of these two factors on demand developments is represented through a set of income and price elasticities. The pattern of the future growth in electricity consumption is expected to remain closely related to GDP growth, in line with international trends.

- **Transmission Study**

The aim of this part of the study was to determine the value from a Transmission perspective of the power station on a full avoided cost basis. This avoided cost of transmission is mainly the costs of deferment of the transmission investments which will be required to reinforce the power corridor linking the Western Cape to the generation in the North. Basically the approach has been to develop system expansion plans with and without the CCGT plant. All benefits and disbenefits were then analysed including capital costs and timing, losses, system stability, contingency studies etc. All indications are that substantial transmission savings and benefits will be derived through a CCGT plant in the Cape area.

- **Supply Side Studies**

This component of the study was probably the most challenging and also the most important. A key aspect here was the development of a set of assumptions to be used. Similar to the approach used in the transmission study, the approach here was to determine an optimal development plan for generation capacity with and without the CCGT plant.

Finally, in determining the value of the proposed CCGT station it has been necessary to approach it from two angles, firstly from a full avoided cost basis and secondly using a market approach. In the case of the market approach, two scenarios are used; the Regulated Market scenario and the Competitive Market scenario. Once again the preliminary results of these studies are encouraging although the viability of the plant obviously varies depending on the scenario applied and the timing of the plant.

- **Overall Conclusions**

As can be seen from the above studies, all indications are that the results will be positive on all fronts. We are therefore confident and hopeful that a motivation can be put together which satisfies even the harshest critics from whatever viewpoint they come.

In order to ensure that sound governance and informed decision making takes place with regard to this project, an empowerment study of councillors and officials was undertaken. This proved most valuable and informative and had the added benefit of giving the project international exposure.

It was identified at an early stage that, given the local and national significance of this project, wide consultation would be required to gather support and to assist in ensuring that ultimately the decision-makers will be in a position to make informed decisions. Stakeholders were identified and an extensive program of consultation was commenced.

Councillors and officials on the empowerment study tour in September 1999 examining the Seabank CCGT plant in the UK.

The responses to date have been most encouraging. Government and in particular the Minister of Minerals and Energy has on numerous occasions spoken of the project in supporting tones. Even the President has mentioned the project in speeches on more than one occasion.

Eskom too, despite currently being the monopoly generator and the current central planner of generation expansion, have recently indicated their support for the project and the desire to be a part of it to ensure that, from their perspective, the maximum national benefit is derived.

In June 2000 an Economic Impact Assessment was commenced utilising funding from various sources. This study will look at the overall economic impact of the development of such a power station in the Cape as well as the impact of bringing natural gas to the Cape. An international scan has been conducted to examine international experiences in this regard. These results should be available at the end of October 2000.

Some overall rough estimates of cost for this project are:

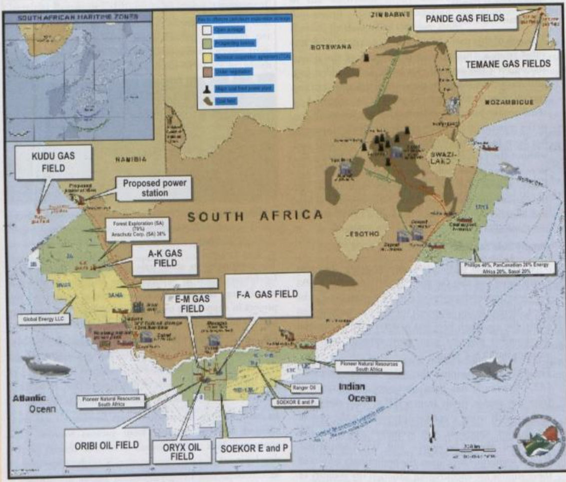
- The development of the gas field, bringing gas ashore in Namibia - 1 bn
- The development of a CCGT plant in Namibia - 350 m
- The development of a 700 km pipeline to the Western Cape - 500 m
- The development of a CCGT plant in the CMA - 500 m

THE WAY FORWARD

The project is now set to enter the next phase assuming a positive assessment of the two studies, i.e. the Technical Study and the Economic Impact Assessment, over the next couple of months. This means that the studies will have to convincingly show that the project makes sense from a technical, commercial and environmental perspective, both at local and national level. This will be necessary to ensure that the project gets approval from authorities within SA (Government and the NER) and is also bankable from an IPP's perspective. The completion of this first phase will have satisfied CAMALA's commitment to Shell.

The next phase will essentially be to look at any remaining requirements which are necessary in order to obtain a licence to generate in principle from the NER. It will also consider possible structures of an IPP and what partnerships are desirable. The extent to which the City of Cape Town has equity in the power station, if at all, has still to be determined. As we are all aware the Generation and Transmission sectors of the ESI are also about to be restructures. An outcome of this may be that ownership of generation is not permitted by Distributors.

In conclusion, this project still faces significant challenges. CAMALA remains confident however that these challenges can be overcome and that natural gas, CCGT technology and IPP's will play a significant role in the generation sector in the coming years to the advantage of all.




From generator to end user:
technology for brighter living

Capacitive coupling systems for rural electrification

Tichaona Boniface Mutangadura

TICHAONA BONIFACE MUTANGADURA

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Mr TB Mutangadura

1. INTRODUCTION

In the Southern Africa Region the Rural population with access to electricity is very low. The main reason for this is that the cost of the electrification is very high and the return on investment is very low. The rural population does not have surplus funds and their consumption of electricity sympathises and they end up resorting to using firewood for their cooking resulting in serious land degradation.

2. RURAL ELECTRIFICATION

The major costs on Rural Electrification are the long lines and low capacity substations that have to be constructed to provide the sparse population with power. In certain instances the length of line will make the project cost prohibitive and option of solar energy can only be applied with limited power output.

In effort to supply big loads like for Towns, Mines and Resort Areas, high voltage lines are constructed across the region passing through pockets of rural settlements. Because the load does not warrant a step down transforming substation, these settlements have not been electrified due to the prohibitive costs. To enable electrification of such settlements low cost substations have to be designed otherwise they can only get the limited solare power. It is a known fact the electricity is a catalyst to development. That is why rural Electrification has been treated as social projects undertaken by Governments to improve the standard of living an curb urban migration.

On such low cost substation technology was developed in Canada in the early 80's which is called Capacitive Coupling Systems.

3. CAPACITIVE COUPLING SYSTEMS

The design was a result of the need to find a solution to provide power to microwave stations along HV lines. So a study was carried out to come up with a minimum cost substation connected to the HV line with the following criteria.

- The substation should be connected to the transmission line and should not disrupt the operation of the line.
- Operation of the substation should be maintenance free as access was difficult distances to be traveled very long.

The result was substation that was:-

- Capacitively coupled to the phase conductor through an insulated ground wire
- A variable inductance electronically controlled to regulate the voltage.
- Elimination of Ferro resonance.
- Insignificant effect on the operation of the live.
- Minimum maintenance on the equipment

The systems have now been used mostly in South America to provide power to isolated rural settlement.

4. TYPES OF CAPACITIVE COUPLING SYSTEMS

4.1 SCC-1

The SCC-1 is connected to an insulated overhead ground wire on the high voltage power line. Since the ground wire is insulated, it forms a capacitor with the conductors, and its value depends on the length of the ground wire and the geometrical configuration of the high voltage line. The available power is calculated in relation to the value of the capacitor and of the voltage operation. The available power is approximately 9kVA/km on a 735kV line. The system can provide up to 10kVA.

4.2 SCC-2

The SCC-2 is connected directly to a phase conductor in the transmission line through a capacitor bank. This replaces the virtual capacity represented by the insulated overhead ground wire and the conductor. The system can extract 100kVA to 150kVA of power from the transmission line depending on the voltage, which can vary from 100kV to 275kV.

4.3 SCC-3

The SCC-3 is connected directly to the phase conductors. It is similar to a capacitor bank like the one in electrical networks to stabilise the voltage and reduce losses. The capacitor bank is capable of providing power of up to 2MVA.

The SCC-3 when connected to a line of between 100kV to 275kV can provide:

- A power output of 2MVA
- A three phase voltage.
- Voltage ranges from 10kV to 35kV.

The SCC-3 can also be easily modified for different input transmission line voltage.

5. OPERATING PRINCIPLE

The SCC-3 is basically a compound bank composed of two banks in series with the output voltage based on Capacitive voltage divider principle. In order to regulate the voltage an inductor is connected to series to the capacitive divider.

The connection is the standard for measuring high voltage but cannot be used for delivering power because:-

- Connecting distribution transformers at the output can produce Ferroresonance.
- High voltage will be observed if the output is shorted.

Connecting a resistance in series with a tuned circuit damps ferro-resonce.

The high voltage is limited by connecting a voltage limiter across the inductance.

The limiter becomes conductive an short circuit or over load conditions.

6. SCC-3 Tests

Extensive test were carried with ten distribution transformers connected onto a 161kV transmission line with output load of 500kW/phase and there was a very slight distortion in the transmission line voltage under short circuit conditions and no ferro-resonance was recorded.

Advantages of the SCC-3 include the following:

- Very low maintenance and reliability is assured since it is composed of passive elements.
- The SCC-3 improves operation of the line and reduces losses thus assisting in reducing the payback period.

7. INSTALLATION IN THE REGION

The technology has been in existence for nearly twenty years with some obvious advantages yet there has no significant numbers installed in the region. Infact I am not aware of any such installation.

Lately we have tried to install a pilot project under PIESA but the cost was prohibitive. It was noted that the supplier is not willing to part with the technology in that6 installation would be on a Turnkey basis.

8. WAY-FORWARD

As I see it the technology can offer a relatively low cost solution to electrification in the region. There is therefore a need to come up with some form of partnership of our industries in the region and the Patent holders to enable some form of assembly of the equipment or even manufacture under licence to cut down on cost.

Benefits of the Internet for engineers

Johan Scholtz

JOHAN SCHOLTZ

Qualifications: National "N" Diploma (Heavy Current Electrical). Drawing Office Practice National Certificate. Member South African Institute of Draughtsmen.

Employment History: Joined Distribution Technology in 1995 as Senior Draughtsperson. Appointed DT WEB Administrator May 2000.. Currently maintaining both the Intranet and Internet sites.

SYNOPSIS

The advent of Internet technology has changed the face of business globally over the past decade. In the new millennium the Internet will increasingly become part of our day-to-day operations.

Distribution Technology (DT) a division of Eskom's Distribution Group utilises both the Internet and Intranet an internal Eskom network, to supply external business partners and Eskom employees with relevant information on standards, regulations, rules, procedures etc.

All DT standards form part of the Distribution Standard. The Technology Steering Committee for Distribution (TESCOD) is responsible for developing new standards for all items of equipment in the Distribution Standard, and certain procedures and processes need to be followed when developing new standards or changing existing specifications.

Standing Study Committees (SC) and work groups (WG) assist TESCOD to identify the need for, and the development of new standards. These two groups form an integral part of the process, by determining the urgency and physical constraints of the task, investigating sources and consulting stakeholders and checking standards for completeness.

Area implementation only takes place once comment on the document has been done through the DT WEB on the Intranet and all problem areas and comments have been addressed satisfactorily, and the document has been favourably voted on.

To gain a competitive advantage in this modern, high-technology age, companies will have to utilise the Internet to its fullest. The key to success however, is to supply industry-specific, high quality information to the target group, to ensure that they return on a regular basis. It is clear, though, that companies who do not choose to follow this road will be left behind.

1. INTRODUCTION

Electronic commerce is the future of the business-to-business community. As Business Internet users become more advanced, they are increasingly drawn to online marketplaces that relate directly to their industries.

Whether it is a scientist, a plant manager or an engineer, professionals in a specific market will continually revisit a site that is geared to their interests and comprehensive in its information.

The Distribution Technology (DT) - Eskom WEB Site is such a site: It acts as an essential, comprehensive source of information and interaction for Eskom employees on the one hand and for external business partners on the other hand. DT publishes documents, visual images, spreadsheets and software, that are of specific interest to Consulting firms, Contractors, Municipalities and Local and Overseas Suppliers. Utilising both the Internet and Intranet, it is a source site that operates on pin numbers and passwords.

2. BENEFITS

The value of an industry-specific website such as the DT WEB Site lies in it being a customer communication/information tool. It is a strategic business imperative, especially for those consultancies and firms that may not have the resources available to keep abreast of current developments and trends in the industry

High-value, high quality content provides a number of important benefits to visitors:

- Electronic access to researched and proven standards, specifications, regulations etc.
- Improved time and cost efficiency.
- Maximised productivity and effectiveness.
- Improved customer service.
- Generation of valuable customer data.
- Access to a virtual library thereby reducing administration and acquisition costs.
- Improved networking and sharing of ideas/expertise.
- Improved troubleshooting.

3. DT INTRANET AND INTERNET

Valuable content encourages visitors to return regularly. Both the DT Intranet and Internet offer access to:

- Standards
- Specifications
- Regulations
- Procedures
- Guidelines etc.

3.1. DT Intranet

The Intranet is available to Eskom employees. Putting data on work in progress right at the fingertips of all employees (technicians to managerial levels) ensures that more informed decisions can be made which, in turn, will maximise productivity and effectiveness.

Key benefits:

- Quick and easy access to information
- More effective communication/transfer of information via e-mail and electronic files.
- More effective problem solving.
- Improved distribution of documents electronically.

3.1.1 Procedure

TESCOD is responsible for ensuring the development of standards and that those standards exist for all items of equipment in the Distribution Standard. To accomplish this task TESCOD has appointed standing study committees that meet on a regular basis to identify needs in each study committee area and prioritise the work. TESCOD is responsible for ensuring that these study committees have proper representation.

A work group (WG) appointed by the relevant Study Committee (SC) is responsible for the preparation of identified standards. The work group consists of relevant people, identified by the SC, from the Distribution Group, who will provide input and write the standard. These identified people must be committed to the project.

Project Leader (PL) is identified by the SC to be responsible to the SC for ensuring that the WG produces the required standard on time.

The SC ensures that the standards are of suitable technical content and fit for purpose.

TESCOD ensures that the standard will integrate into the business.

The Technical Administrator (TA) is responsible for providing the administrative support for this process and for publishing the final standard on the DT WEB.

The Network Services Manager distributes the standard to the local change control committee for local implementation.

3.1.2 Process

Once the need for a standard has been identified or for an existing specification to be changed the following processes will be followed (Annex A):

- The relevant SC verifies the need for the document.
- The SC establishes the urgency for the standard and the standard is prioritised in terms of other work.
- TESCOD allocates resources to the SC.
- TESCOD establishes whether the proposed standard applies only to Distribution Group or whether it will affect other Eskom Groups.
- TESCOD approves the work and identifies a work group.
- The SC appoints a Project Leader (PL) and a WG, or nominates an existing WG. If necessary representatives from other Groups can be recruited.
- The PL registers the project with the Technical Administrator (TA).
- The PL opens a working file.
- The WG determines the performance expected of the WG members to complete the task. This will involve inputs from various members of the Distribution Group to establish the needs. The WG determines the type of standard to be produced for example, a specification, standard, procedure or guide.
- The WG establishes the physical constraints/requirements of the task (item).
- The WG investigates sources to determine whether items that meet the requirements and constraints are available or can be made available at a reasonable price.
- The WG determines the elements necessary for inclusion in the standard.
- The WG writes a "Scope of Work" document with proposed target and completion dates etc.
- The WG leader ensures that the required information is collected and that the draft document is drawn up in accordance with the standard template of the TESCOD format and with the correct Revision Control reference and gives it to the TA.
- The WG prepares a supporting impact assessment document identifies all areas affected by the new/changed standard and the relevant stakeholders.
- The WG ensures that all stakeholders are consulted.
- The PL ensures that an independent reviewer checks the basic calculations in a document.
- The TA quality checks the draft document for basic grammar errors, standard Eskom format and that the document has an Eskom reference number.
- The TA places the draft document on the DT WEB for review and comment by the WG, Technology and Quality (T&Q) departments.
- The PL circulates the draft standard to relevant suppliers (where applicable) and other stakeholders, as identified by the project leader, for comment.
- The TA sends the draft specification to QA and Commercial departments for their comment.
- The PL in association with the WG amends the draft standard to address comments where necessary. The draft number is advanced as appropriate and the WG advised
- The PL briefs the SC on the standard.
- The SC members check the standard for completeness. Any comments from the SC are considered by the WG and a new draft is submitted for review, if necessary. The WG prepares the necessary Distribution Standard Buyers Guide drawings, etc.
- The TA moves the document to the voting section of the DT WEB for voting by TESCOD.
- TESCOD members check the document for its impact on the Business.
- TESCOD votes using the DT WEB system.
- The TA records all voting on the document on the database as well as any further comments.
- The PL addresses comments in consultation with the WG, if appropriate, and the process is repeated as necessary.
- When the document has been approved the TA obtains the necessary signatures.
- If the document is applicable to other Eskom Groups it is sent to the Technology Standardisation Division (TSD) to process the standard and arrange for voting papers for the relevant Executive Directors or other signatories.
- Document revision control is done in accordance with the revision control process and an annex on the revision history, is included in the document.
- The Network services managers distribute the document to the local change control committee for area implementation.

3.2 DT Internet

The DT Internet makes available approved information to external business partners such as consultants, contractors etc. The DT site ensures a high degree of authentication and privacy in communication with DT.

Business partners must authenticate themselves with the DT Internet using a valid username and password before any business function can be performed on the website. A database of valid business partners is updated and maintained regularly.

Additional features:

- Initial access to the site is open to everyone.
- After payment of an annual R500.00 subscription fee and receiving a User/Login name and Password, access to the secure site is obtained.
- Access can be gained at any time (24 Hours availability).
- All DT documentation on the external site can be accessed and used as referrals.
- Applicable software can be downloaded.
- Contact details of DT experts are available on the site, if needed.

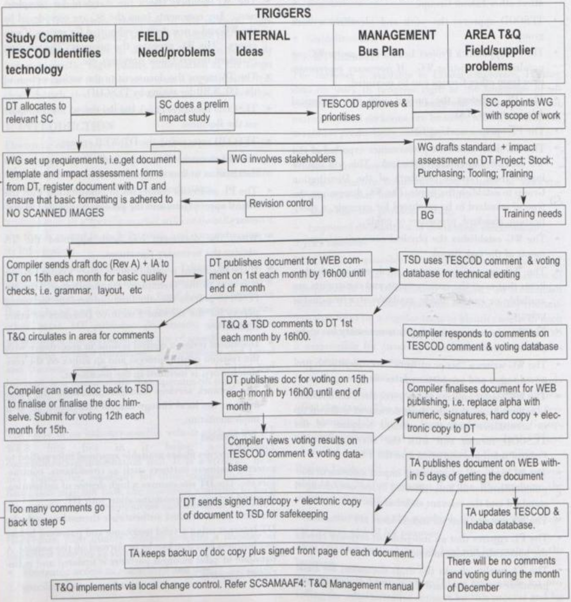
4 CONCLUSION

According to the latest SA Company e-commerce survey by BMI-TechKnowledge, South African companies are increasingly embracing the e-commerce revolution. Excluding micro and survivalist companies, there will be approximately 320 000 Internet connected companies in South Africa at the end of 2000.

Within the next three (3) years, the Internet will be a "critical business component" and the entry of international competition as well as emerging local e-entrepreneurs will introduce a significal competitive threat to many companies.

Annexure A:

NATIONAL TESCOD STANDARDS



A meter on the Internet ?

Rob Surtees

ROB SURTEES

Current Position: He now manages Enerweb, a specialized Energy Information Services company within ESKOM Enterprises.

Qualifications: BSc. Electrical Engineering, an MSc. in Industrial Engineering (Wits) and an MBA.

Actively involved in Energy Information Systems and the applications thereof since 1987, having started ESKOM'S Load Research Group. He now manages Enerweb, a specialized energy information services company within Eskom Enterprises.

ABSTRACT

The Internet has revolutionized the field of energy information management. Industry transformation to a more competitive environment internationally has been enabled to a large extent by Internet and related technology advances. Energy flow and related information (price etc.) has become a vital link in the new energy generation, transmission and distribution value chain. A simple Internet connection enables access to current and historic prices, billing data, demand profiles and other statistics down to an individual meter level. Energy trading systems, complex tariff implementation, including real-time pricing and various derivatives thereof are now being implemented using the Internet as the primary enabling mechanism. Load management controllers and other plant performance monitoring devices are also easily configured through the Internet enabling quick response to dynamic pricing signals.

The paper deals with market and technology developments internationally, particularly in the new competitive environments as well as local initiatives in this area.

1. INTRODUCTION

The current transformation in the electricity industry is not unlike the changes that have occurred in the manufacturing sector over the past two decades. Industry has abandoned previous mass production protocols in favour of highly flexible, computer integrated "just in time" manufacturing approaches with inputs being sourced from a wide range of specialist OEM's, often widely dispersed. The Virtual Utility (VU) concept is a flexible collaboration of independent market driven entities that provide energy services demanded by customers without necessarily owning the assets.

It is generally accepted that the Internet and e-commerce will have the most profound impact on every aspect of business. A hot spot in history and strategic inflection point which is revolutionizing the very basis of everyday life - (Andy Grove - Intel). While the utility industry has generally lagged behind other sectors, in the application of web-based technology, particularly in South Africa, the imminent changes in regulatory environment will precipitate wide application of these new technologies. Transformation of the Electricity supply sector in other parts of the world, particularly in the early and mid-nineties had been a relatively slow and costly process. Technology advancements in communications, computing power and the Internet, have now virtually eliminated the technical and related cost constraints in the transition process. Applications range from energy trading through to metering and management of electricity consumption.

2. THE NEW ELECTRICITY MARKET PLACE

2.1. Electricity: Just another commodity?

The fundamental premise upon which the new electricity supply industry is based is that electricity is simply another commodity, distinguishable only by quality and price. It can (and is) therefore be traded in a similar fashion to other commodities as is evidenced by the proliferation of power and energy exchanges around the world. Electric power Spot, Forward, Futures and Options contracts are actively traded just as is the case with other commodities.

There are however some fundamental differences which impact on the short term price volatility of electricity viz.

1. Electricity cannot be cost-effectively stored
2. It has rigid transportation constraints
3. Demand is highly weather dependent

Figure 1. compares electricity with other products in the commodity volatility ranking

Electricity is probably the only commodity in the world where under certain conditions it is available for free and under other conditions the price can be over ten times its daily average. In an established market such as the one operating in New Zealand, the average daily price in 2000 has seen variances from 2c/kWh to 6.5c/kWh (NZ cents) as illustrated in Figure 2 (download from http//www.m.co.nz). The hourly variance within a single day this year has been from 1.1 c/kWh to 10.8 c/kWh (NZ Cents).

2.2. Power Pool based Market

Detailed market operation explanation is beyond the scope of the paper. An overview of the mechanisms are described in order to provide an understanding of the technology applications and constraints in the new market place.

When more than one generator supplies load into a power network, it is impossible to distinguish where the power

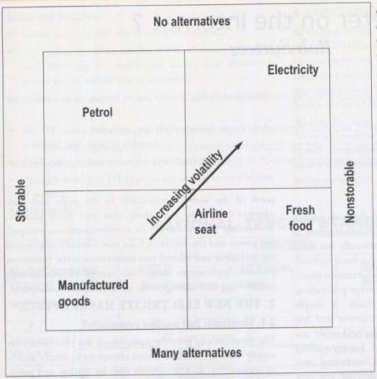


Figure1. Commodity Price Volatility i)

originally came from. The concept of a pool is then applied where all generators participate by pumping power (like the water analogy) into the pool and customers purchase their energy from the central pool. The pool and market are however not necessarily the same entity however. Generators, Traders and customers would participate in an open market, buying and selling energy contracts based on their energy requirements and risk dynamics. The non-physical market activity occurs outside of the pool. The pool serves as the market for the physical transactions, inherently allowing a mechanism for spot market transactions. There are many variations of the above in the way pools and markets are structured internationally. Power pools can be operated on a co-operative basis with bi-lateral generator/customer agreements being preferred as is the case with Sweden and Norway or on a mandatory basis such as England and Wales (ii).

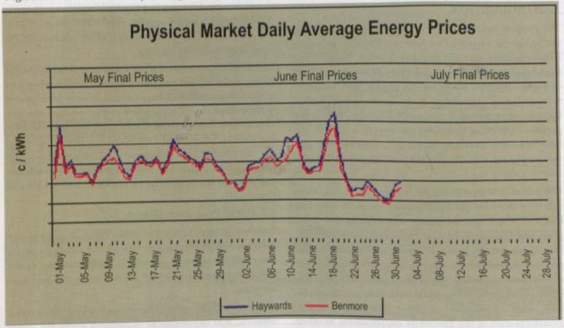
A common characteristic however is that there is that customers and wholesalers can choose, based on their risk profiles and load characteristics, the degree to which they would want exposure to the variable electricity spot market. Typically this is between 5 % and 10 % of total energy traded in the market.

3. DEVELOPMENTS IN SOUTH AFRICA

3.1. Eskom Power Pool

Eskom has an operational pool, simulating a competitive mandatory pool, similar to the England and Wales arrangement. The only participants currently are Eskom Generation, Eskom Distribution and the Eskom

Figure 2. New Zealand Daily Average Energy Prices 2000 (N & S Islands)



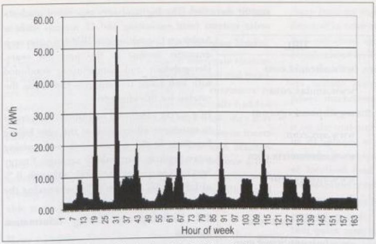


Figure 3. Eskom Power Pool price July 1999 typical week

International trader. Eskom's Transmission group administers the pool, with the hourly prices being set by internally competing generators. These prices are determined by the most expensive generator required at the specific time. A system load forecast represents customers, with the schedule being centrally determined. Although the pool is believed to be operating well, simulating a competitive market, the true test will be when Eskom Generation is unbundled and real competition is in place. Pool prices for a typical week (in July 1999) are illustrated below.

3.2. Ancillary Services Market

Provision of Ancillary services has historically been provided by the Eskom generators. Spinning, operating and regulating reserves can however also be provided by the demand-side, primarily through interruptible and other flexible loads. While there is limited potential for the instantaneous reserves on the demand-side, where response times in the order of 10 seconds and longer are required, demand side participation provides a highly competitive alternative to supply-side provision.

A number of development and research type initiatives have been undertaken by Eskom in this area over the past two years. The Eskom Power Pool Administrator intends accepting some demand-side bids on a pilot basis in 2001. These most notably would be interruptible and large dual fuel customers, where oil or gas hot standby plant is available.

3.3. Structural Industry changes in SA

The Government appointed Price Waterhouse Coopers (PWC) consortium have advised:

- That REDs would be allowed to purchase their energy from a wholesale generation market, with incentives to minimise their supply costs.
- Customers larger that 100 GWh should be allowed a choice of licensed retail supplier from day one i.e. contestable customers.
- In the end-state regulation of the REDs there be separate accounting for their distribution (wires) business, their captive retail energy business and their contestable retail energy business.

While it is known that Government intends completing of the restructuring exercise by 2004, the time frame for full RED and wholesale market establishment is uncertain. The one certainty however is that there will be significant changes in the way electricity is bought and sold within the next few years. The technologies (specifically internet based) required to enable the changes to be made are the focus of the remainder of the paper

4. TECHNOLOGY CHANGES / TRENDS

Historic justification due to the pattern of declining marginal cost through economies of scale has been the major justification for monopoly establishment. Greater cost efficiencies are now being realised in competitive markets primarily due to technological advances. What microwave and digital communications did to the telecommunications industry in the last decade, a range of technologies is currently having the same effect on Electric Utility businesses throughout the world. Smaller more efficient generation plant including combined cycle gas turbine technology in the late 1980's and early 1990's enabled greater private participation in the industry in the USA and Europe, with pressure being brought to bear on governments and regulators to start opening up markets. This could however only be done at great cost, with the technical and administrative infrastructure required being in a similar order of magnitude to the electrical distribution network itself.

Information, communication and metering technologies now enable electricity to be treated as a product separate from the transportation means, with the Internet being the all-pervading technology from the Power Exchange through to billing and settlement.

4.1. Electronic Electricity trading

Just as the exponential growth in on-line trading in Equities and general commodities has been witnessed over the past year, the proliferation of on-line energy auction and exchanges has followed suit. The largest power exchange being the Californian Power Exchange and largest trader being Enron Online. Table 1 below lists the major players in the US market

The California Power Exchange (CPX), currently a monopoly, effectively operates a competitive electronic auction. Generators, scheduling coordinators and buyers submit their bids daily and the CPX determines the market-clearing price, by matching supply and demand. The

Table 1. e-Electricity Sites in the USA (Source - Energy Markets April 2000)

COMPANY	URL
Altra Energy Technologies	www.altranet.com
American Direct Access Exchange	www.amdax.com
APB Energy Inc	www.apbenergy.com
Automated Power Exchange	www.apx.com
Enermetrix.com	www.enermetrix.com
Energy.com	www.energy.com
Enron Corp	www.enron.com
Excelergy Corp	www.e-choicenet.com
HoustonStreet Exchange	www.houstonStreet.com
i2i Energy	www.i2ienergy.com
Marketing Database Associates	www.mda-energynet.com
PSEG Energy Technologies	www.PSEGET.com
RedMeteor.com	www.redmeteor.com
Scana Corp	www.scanaonline.com
TradeCapture.com Inc	www.tradecapture.com
TrueAdvantage Inc	www.trueadvantage.com

CPX charges a transaction fee in each of the markets it operates i.e. the Day-Ahead and Hour-Ahead. (iii)

Enron is by far the largest and post profitable wholesale energy trader, expecting to handle wholesale trade volume worth \$20 billion in 2000. This includes everything from gas, electricity, paper pulp and coal.

There is much speculation as to whether there is room enough both in Europe and the USA for the number of players that have recently entered the market but the one certainty however is that the on-line market itself is here to stay and continuously growiv.

4.2. Customer Information systems, Customer Relations Management

Without exception all the major CIS vendors are introducing browser-based technologies as the primary interfaces from enabling the Customer Service Representatives to check billing history through to direct interfacing with a customer demographic database.

Increasing access to the internet, particularly for the larger customers provides opportunity for enhanced service provision offerings including electronic bill presentation and payment. The CIS's are now commonly linked to a broad array of customer relationship management (CRM) tools, encompassing everything from outage management systems to automated meter reading (AMR) systems. Coinciding with the growth in web based CRM tools, the number of big multi-year CIS development projects has rapidly dwindled. The big (and very expensive) made-to-order systems from consulting and IT mavens such as Andersen Consulting and IBM have also seen dramatic decline in the past few years. Deregulation and competition, combined with web based technologies have been the catalyst for this changev.

In a survey conducted by Utilities IT, a trend to outsource all or some of the core billing functions in the revenue cycle is becoming more popular, particularly amongst Energy Service Companies (ESCO's), although 8 % of US utilities are now fully outsourcing the function.

4.3. Metering and Energy Information Systems

In the competitive markets of the UK and California, historically simple issues of meter ownership, servicing and reading has changed considerably, with Meter Operation, Data Collection and Data Aggregation all being separated and a degree of competition being introduced in these areas (although not entirely successfully). Even meter ownership could lie with one of three parties, i.e. the customer, the utility or the service provider. AMR has become a prerequisite for all larger customers (those over 100 kW in the UK) in order to enable the market to function effectively. Once again, the reduction of unit costs based on technology improvements has enabled wide scale implementation. In the UK, almost 75000 meters are automatically read every day.

The number of players in the new energy information services market has as a result of these developments grown dramatically. A common feature is the use of the Internet for the provision of the services, for example. Customers are able to access their aggregated half-hourly demand profiles for the previous day via the service provider's web page. Intelligence and greater functionality is also being built into the new generation metering devices. Some of the new meter capabilities include:

- Integrated radio modems enabling two way communications
- Bi-directional email via the local ISP for tariff updating and energy data downloading
- Ability to remotely (via the internet) upgrade the meter's firmware
- Demand threshold notification by the meter (urgent email)

There can be little doubt that as the world becomes more and more "wired", the Internet will become the medium of choice due to its flexibility and ubiquity in all other areas. Some see the meter not so much as a measurement device but as a gateway into the customer's facility through which a multitude of other services can be provided.vi

4.4. Demand-Side Participation in the Emerging Market

Extreme price volatility in US regional wholesale electricity markets have led to energy service providers and retailers instituting measures to enable their customers to respond accordingly. Customers have historically had two part tariffs or fixed time-of-use rates, and while they may have responded to the constant signal, there was no incentive for dynamic real time response. New load management strategies are being implemented to achieve a balancing effect. Market linked products are convey peak pricing signals directly to customers who are willing and able to respond to high prices by temporarily reducing load.

Many customers have elastic demands, which they are able to reduce with little or no advance warning, provided the incentives are warranted. These principles are not new in the industry, with Time-of-Use rates, Interruptible rates, direct load control (ripple), and Real-time-Pricing having been around for some years. While these programmes are a progression towards true cost reflectivity, they don't convey the real hour by hour supply vs demand pressures.

The application of the current "first generation" load control has been limited to the large energy intensive customers or blocks of residential hot water load. The major problem with extending the more dynamic pricing signals to a broader customer base has historically been the high cost of implementing and administering the programmes for the smaller industrial, commercial and residential customers. Technology advancements in wireless telecommunications, metering and the Internet once again overcome the historical cost constraints. Market volatility and these new technologies have spurned "second generation" load management initiatives. Groups of flexible customers are now being aggregated and are able to provide large blocks of Megawatts or Negawatts in response to dynamic pricing or load control signals.

The following points characterise second generation load management.

- Payments to customers are based on actual service interruption, unlike past arrangements where discounting was effected, with interruption being very rare.
- Performance would depend on price signals rather than maximum demand thresholds
- Rewards are inherently customer specific depending on load response characteristics and risk/reward tolerance.
- New participants in the market include aggregators, traders and a broader customer base.

An active on-line demand auction site has even been established viz. Apogee's Demand Exchange. End-users are given day-ahead and day-of price signals on a proprietary Internet site. End users who want to reduce their demand in return for a payment post information on the Web site about their willingness to participate, including details about how much they will reduce or eliminate or eliminate load and when they will do so. Interested buyers include generation or distribution companies (or power marketeers). If a deal closes, payments for purchased Negawatts come in the form of a check or a credit on the end-user's electric bill. While the market is still in its infancy it is rapidly growing, with Apogee now including area specific price signals to enable rewarding of localised load reduction where distribution and/or transmission constraints are present.

Where loads can be controlled without prior warning and respond in under 10 seconds, participation in the generation quick reserve market is also possible, thus illustrating the diverse nature of the new market place.

5. INITIATIVES IN SOUTH AFRICA

Of particular interest to the Distribution sector is a recent pilot initiated by Eskom to investigate the potential benefits of aggregating blocks of controllable load and then controlling the load in response to a pool-based price signal. This initiative was undertaken as a part of Eskom's Demand-Side-Management (DSM) research programme. Three components made up what was collectively called the Virtual Power Station (VPS) viz.

- Coordinated Municipal Ripple Control - COMRICON
- Dual Fuel load interruptibility
- Real Time Pricing

The greatest potential (and most cost effective load) was deemed to be the residential hot water load and was the focus of the first phase of the initiative, with Kempton Park, Durbanville and Roodepoort being the COMRICON pilot participants.

The objective of the research, and the practical work in the form of the pilot was to deliver, a post installation CONTINUOUSLY MEASURABLE, net load shift of over 50 MW on the national system demand profile.

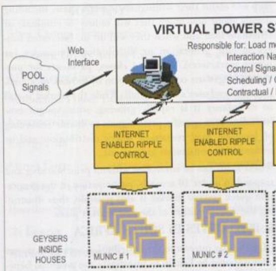
A block diagrammatic representation of the Virtual Power Station (VPS) concept is shown in Figure 4. The control efforts would initially be co-ordinated by a central body, who will have the responsibilities of interacting on behalf of all the participants. The VPS operator would derive the pricing signals from the pool, perform the load measurements and provide the optimal control signals via a scheduling system. The contractual, financial settlement and operations would also be handled by the VPS.

5.1. Pilot Technological Infrastructure Establishment

The technology infrastructure required included:

- On-line one-minute data-acquisition systems, for each of the substations feeding the participating municipalities.
- Dedicated high speed digital networking
- Custom built decentralised PC104 based COMRICON ripple controllers

Figure 4. Virtual Power Station - COMRICON



- Systems for a central operations centre, including potential load availability forecasting

5.2. Controllable Dynamic Megawatts

Several trial runs were made throughout 1999, culminating in a final live "1-week" test run during the second week of August 1999. Two primary scenarios were tested i.e. Real Time Pricing response simulation and emergency shedding signals simulating reserve market participation. A summated controllable DSM load of more than 100MW was measured on Friday 15 August 1999, this being achieved by the simultaneous control and measurement of the three municipalities viz. Durbanville, Roodepoort and Kempton-Park. This is illustrated in Figure 5 below.

Considering the hypothetical case of the three Municipalities being on the Wholesale tariff during the three hour 'high-demand' period, 270MWh of energy was moved out of peak time, into standard time, resulting in a calculated purchase cost saving of R 60 000.00. This is based on a "no-response" comparison.

In 2000 the VPS programme has been expanded to included additional Municipalities, Large interruptible Industrial loads and some commercial facilities. In the event of mechanisms being successfully tested, the first real trial run will be conducted in early 2001, where these loads will be bidding in direct competition to the Eskom Generators.vii

6. CONCLUSION

The SA Electricity Supply Industry is on the threshold of major change, not unlike similar industry transition internationally. While there may be significant non-technical challenges ahead, SA is in the fortuitous position of being able to exploit the recent technological advances resulting from international industry developments as well as the Internet explosion. The resources and skills required to implement the technology changes quickly and efficiently are believed to exist in South Africa.

(i) Kiernan B. From RTP to Dynamic Buying - ESOURCE Strategic Issues Retreat presentation

(ii) Fabricius C & Roos M - The development of a Pool Based Electricity Market in South Africa

(iii) Sioshansi P - Menlyn Energy Economics - E-Commerce and the Energy Sector

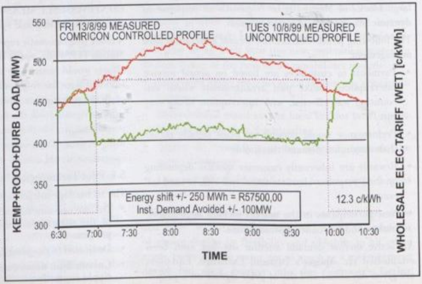
(iv) Den Ouden B & Thompson RP - Power Economics Power Forum - June 2000

(v) Causey Warren B - Energy it - May/June 2000 - CIS brings home the bacon

(vi) Sioshansi P - Metering, Billing and Settlement Issues in Competitve Electricity Markets

(vii) Van Harmelen G -The Virtual Power Station Targeting Residential, Industrial and Commercial Controllable Loads - IFAC Conference Jul 2000

Figure 5. COMRICON Load Shift Results



Critical circuits - DTS imperative

Ken Barber, Mark Jansen and Peter Orrell
Presented by Dillwyn P David

KEN BARBER is General Manager, Development and Engineering, and MARK JANSEN is EHV systems engineer of Olex Cables, a division of Australian Cables, Victoria, Australia. PETER ORRELL is International Sales Manager, York Sensors Limited, United Kingdom.

DILLWYN P DAVID is Product Manager, York Sensors.

Qualifications: 15 years involvement in Optical Fibres industry, 5 years - York Technology, leading manufacturer in optical fibre characterisation, 10 years - York Sensors, leading manufacturer of fibre optic distributed temperature sensing (DTS).

Having held positions in both technical and sales roles and holds a joint patent for application of the DTS technology.

Mr Dillwyn P David

ABSTRACT

The use of optical fibres for distributed temperature sensing is now well established technology. Significant advances have been made in both the performance and reliability of the measuring equipment as well as the design of cable systems and method of incorporation of the fibre to ensure reliability and accuracy.

Many supply authorities are now introducing this technology as a means of protecting the value of their expensive cable assets. This paper examines the results obtained on a 9.2 km route of 110 kV cable installed as one of the new main transmission distribution feeders in the City of Auckland, New Zealand.

Whilst every precaution was taken during installation to stabilise the environment, the geophysical aspects of the cable route means that the cable passes through a number of areas which can effect thermal rating of the cable system.

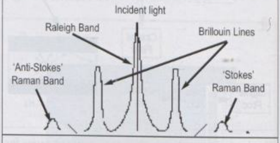
Due to the highly critical nature of this circuit, optical fibres were incorporated within the cable construction and for some areas other fibres are also provided externally to the cable. This provides unique advantages in terms of being able to very accurately assess the data obtained and provide opportunities for further system enhancements.

The paper discusses some of these possibilities in the light of technology currently available and the opportunities that exist for maximising the installed assets on the installed cable system.

DISTRIBUTED TEMPERATURE SENSING (DTS) PRINCIPALS

In conventional temperature measurements, a sensor, such as a thermocouple or platinum resistance probe, is needed for each point of interest. For applications where large areas or long distances are involved, conventional systems therefore become over-complicated, bulky, unreliable, and costly to maintain. An effective alternative solution is a distributed sensing system.

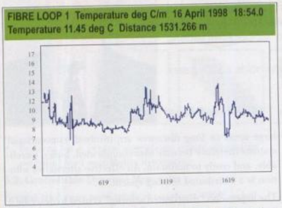
The expression "distributed sensing" is used to describe a technique whereby one sensor can give data spatially distributed over many thousands of individual measurement points. A single optical fibre has the ability to act as a distributed temperature sensor with potentially many thousands of individual measurement points. Current Distributed Temperature Sensing technology (DTS) allows fibre lengths of up to 30 km in length with sampling every 2 metres to be used in this way. Optical fibre sensors for power asset monitoring have significant advantages because they are totally immune to EMC interference and can also be used in hazardous areas.



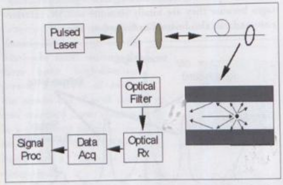
Back-scatter Spectrum

A DTS system is essentially a combination of two technologies. Temperature measurements are achieved by analysing the Raman back-scatter signals caused when a laser pulse is travelling in an optical fibre. The position of each measurement point is determined by its time-of-flight from laser emission.

When DTS systems are used to monitor buried and sub-sea power cables, the resultant temperature profile enables cable owners to determine the size, location, and potential impact on rating performance by any hot spots caused by localised environmental conditions. For example, a 12 km long power cable can be profiled with sampling points every metre using just one optical fibre. The impact of changes to the cable environment caused by seasonal conditions, climate, and land development, can be continuously tracked to ensure the cable is always correctly rated.



The laser pulse is transmitted into the fibre via optical directional couplers which allows the returning back-scatter signals to be filtered into a highly sensitive dual-channel receiver where the Raman signals are detected and converted into a digitised format specifying temperature and position. The function of the signal processor is to provide a user-controllable level of signal averaging to obtain the desired level of temperature resolution.



The level of temperature resolution required varies for different types of application and is proportional to the time required to complete the averaging process.

It is possible to produce a complete 12 km profile to a resolution of 1∞C within several minutes, but as the typical time constant of a buried cable is measured in hours or even days then a longer period is usually set. Fast measurements are ideal for obtaining a "snap-shot" for hot spot detection.

Other critical DTS performance indicators are spatial resolution and positional resolution. These are often confused, but positional resolution defines the range location accuracy of features (hot-spots), and spatial resolution determines the ability to measure the peak value of the feature. For example, when the feature occupies a section of fibre less than the spatial resolution of the DTS, then the measured temperature is lower than its true value by approximately the ratio of hot-spot width/spatial resolution. Once the hot spot width is greater than 1.5 times the spatial resolution of the DTS system then the measured value approaches the true temperature.

Also of interest is the method of interrogating the fibres. Over relatively short measurement distances the sensing fibre is connected to the DTS unit as a loop using the double-ended processing technique. In this method the laser pulses are injected into the fibre from both ends. This method provides automatic calibration for fibre losses, splices, connectors, and micro-bending effects. Further, in the event of an in-service fibre problem, the sensing fibre can still be measured from both ends up to the loss point providing continuous monitoring. Typically, multi-mode fibres are useable for DTS applications up to 12 km fibre length without significant reduction in measurement precision. This allows up 6 km of cable to be monitored using the double-ended technique or 12 km using a single-ended connection. In the case of the latter it is necessary to calibrate the fibre during installation by independent means.

For temperature monitoring applications above 12 km then it is advisable to consider using single-mode fibres which have a lower attenuation and better spatial resolution than multi-mode fibres. Current DTS technology based on single-mode fibres enables ranges of up to 30 km to be spatial measured at 2 metre sampling intervals. A significant advantage for single-mode DTS technology is the ability to provide temperature profiles of power cables where a separate communication f/o cable has been installed in the same trench. This allows potential "retrofit" application of temperature monitoring to cables which do not have dedicated sensing fibres.

PRACTICAL APPLICATION FOR POWER CABLES

A circuit rating is primarily governed by the thermal resistivity of the medium surrounding the cables. For direct buried cables the surrounding medium in the trench in which the cables are buried will normally be a backfill that has a guaranteed maximum thermal resistivity. The thermal resistivity of soil outside the backfill area will depend on its structure and to a very large degree its moisture content, the lower the moisture content of the soil the higher its thermal resistivity. The amount of drying out of the soil is dependent on what load is being placed on the cable and the general climate in which the circuit is operating.

A DTS provides a means by which a cable rating can be compared to its operating temperature, the DTS measures and collects the cable temperature data. Analysis of the collected data, in conjunction with the system load data, using IEC 287 through software packages such as Excel, MathCad and/or a finite element analysis packages such as Sirolex, enables the user to establish and then predict the cable behaviour along the entire route. Through analysis of the data, the system can then be loaded to maximise its use and thus prolong the system 'life' as the cable temperature will not exceed limits determined and thus prevent possible damage to the cable through overheating.

The location of hotspots along a cable route can also be located with a high degree of accuracy using a DTS. A trace of the temperature profile can be displayed and recorded by the DTS. This trace will display the location of any hotspots along the fibre route. To establish a relationship between the distance along the fibre route compared to the cable route, a Non Temperature Sensitive (NTS) trace can be downloaded from the DTS. A NTS trace is basically an OTDR trace and the location of splices in the optical fibre can be established in relation to the cable route. Then, in conjunction with a route drawing which shows and lists the services that cross over the system, hotspots can be very accurately located.

Once the location of these hotspots has been established in relation to the cable route, the factors which may be causing the hotspots can be determined. There may be several existing services that are being overrated and as such these influence the critical circuit, or the cable may be installed in a region where the soil thermal resistivity has become high due to drying out of the surrounding medium. Having established the region in which services are affecting the cable temperature, these services can then be turned off for a predetermined period to confirm their influence, and establish if the critical cable is being adversely effected. Having established which services are effecting the critical circuit, corrective action such as derating or if necessary, removing or relocating the service that is causing the problem can be taken. As an added measure, a zone can also be programmed into the DTS that will trigger an alarm message if the cable temperature in that zone exceeds a predetermined temperature limit.

OPTICAL FIBRE IN SCREEN OR STRAPPED TO CABLE EXTERIOR?

The cable used for this project was originally designed for use installed in air in a tunnel. The design of the cable was such that graded index 50/125 (m optical fibres in a loose tube were provided with the helical copper wire screen of the cable. Incorporating the optical fibre in the copper wire screen enables the conductor temperature to be more accurately calculated and the loose tube is protected from mechanical damage that may occur during handling of the cable. The cable was installed in a horizontal flat formation and the fibre spliced together in each joint bay. Splicing the fibres together in such a fashion enabled each phase of the circuit to be monitored for its entire length thus ensuring that any problem regions are not only accurately located but can be verified using the data from the other phases. A single length of fibre was also strapped to the outside of the phases for two sections of the cable route and then laid in a loop in ground. The purpose of this additional fibre is to measure the temperature along the outside of the cable and also to provide a reference for the ground temperature.

The images in Figures 1&2 were generated using Olex Cables' finite element analysis program Sirolex. Sirolex is used to estimate the temperature within the cable and trench under both steady state and transient conditions. Figure 1 displays the position of the two optical fibre cables in relation to the main power cable, and indicates

Figure 1. Sirolex Plot at Maximum Rating

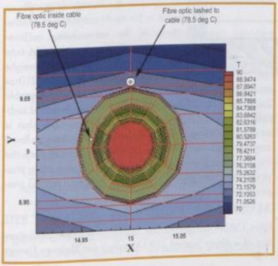
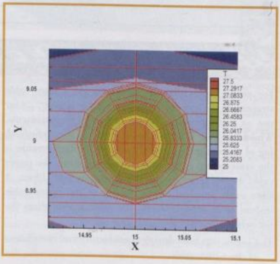


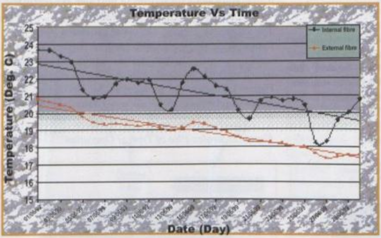
Figure 2. Sirolex Plot of Typical Operation



the temperatures within the power cable when it is operating at 90(C under steady state conditions. Figure 2 indicates the temperature of the centre phase on the circuit mentioned later at its present loading. Having a fibre either incorporated into the cable or strapped to the cable exterior enables the conductor temperature to be estimated using data gathered from the DTS.

Both methods of fibre installation for the purpose of temperature measurement have some advantages and disadvantages. Installation of the fibre within the power cable enables a far quicker response to changes in load and hence follows the cyclic behaviour of the cable temperature better than a separate fibre cable that is strapped to the outside of the power cable. An example of this is shown in figure 2, displaying temperature plots of both fibres for the month of June. The fibre that is incorporated into the cable (internal fibre), displays behaviour that is consistent with the cable loading (See figure 6 for an example of cyclic behaviour of cable loading). On the other hand, the cable that is strapped to the outside of the power cable (external fibre) has a somewhat smoothing effect, indicating little change in temperature due to cyclic loading of the cable. This fibre, therefore, is more representative of the trend in cable temperature, which as expected, follows the changes in the temperature of the installed environment.

Figure 3. Fibre Temperature vs. Time



For power cables that are direct buried a fibre cable strapped to the outside of the power cable is adequate for use as a temperature probe for DTS measurements. Whilst this fibre is not a true reflection of the cyclic loading of the cable the general trend of the temperature is the same as that of the fibre incorporated into the power cable as evidenced by the trendlines for both fibres. A fibre cable attached to the outside of the power cable instead of incorporated into the cable screen offers the following benefits:

1) Cost savings both during manufacture and installation of the power cable.
2) Decreased risk due to handling of the optical fibre. The process of jointing the power cables means that the optical fibre tube is subjected to a significant amount of handling. Whilst all care can be taken, there is a substantial risk of mechanical damage.
3) Better fibre attenuation. Olex experience indicated that, on average, optical fibre attenuation is increased by 0.05 dB or less per length, at the measurement wavelength of 1300 nm during manufacture of the power cable. Olex cables had factored in the effect of this increase in attenuation when selecting a DTS instrument, however with a separate fibre this attenuation would not be present.
4) Decreased losses due to splicing of the optical fibre. Each splice represents a loss of approximately 0.2 dB along the fibre route. Strapping a fibre cable to the outside of the cable means that the fibre cable can be installed in far longer lengths that in the case of a power cable where the fibres must be spliced together at each joint bay.
5) Increased capability of measuring greater circuit lengths. The DTS currently in use in Auckland has a fibre measurement range of twelve kilometres. With the fibre incorporated into the power cable the maximum circuit length that the DTS is capable of measuring is approximately 10 kilometres. Strapping an optical fibre cable increases this length closer to the DTS limit of 12 kilometres.

There are, however, situations whereby incorporating an optical fibre into the screen wires will be necessary to obtain an accurate profile of the cable temperature. One such situation, is the case where the power cable is installed in air, such as a cable pulled through the main supporting structure of the bridge, or a cable installed in a tunnel. An optical fibre cable strapped to the outside of the power cable is far more subject to the influences of the surrounding environment than a fibre incorporated into the power cable. A power cable might be undergoing a load that has increased the conductor temperature above acceptable limits. The fibre incorporated into the cable would indicate a critical temperature, whilst a fibre cable that is strapped to the outside of the cable would have a slower response and would represent a combination of both the environment temperature and also the power cable temperature. Thus, this fibre may not indicate a critical temperature.

AUCKLAND EXPERIENCE

Olex Cables completed the installation and commissioning of a direct buried 110 kV circuit for Mercury Energy

New Zealand (now known as Vector Limited), in December 1998. The circuit is approximately 9.2 km long and is installed from the Mt. Roskill outdoor substation to the Liverpool St. Substation in Auckland City. Due to variation of the soil types along the cable route the trench was backfilled with a selected mix with known thermal properties when fully dried out. Soil types along the cable route varied from fine gravel to volcanic rock. To detect regions of higher thermal resistivity and protect the system from possible overheating, and also to maximise the use of the circuit, a York Sensors DTS 800-MR was installed at the Liverpool St Substation. This unit has a range of 12 km, a spatial resolution of 2m and is accurate to (1 (C. This unit was selected as it offered the greatest accuracy over the given length and had proven field experience in the power industry.

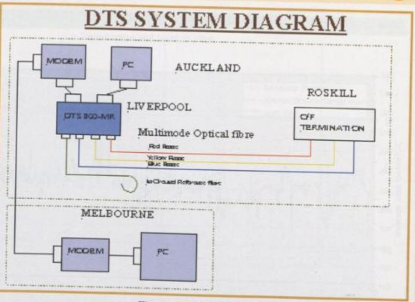


Figure 4. DTS System Diagram

As part of the contract agreement Olex cables provides a monthly report to Vector Limited on the performance of the 110 kV circuit using data obtained from the DTS and load data provided by Vector. The DTS information and load data is accessed via a modem link over a normal telephone line and is analysed by Olex engineers located in Melbourne (which is some 2000 kilometres from Auckland). There are several objectives with this work:

- The temperature trace is analysed to accurately locate regions where the temperature is not uniform in relation to the rest of the circuit (Hot spots).
- The trace is viewed over a 24 hour period to ascertain the consistency of any regions noted above to establish the worst case scenario.
- The actual mean and maximum current carrying capacity of the circuit is determined. This is done by sorting the data using software associated with the DTS 800. This software has as one of its functions, the capability of being able to convert the DTS data to an ASCII format Olex Engineers can then use software applications such as Microsoft Excel and MathCad to derive the current rating under the current set of operating conditions.
- These calculations are also used to estimate the average soil thermal resistivity at locations along the cable route and thus verify the system rating.

DTS TRACE ANALYSIS

Figure 5 displays a temperature trace of the 110 kV circuit taken during April 1999. To maintain a high degree of accuracy each trace represents the average of many traces. Under the current system of monitoring each fibre is sampled approximately every two hours as the cable has a high thermal time constant. As was expected, the majority of the trace indicates that the thermal conditions along the cable route are uniform. There are, however,

Figure 6. Services Crossing the Cable.

certain regions along the cable route where the cable temperature is warmer than average. Initial investigations have indicated that factors beyond the control of both Vector Limited and Olex Cables may be having an adverse effect on the cable behaviour. Vector Limited is now able to take corrective action before the loading on the 110kV cable becomes such that these regions limit the circuit rating. These regions are currently under investigation and a program to determine what factors may be causing the excessive warming is being developed. The main theory being postulated is that some specific electrical services crossing over the cable are producing a significant heating of the surroundings (Figure 6) and the program will primarily focus on the services in the effected area.

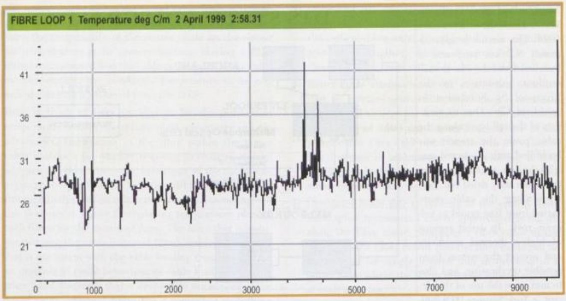


Figure 5. DTS Trace

NUMERICAL ANALYSIS OF THE DTS AND LOAD DATA.

The international standard IEC 287 is used as a basis for all current rating calculations. The thermal resistivities of the cable components are known (T1, T2 and T3), thus the only variables that do significantly vary are the AC resistance of the conductor (R), and the external thermal resistance (T4) which is directly related to the thermal properties of the medium surrounding the cable. Given that the backfill placed in the trench has a known thermal resistivity, it is assumed for the purpose of the rating calculation that only the thermal resistivity of soil surrounding the trench can vary.

IEC 287 Permissible Current Rating Formula

$$I = \sqrt{\frac{\Delta\theta - W_d\left[0.5 \cdot T_1 + n\left(T_2 + T_3 + T_4\right)\right]}{R \cdot T_1 + n R \cdot \left(1 + \lambda_1\right) \cdot T_2 + n R \cdot \left(1 + \lambda_1 + \lambda_2\right) \cdot \left(T_3 + T_4\right)}}$$

Having the optical fibre integrated into the copper wire screen of the cable enables the conductor temperature to be calculated accurately. The ambient ground temperature is obtained from a buried loop of fibre. These parameters, as well as the load, are then imputed into the IEC equations. The soil thermal resistivity is then varied until the calculated current rating matches the measured current. Once the soil thermal resistivity has been calculated the conductor temperature is reset to the maximum operating temperature and the circuit rating determined.

Under normal operating conditions the circuit is designed for a maximum rating of 150 MVA. Due to the influence of these warm regions however, we have calculated an effective de-rating to the 110kV circuit such that it will not overheat at these "hot-spots". Once the cause of these points of localised heating are investigated and rectified, the calculations clearly indicate the circuit will comfortably achieve the 150MVA design rating.

CYCLIC BEHAVIOUR OF THE CABLE

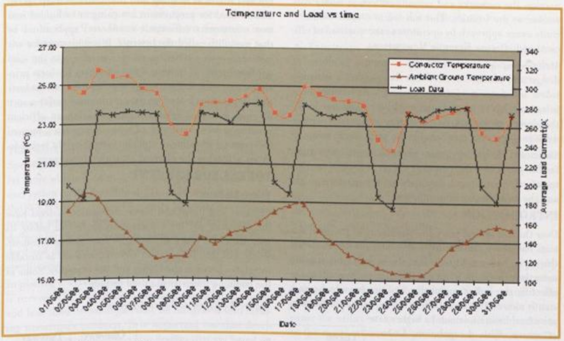
Sampling each phase on a regular basis is enabling the cyclic (daily, monthly and eventually yearly) behaviour of the cable to be established thus providing a basis from which the cables' thermal behaviour can be analysed. Figure 7 shows a plot of the conductor and ground temperatures as well as the load data versus time for the month of May. The chart indicates the cyclic nature of the cable loading and also clearly indicates that as the Auckland soil temperature cools as winter approaches, the cable operating temperature is also decreasing. As more data is gathered a seasonal profile of the cable behaviour will be developed and trends in the cable behaviour that may be detrimental to the cable will be able to be predicted.

DTS IS COMPLIMENTED WITH RTTR

To further enhance the advantages provided by a DTS system, Olex Cables are proposing that when more of the HV circuits are connected, Vector Limited should consider a SCADA system that is known as Real Time Thermal Rating (RTTR). This would accurately measure and predict circuit loading and would, in effect, enable the circuits it monitors to become "self governing".

Systems are currently being developed to directly read circuit load data as well as data generated by the DTS via. a data acquisition unit. This real time data can then be analysed and manipulated to predict current operating condition and capacity, as well as capacity for future loading for a number of different continuous, and short time loading scenarios. The RTTR system could thus automatically generate alarms to indicate possible dangers and

Figure 7. Conductor and Ground Temperature and Load Data vs. Time



thermal instabilities and could give prior warning of such situations.

CONCLUSIONS

The experience of Vector Limited in New Zealand has highlighted the need to be able to monitor the thermal behaviour of critical circuits. As the demands for assets to be fully utilised increases, it is becoming imperative to have a monitoring system such as DTS, in place to enable the prediction and detection of possible problems such as thermal runaway. Such a system also allows trends to be monitored, thus allowing time for appropriate actions to be taken prior to emergency situations arising. The data obtained from the DTS enables the distributor to maximise the use of a circuit during periods of peak loading e.g. mid-summer, when the soil around the cables may begin to dry out. The real-time nature of the data allows the cable behaviour to be carefully and closely monitored, thus allowing optimum use of the circuit.

Whether or not the optical fibre is incorporated into the power cable or is simply strapped to the outside of the power cable will depend on the conditions in which the power cable will be installed and the length of the circuit to be monitored.

Using technology to manage revenue

David Smart

DAVID SMART

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Mr David Smart

SUMMARY

This paper looks at the history of prepayment and the advances made in applying the latest token technologies for transferring credit purchased at the Vending Unit (point-of-sale) to the utility meter. These prepayment meters are now being accepted by Utilities as a cost-effective solution to a growing problem of non-payment for services by consumers. Privitisation of the Utilities including Water, Electricity,

Gas and Heat has created opportunities for companies to manage the networks and revenue collection under concession to the Utilities. This has led to a more commercially aware approach by operators to the question of efficient and effective Revenue Management.

Metering equipment manufacturers are now motivated to design and produce devices that share either a common token interface, a common vending/data management infrastructure or a combination of both. This has led to the design of multi-utility metering equipment with a drive to a common platform for the prepayment token.

Smartcard technology now provides multi-application facilities to enable the customer to carry only one card for transferring credit and data between the vending points and the customer's meter interface.

INTRODUCTION

Over the last several years the popularity of payment systems has grown enormously worldwide. The rationale for this varies between Utilities, but the major factor appears to be the privatisation and deregulation processes that are affecting the industry globally. Utilities have to be constantly aware of their cost effectiveness, as shareholders in privatised Utilities demand a higher rate of return. With deregulation, Utilities face the dilemma of retaining their existing customer base while providing incentives to attract new customers.

The original "coin in the slot" prepayment electricity meter was designed for customers who wished to avoid any form of debt. Outstanding debt collection was possible by artificially increasing the "going" rate of the unit charge to include a debt element. Overall the system offered prepayment for the customer and helped him to budget for the energy that he consumed. But it was not prepayment for the Utility that had to periodically collect the money held in each meter. This caused obvious security concerns for the customer and Utility alike as there was a large amount of money that was a temptation to thieves. In many instances, the system was up to ten times more expensive to operate than a normal credit account, and the meter still had to be visited to change the coin mechanisms, to modify the collection rate and to collect the money. Collection of the money, a job that originally entailed one man on a bike, had to be replaced by three men and a security van as the value of money increased.

A new solution was needed that would primarily remove the money from the meter. In their continued search for mechanisms that were both more customer friendly and economical to operate, the Utilities appeared to move towards standards with respect to non-banking applications, where frequent small sums were involved - these can be called Token Systems.

The Utility "technology train" has moved from the steam era and it is now heading into the future at warp speed. Tokens used for prepayment are going to be hauled into new e-commerce (electronic commerce) applications by that monolith called the Internet. It is important for any business - even a cyber based one - to adhere to the solid application of old fashioned but necessary business principles. An e-commerce strategy must address various business imperatives including the creation and maintenance of good customer relationships, providing an efficient vending process, reviewing of business processes, focused incremental investment, and choosing the right technology for achieving the planned return on investment.

TOKENS FOR PAYMENT

Token Medium

Payment and integrated home automation systems have the customer pay for a commodity or service before its use. Advanced token technologies have emerged concurrently with the prepayment concept, and act as suitable interfaces between the Utility and the customer. Some of the common token media used include:

Figure 1 - Payment Token Options

Token	One-way	Two-way
Coins		
Magnetic Cards		
Paper (Numeric Strings)		
Touch Disk ("Dallas Chip")		
Plastic Keys (Memory "Keys")		
Memory Cards		
Smartcards (Chip Cards)		
Radio Frequency Carrier		
Power Line Carrier (for electricity meters)		

One-way tokens deliver credits to the meter while two-way tokens additionally transfer meter statistics and data back to the Vending Unit for processing by the Management System.

The Token as Credit Transporter

Up to now, both magnetic stripe disposable tokens and number strings for keypad token entry were the defacto standard transport method for the delivery of credit from the Vending Unit to the customer's meter. Credit transfers have almost always been in utility units, where the tariff conversion takes place at the Vending Unit. Successful algorithms were developed to manage complex tariffs, such as the multiple step method that is used in many international Utilities.

The international market began to influence the meter software design, and manufacturers introduced keypad tokens for the transfer of electricity credit tokens using "cash equivalent units". This method of credit transfer has the Utility tariffs stored within the meter rather than at the Vending Unit. This is a significant departure from the traditional "South African system".

The Bambamanzi (now Conlog) water prepayment company also introduced "cash equivalent units" for the transfer of credit to their water meters, and their Smart Token Dallas button is used as the token transport medium. The credit token data, and meter return data, are stored on the same re-usable token.

The South African developed STS (Standard Transfer Specification) compliant magcard and keypad meters, are far more widely used than any other open standard token encryption method worldwide. Its nearest rival is possibly the SCEMA (Smart Card Electricity Metering Association) method where a single-application Smartcard token is defined for electricity meters. This is a single utility standard and does not cater for water or other utilities in the specification.

In plotting a strategic course for the metering industry, it is necessary to review token technologies available today and how these technologies may be integrated into creating tomorrow's products. It is important too that developers do not rush headlong into designs that are based on the latest "fad", given the huge capital investment.

Smartcard Technology

Smartcard technology is slated as the next revolutionary development for financial service management and "e-commerce". E-commerce refers to those business-to-business (B2B) and business-to-customer (B2C) transactions that are managed on a digital network. The Internet is fast becoming the data transport network of choice, and one only needs to browse the Net to see the incredible ballooning of new applications made available daily to users. The Smartcard is a perfect fit as a support mechanism for e-commerce, and as such, it demands critical review as the token medium that will enable transaction processing for multiple applications. Electronic cash purse applications have been tested worldwide, and they offer a solution to the banks and customers where low-value transactions can be economically managed.

Token Systems

The essential need of a token system is to take the money out of the original prepayment meter. In order to do this it is necessary to establish an infrastructure where the customer's money can be collected.

Important aspects of revenue collection are:

- Efficient collection of revenue - cash flow improvements, minimised costs relating to meter readings, billing and collection, debt collection.
- Enhanced customer features - pre- and part payment facilities, emergency credit, budgeting.
- Reduced/eliminated site visits - self disconnection, automatic meter reading, remote programming for tariff changes, remote fault diagnosis, remote change of tenancy procedure.
- System security - no token fraud, accuracy and validity of data, secure access.
- Expansion capability - common communications media i.e. telephone and Smartcard, multiple applications, international standards ensure that there is a common link for expansion.

The prepayment industry is dependent on the transfer of secure information between the Management Systems, Vending Units, the customer and the utility meter. Security of information is managed through using suitable encryption methods.

One of the significant challenges introduced by prepayment is that of providing the utility sales service to meet the customer's needs where the customer wants it - and at a cost acceptable to the Utility.

The Sale of Utilities is a Retail Business

The retail service uses a customer meter specific prepayment token sold at a Vending Unit, where the token transfers a credit amount to the customer's meter equal to the amount of money paid. The customer is then able to consume the utility to the value of the credit contained within the meter, after which the meter interrupts the utility supply, unless a further credit token is purchased and entered into the meter.

A good analogy is the petrol station, where the motorist must prepay for fuel to be pumped into the petrol tank of his car.

Business priorities for the Utility include the minimising of costs and the elimination of risks associated with the handling of cash. The Utility should consider the following factors when establishing a suitable sales infrastructure:

- Customer focus - establishing the customer centric sales network
- Customer acceptance - the type of token used by the Utility
- Affordability - capital costs of the sales network
- Multi-functionality, multi-application - support for multiple utilities and sales applications

Customer Service Expectation

Research has shown that customers regard the following service factors as being important:

- Trust - the Vending Unit must be trustworthy
- Security - the tokens issued must be secure i.e. the tokens must operate in the meter and these tokens must be rendered useless if stolen by a third party
- Convenience - the Vending Unit must be open at convenient times during the day
- Simplicity - token purchases should be a simple procedure and be a straightforward experience
- Travel - travel time and cost for travel to and from the Vending Unit should be acceptable

- Focus - the service provided should be customer focused

Utility Service Philosophy

Some service concepts that should be noted for the establishment of a vending infrastructure, are:

- Profiles - a wide range of customer categories will be served
- Location - the Vending Unit should be placed where people wish to buy tokens
- Payment - the customer must have a choice of payment method
- Availability - Utility tokens must be a highly available retail commodity

Payment Method

Generally cash is used to pay for utility prepayment tokens. The following table lists possible methods of payment available today, with emerging options that could be used together with an Internet connected world.

SECURITY AND CONVENIENCE

All commercial applications rely on cryptography to provide data integrity, authentication and confidentiality. Current Smartcard technology enhances these essential requirements with the facility of non-repudiation of transactions i.e. ensuring that a person cannot deny ever having performed a particular transaction.

In addition to PIN codes used to prevent unauthorized access to Smartcard data, sensors on the card are designed to prevent logical or physical attack from would-be hackers. Most Smartcards are able to lock themselves if their security is threatened.

To ensure data integrity and to increase the level of security, the memory and microprocessor of a Smartcard are contained on the same microchip. Where multiple appli-

Figure 2 - Payment Methods

Method	Description	Future
Cash	Generally accepted, well known a target for theft	High risk option for vendors making it
Paper Cheques	Country specific - must present at the point of sale	Unlikely option as most customers don't have the required bank facilities
Credit Cards	Country specific - can be used at point of sale or for telephone/Internet purchase	Here to stay although rapid increases in the level of fraud could curtail its use - many customers don't have the required bank facilities - specific vending support
Debit Cards	Spending limits equal to amounts on deposit	Popular method of payment but depends on specific vending support
Smartcards home banking	Chips replace magnetic stripes on cards and provides added security, PC compatibility and support for dependent	Many trials worldwide - expected to become the replacement for credit cards - vending infrastructure
Electronic Purses	Electronic purses on Smartcards are being promoted by banks for low value transactions	An extension of the secure Smartcard, it is the electronic debit/credit card all in one - vending infrastructure dependent
E-cheques	Secure cheques sent via E-Mail for digital signature - Internet specific	The USA is running trials - it has application with home banking - niche customers
Micropayments	Internet specific for small transaction payments - could be managed by an ISP	This method may have limited appeal given the demographics and profiles of customers
Electronic Bill Presentment	A consumer version of "electronic data interchange"	Future application with home banking - niche customers - "billing" before use would be required

cations coexist on the same card, operating systems embedded in the silicon provide a degree of "fire-walling" where each independent application cannot interfere with its neighbour. In the Multos operating system, there is a common interchange area of memory where data can be shared by applications. Coding instructions designed to "hack" into independent applications cannot be "loaded" through this common area.

When linking the Smartcard to a vending infrastructure, the processing power of the card allows it to encrypt and decrypt information, adding further authentication and providing a safe means of securing end-to-end transactions. The reach of the Internet is growing daily, making it a viable means of transaction delivery to a suitable utility Revenue Management System. Due to the disparate nature of the Internet, electronic commerce will only succeed if there is consistency of transactions from the point of entry, to the point of use, independent of the network topologies between the sender and receiver. Public Key Infrastructure (PKI) cryptography plays an integral part in establishing the idea of end-to-end electronic security on the Internet.

The Secure Electronic Transaction (SET) specification offers a credible solution to the global e-commerce fraud problem. It is an open-network payment specification that uses encryption and digital certificates to secure payment card transactions in cyberspace. Visa and MasterCard developed SET in 1996 for the commerce industry to provide confidentiality of information, ensure payment integrity, and identify authentication.

MULTI-APPLICATIONS

Smartcard technology has moved from single application proprietary systems to multi-application open systems (see Figure 4 below). Smartcards can now store significantly more information than existing debit/credit cards, with a strong emphasis on fraud prevention.

Smartcards can:

- Accommodate common applications that permit the storage of multiple currencies for traveling,
- Enable secure purchases on the Internet anywhere, anytime,
- Allow payments for products and services including utilities, public transport, and telephone calls,
- Permit traditional debit and credit purchases.

These are "Lifestyle Cards" in the truest sense. The benefits of using multi-application Smartcards are:

- Share costs between applications,
- Exploit links between applications,
- Improve consumer convenience and utility.

METERING THE CONSUMER

Considering the different types of token available and the use of complex tariffs, the Smartcard is a viable option for a multi-Utility Revenue Management System. Major benefits include:

Figure 3 - A Smartcard Prepayment Multi-Utility Meter Interface

- Reduced operating costs,
- More reliable risk assessment,
- Zero debt-collection, and
- Ironclad security.

With prepayment Smartcard systems, meter reading, billing and collection are optimised. Utility companies are now able to obtain detailed consumption profiles while improving communication with their consumers. Smartcard metering systems help streamline infrastructures, increase revenues and boost profits. They also make it easy to introduce new services. Prepayment Smartcards are secure, user-friendly, and meet with universal consumer acceptance. In particular, the Smartcard finds application with low value, high volume transactions.

UTILITY REVENUE MANAGEMENT

Vending Infrastructure Today

Eskom started the Electricity for All social programme in the 1980's and commissioned the development of innovative prepayment metering systems through the issue of ENC's (Eskom National Contracts). Standards soon emerged from the installed base of proprietary systems to meet Eskom's need for a common metering platform and common token coding system developed in 1993. This standard became known as the STS (Standard Transfer Specification) that allowed meters to be configured to accept credit and control tokens issued from the new CVS (Common Vending System).

Eskom rolled out their STS and CVS requirements from 1994, and today STS meters account for the majority of the more than 4 million prepayment meters installed in South Africa. To support token vending to these meters, some 2 000 Vending Units (Credit Dispensing Units, CDU's or points of sale) are distributed around the country to service the needs of Utility customers that use the prepayment meters. The task of the CVS is to support the sale of STS compliant tokens while also being able to vend tokens to the legacy proprietary metering systems installed up until the mid-1990's.

The Vending Units maintain a database of customer information and sales records, in order for fraud detection through sales statistics to be performed at a central Management System. Eskom adopted the point of sale model where the Vending Units are attended and stand-alone i.e. there is an attendant to handle the cash (and the data entry) and where the Vending Unit is not online to a large regional database of registered prepayment system users.

The Management System (System Master Station or SMS) functions to coordinate the distributed Vending Units, maintain and update the central customer database, update the relevant Vending Unit databases and maintain a table within the database of sales information extracted from the Vending Units. The Management System data can also be passed on to higher-level computer data management systems to extract information and statistics.

Planned integration of the token vending function with the South African ATM network has not happened, although this seemed to be a logical progression, at least from the perspective of early prepayment development projects.

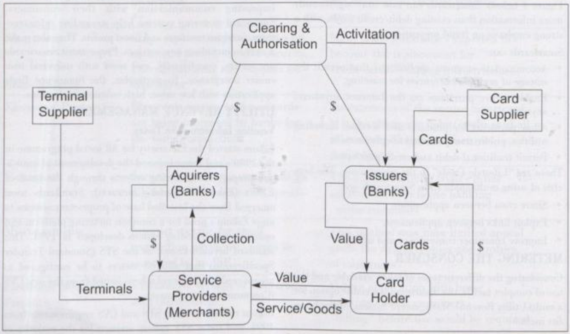
Adopting New Stored Value Schemes

There has been growing pressure from the Utilities to provide an up to date transaction management system for the prepayment metering and revenue management systems. With the introduction of prepaid GSM telephone cards, Utilities now view Smartcards as an ideal means to grow their portfolio of services. Utility applications can share the same Smartcard platform as other applications such as the electronic purse, loyalty and retail schemes, gaming applications, pay TV, pay telephones, healthcare and social services, mass transit and even government identification cards.

There are two fundamental ways in which electronic cash can be implemented, both of which can be seen in stored value schemes currently on trial. Figure 4 shows an open standard model for Electronic Payments.

1. **Token-based electronic cash** - this scheme is closest to physical cash and operates in the same way as notes and coins. Once electronic cash has been loaded onto the card, the card holds real monetary value that can then be freely exchanged by consumers, merchants and banks. Person-to-person transactions are possible, and there is no settlement process except for those transactions at which the electronic value moves into or out of the audited banking system. The Mondex scheme, which was launched in a major trial in Swindon, UK, in July 1995, is an example of a token-based scheme.
2. **Float-based electronic cash** - this scheme is a prepaid promissory system, closer to traveler's cheques than to cash. When a consumer purchases an amount of elec-

Figure 4 - Open Standard Model for Electronic Payments



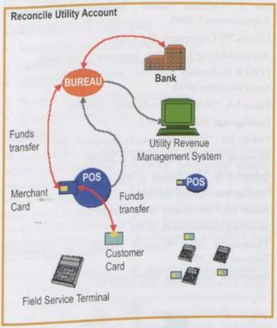
tronic cash from a bank, the bank holds the consumer's payment in a float account to cover its liability for the value stored on the card. All transactions with the card are auditable, with each being settled against the amount held in the float account. Both VISA Cash and MasterCard Cash are fully audited float-based systems.

Stored value cards can be stand-alone applications or they can be combined with other transaction applications, such as in Utility token sales, where the full potential of Smartcards can be reached. Multiple Utilities can be support on a single customer Smartcard.

THE BUREAU

The Utility Revenue Management System can operate either as a standalone system with direct access from a central point to the Vending Units, or the system can use a third party bureau transaction data transfer network. This decision will be based on the proposed application and whether a secure banking transaction network is needed for the electronic purse application. The system can be viewed from two perspectives, being financial data flows (Figure 5) and information data flows (Figure 6).

Figure 5 - Financial Data Flows



Two fundamental principles are driving the introduction of Smartcard technology:

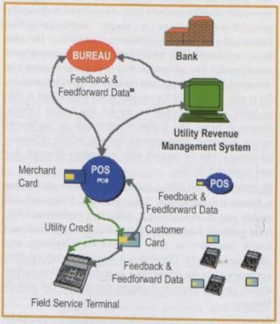
- The need for global interoperability - application consistency worldwide, and
- Flexibility - customer choice of applications and operating systems.

Wireless Vending

The explosive growth of cellular telephone technology, and in particular GSM networks, holds promise for using individual telephones as personal transaction terminals. WAP (Wireless Application Protocol) is here, now. Users trust the security on GSM, so it is likely that they will accept new, emerging standards like WAP for transactions and security.

The mobile telephone manufacturers have already introduced dual Smartcard slot units into the market. The customer would insert his multi-application Smartcard into the telephone and dialup a Service Provider to load the card with electronic credits. This could have a significant impact on the strategy for the deployment of a vending infrastructure - the customer has his own Vending Unit in his hand!

Figure 6 - Information Data Flows



TECHNOLOGY ADVANCES

Technology needs to be demystified and democratised. During the past 30 years, technological advances have redefined how, where, and when consumers can make payments. Today fraud prevention measures are under pressure. There is a growing demand for banks to harness the power of the Internet as a means of servicing their customer base.

The Internet is Everywhere

The powerful technology of the Internet has created a new business model. The Internet revolution has changed the way people work, live, play and learn. Prepayment metering systems will be significantly affected where meters are connected directly to the Internet, and where the Utility automatically reads the consumption. Internet enabled meters will have prepayment features, such as the

Figure 7 - A Typical Vending Unit used in a Bureau Application

device that causes self-disconnection for non-payment of services. Tokens will be delivered directly over the Internet. However, the Smartcard will still be needed as an authentication and security tool for these "smart" payments.

IN CONCLUSION

This paper has introduced the Smartcard token as an e-commerce enabler for the Utility. The idea of multi-Utility sales management on a single, multi-application Smartcard platform for customer convenience has also been introduced. This technology applied to prepayment metering, has the advantage that it puts the customer in charge of his own usage and budgeting of utility services. He is able to keep tighter control of his budget and is able to tailor the commodity or service use to the circumstances at hand. The Utility is better able to implement secure Revenue Management Systems where efficiency advantages can be passed onto customers through fair and equitable tariffs.

By 2001, over 100 billion transactions will be made using a Smartcard worldwide. Your personal Smartcard will enable you to manage your daily and professional life, from ordering food and theater tickets to controlling your health insurance or your finances via telephone, anywhere in the world. The chip can store all the information necessary to make tomorrow's paperless, cashless society secure and convenient, changing the way we live and do business.

As e-commerce grows daily, the network that supports its growth (the Internet) is becoming more easily accessible and available even to remote, rural vending points. If there is a telephone point available near to the Vending Unit, then it seems logical that the point of sale should be connected to the Internet. This will allow application developers to exploit either online or offline transaction processing. Combined with a multi-application Smartcard, the Utility can now have an e-commerce enabled prepayment vending business that supports their business strategy for keeping pace with technology and modern business practices.

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Aspects of power and information technology convergence - A cable manufacturer's viewpoint -

John W. Yuill

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Mr John Yuill
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This paper highlights some aspects of the apparent convergence of power and information technologies. Its content is not exhaustive, the purpose being merely to support further technical discussion on the subject.

Comment is drawn from the ITU Conference (Telecom 99) in Geneva, Switzerland, the 5th International Transmission and Distribution Conference (Distribution 2000) in Brisbane Australia and Aberdare's own strategic positioning of its Power and Telecommunications businesses in Southern Africa.

CONVERGENCE DRIVERS

- Mankind's innate need to communicate
- Global deregulation and privatization
- Changing technology
- Increase in silicon chip performance
- Reduction of cost per bit

COMMENT

To some observers, developments in the energy sector might appear drab and unexciting, particularly against the imminent deregulation of South Africa's fixed-line telecommunications network. Unlike the telecommunications sector, technology churn is not as evident in the power sector. Transmission and distribution products, particularly from a cable manufacturer's viewpoint, are not changing rapidly.

However, restructuring of the electricity supply industry is underway in South Africa and, if the Australian experience can be used as a benchmark, fundamental changes are around the corner. Much however depends on the courage and vision of the industry regulator and other stakeholders.

Australia's electricity supply industry has undergone significant change in the last decade. The then state-owned businesses were noted for engineering excellence but not particularly for customer service and business acumen. Prior to 1990, the industry was characterized by single, vertically integrated government-owned authorities responsible for generation, transmission and distribution.

These utilities have now been broken up with monopoly transmission elements separated from generation and distribution. Some 7 competing distributors have been created in each state. These hold retail licenses allowing them to sell electricity to contestable customers but bought from a central wholesaler. By 2001, some 7 million residential customers and more than 1 million businesses will be free to choose their electricity supplier.

Deregulation and competition are driving fundamental changes in the power business which in turn are setting new challenges for utilities. They are having to find ways of reducing cost whilst at the same time improving availability and reliability of services. Multi-services appears to be a developing trend in the utility industry. The need to diversify services becomes a harsh reality as traditional services come under competitor attack. Utilities are turning to advances in materials, computer-processing power and power electronics meet accommodate a growing business approach.

A number of "cross-over" products and services are emerging - "cross-over" in the sense that products and services straddle traditional demarcation of power and telecommunication. These new products and services could assist utilities in reducing costs, improving services and finding additional services in new and more competitive business environments.

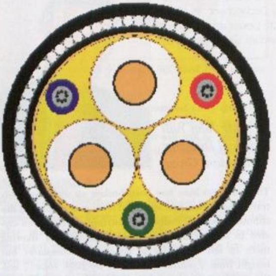
The term "telecommunications" is used in its broadest sense, i.e. signals conveying voice, data and image information.

ADSS, OPGW AND LASH/WRAP TECHNIQUES

Most utilities own and operate overhead high voltage transmission lines over established rights of way.

Technology to incorporate broadband telecommunication channels on new or existing lines is well established. The range of products includes ADSS (All Dielectric Self-Supporting), OPGW (Optical Ground Wire) and Lash/Wrap OF cable.

ADSS cable comprises of an assembly of gel-filled buffer tubes laid-up around a central strength member, further reinforced with aramide yarn and sheathed with a tough anti-tracking polymer. Each tube can house up to 12 fibres. ADSS cable can be retrofitted on existing lines or



on new lines. It is a cost-effective method of rolling out telecommunication links. Unfortunately, its use is limited to rated line voltages of ± 150 kV as the outer sheath undergoes dry-banding deterioration as a result of atmospheric pollution under a voltage gradient.

OPGW construction varies widely. A construction frequently used in South Africa includes a central gel-filled stainless steel tube housing up to 24 fibres. The tube is laid-up with high-strain galvanized stain steel wires in a 1+6 and 1+6+12 configuration. OPGW technology is more appropriate to new line installation and unlike ADSS is not limited in respect of rated line voltage.

Lash/Wrap OF comprises of gel-filled buffer tubes laid-up with strength members and sheathed with a tough polymer for environmental protection. Tubes can house up to 48 fibres. Lash OF cable is lashed longitudinally onto conductors with self-adhesive tape, whereas Wrap OF cable is wrapped helically around the supporting conductor. Lash/Wrap OF cable can be easily installed on existing lines and is Eskom Enterprises' technology of choice. It is a fast and cost effective way of lashing optical fibre cable to the ground (or phase) conductor of overhead lines.

These technologies provide utilities with the means of establishing optical telecommunication channels on existing and/or new overhead lines.

Telecommunication Channels in Land Power Cables

The incorporation of optical fibres in land power cables has always been stymied by the fact that power cables are usually installed in short lengths, e.g. 300 - 500 m, compared to current installation practices for optical fibre cables of 6, 12 and even 25 km lengths. The excessive number of joints and splice organisers would make such a system impractical.

However, recent studies have indicated that the incorporation of blown fibre tubing in XLPE-insulated MV-power cables is entirely feasible, making it possible to include optical fibre communication along electrical distribution infrastructures.

The idea is to position tubes in the outer interstices between cores, underneath the overall screen (see diagram at left).

The main tube body is extruded XLPE with an outer diameter of 9 mm. The tube material has low friction characteristics, and is translucent so the tube content can be seen. The tube has an internal diameter of 5 mm and has a pulling cord installed along its entire length in order to permit the pulling-in of fibre. The tubes can accommodate four fibres each.

The air blown fibre bundle is available in an eight-fibre unit contained in a protective multi-layer acrylate coating, which has a low friction coefficient to facilitate blowing of the unit into the tubes. The coating may be coloured and/or marked as required. It can be readily removed using an appropriate stripping tool. Lengths are available up to 4 km.

The blowing process is controlled by a blowing head, which has an air inlet, a fibre drive and a buckle detector. Air is fed into the main chamber at 10 bar pressure, and leaves via the tube connected to the outlet port. Once a steady airflow is established, the fibre may be fed into the air stream at the desired speed. Soon the fibre is caught-up by the air flow and is gently carried along.

It is possible to install several kilometres in this fashion, but generally, 1 km is believed to be a practical limit. This distance can be doubled by blowing from a central position in two directions, effectively increasing the practical distance to two km.

Tubes can also be included into PILC (Paper Insulated Lead Covered) cables. In these cables, the tubes are positioned over the lead sheath so that the low friction tubes are not subjected to the high-temperature vacuum drying and impregnation process.

In general, the system has some notable advantages:

- Rapid fibre deployment.
- Point-to-point fibre communication.
- Deferred capital cost.
- Simple push-fit connectors allowing for branch-out without splicing.
- Space saving.

- Seamless transition between internal & external plant applications.

TELECOMMUNICATION CHANNELS IN AERIAL POWER CABLE

Two types of aerial power cables are typically used in South Africa, i.e. 1 kV ABC and AIRDAC cable. Some utilities are asking whether narrow and broadband communication elements can be introduced into these cables - the answer is yes. The links could take the form of a simple copper pair or more sophisticated optical fibres.

Copper pair performance for analogue voice transmission is well understood. The recent emergence of DSL (Digital Subscriber Line) technology has boosted the capacity of paired copper lines to a few megabits per second. A specific form of DSL technology is ADSL (Asymmetric Digital Subscriber Line) which enables downstream and upstream bit rates of ± 5 and 0,8 Mb/s respectively. The technology lends itself to Internet connection services. A copper pair can be easily incorporated into the above cable constructions. It is understood that Telkom SA is about to deploy ADSL technology into its largely copper-based access network in the near future.

Optical fibres are also relatively easy to install but must be protected from tensile stress. Again this technology is well understood and is applied strictly in ADSS, OPGW and Lash/Wrap cable systems. The increase in bandwidth over copper is significant and limited more by end equipment than the fibre itself.

The overall system costs of copper vs. optical fibre links needs to be made. Nevertheless, the means exist to include telecommunication links into these aerial power products should utilities so require.

POWERLINE TELECOMMUNICATIONS FOR FIRST MILE ACCESS

Deregulation is prompting utilities to seek new services, one opportunity being the supply of telecommunication services. Access to residential and business subscribers via the "First Mile" or "Local Loop" is therefore essential.

Traditional telecommunication services have enjoyed singular access for decades but this is about to change. Existing infrastructure in the form of low voltage distribution networks offers a potential communication connection. Broadband PLC (PowerLine Communications) technology provides this enabling broadband data rates of about 1,3 Mb/s over distances of more than 300 m.

A trial installation has been installed in one of the biggest German utilities, RWE Energie, and has been operating since the spring of 1999.

DTS (DISTRIBUTED TEMPERATURE SENSING)

The use of optical fibres for distributed temperature sensing is established technology. Utilities worldwide are introducing this technology to protect expensive cable assets. The expression "distributed sensing" describes a single fibre's ability to give spatially spread temperature information. The measurements are achieved by analysing Raman backscatter signals and the time-of-flight of laser pulses.

The current rating of a cable is primarily governed by the thermal resistivity of its surrounding medium. Measurement of distributed temperature will provide information about temperature rise along the cable and thus enable behaviour prediction along its entire route. An added advantage is that high temperature zones can be identified and used to trigger alarms and/or protection systems.

Lord Kelvin encouraged engineers to make system measurements - improvements cannot be made in the absence of these. Competition will follow in the wake of deregulation and the need for improved asset management will grow. DTS is just one method of supporting this process and long-term business sustainability.

NETWORK BUILD & MAINTENANCE

Some suppliers of traditional passive power system components have responded to the convergence of power and IT technologies by offering integrated network build and maintenance services. These services can no longer be bounded strictly as power and communications activities.

This build and maintenance service will assist emerging utilities to focus on their core business particularly under conditions of organizational and technological change.

CLOSING COMMENT

Convergence of power and telecommunications technology is resulting in new business opportunities for utilities and their traditional equipment suppliers.

It is also testing the demarcation of power and telecommunications activities and encouraging traditional heavy and light current engineers to reach out to each other.

Contribution: Utilities as competitive local exchange carriers

Dr Pieter Viljoen

DR. PIETER E VILJOEN
He received a MSc in Semiconductor Devices from the University of Port Elizabeth in 1994. He lectured Modern Physics and Applied Mathematics from 1996 to 1998. In 1998, he joined Corning as an Applications Engineer in South Africa, providing technical assistance and solutions to end-users. From November 2000, he assumed the position of OEM Market Development Manager based at Corning's Optical Fibre manufacturing facility in the UK.

Dr Pieter Viljoen

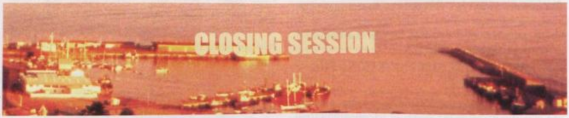
EXECUTIVE SUMMARY:

Utilities have an opportunity for significant additional revenue in the changing telecommunications structure by acting as carriers for traditional telecommunications companies.

The key strategic asset that utilities have is their extensive rights-of-way (ROW)-corridors of cleared land connecting one city to another. This ROW allows easy placement of fibre optic cable, either in the ground or on existing electric transmission poles. Add the proper electronics at each end, and you have a state-of-the-art fibre optic telecommunications link, ready to carry voice, video, and data traffic for a variety of potential customers.

Many utilities have already installed extensive fiber communications networks for internal use over the last few years and can take advantage of these existing assets.

This talk will explore the trends and business models employed by US utilities entering the telecommunications market, as well as provide insight into the cost per bit scenario's that currently exist for utility applications.



Thanks from the Affiliates

Clive Burchell
Vice Chairman: Affiliates Committee

Mr Clive Burchell

As we come to the close of this Technical Meeting, it is indeed a great honour for me, as the sun sets on my career to address you on behalf of Chairman Trevor van Niekerk, Treasurer Mike Cary, Honary Secretary Jacky Burns and fellow committee members and Hennie Jacobs, representing the 160 Companies who are Affiliate members of the AMEU.

As usual, the exhibition, which has become a traditional part of the annual meetings of the AMEU, was over subscribed and as could be seen, overflowed on to the outside of the hall. Thirty-two companies exhibited and I thank them for their participation. Thanks must also go to our two new committee members, Gerold Brown from ABB and Hennie Jacobs from Reyrolle who were given the task of organising the exhibition, which I believe was a job well done,

The Sports Day organized and funded by the Affiliates was once again a resounding success and we thank all those who participated and in particular John Welby for organizing the bowls, Mike Cary for the hike and I organized the golf. We trust that you enjoyed the day with us.

This being a Technical Meeting, all delegates to the conference were invited to the prize giving and the supper that followed, which we trust, you enjoyed.

During the year Keith Bull resigned from African Cables to join another Cable Company and thus resigned as Vice Chairman of the Affiliates Committee, and I was elected to fill this position, and continue with my responsibilities, looking after the Affiliate Branch Representatives.

I have been fortunate in being able to attend most of the AMEU Branch Meetings during the year and I wish to thank my company for their support in doing so.

There was a time in our history where affiliates were not allowed to participate in these branch meetings, other than to exhibit outside of where the meetings were taking place and for the honour of sponsoring the refreshments and meals, etc. However, that's now history and I am pleased to see our participation in branch meetings with the presentation of technical papers is now an integral part of the branch agendas. We continue to exhibit new products at these branch meetings whenever possible.

I thank Dave Smith, our representative for the Good Hope branch, Lawrence O' Riley, who looks after the Eastern Cape and Henry Swanepoel, who has taken over from Tony Simmonds looking after Kwazulu Natal, for their active support of the branches. I have been responsible for the Highveld and Free State and Northern Cape branches.

I was delighted that in this eleventh hour of our association with the AMEU, that the AMEU Executive has seen fit to have accepted a proposal that I had moved some years ago, seeking Affiliate representation on the AMEU Executice Commitee. This will assist in communication.

On a sad note, the planned Applitech Seminar, which was due to take place in August, had to be cancelled, due to the poor response of delegates, which may be indicative of the state of our industry. The organizing committee will revisit this in the New Year in the light of the changes taking place in the ESI.

On the subject of the ESI, the pace of change is at last encouraging and I hope that what we have heard over the last few days will, in fact, bring to fruition the envisaged changes to our industry as soon as possible.

We, your affiliates, are finding it increasingly difficult to hold on to our expertise and to encourage young engineers into our industry and had it not been for our drive across our borders and our success in exports, many of us would have had to close our doors.

On behalf of the Affiliates, I would like to express our thanks to Ockert Bothma and his team for the excellent organization of this technical meeting, and the ATKV of Hartenbos for the venue, and the hospitality of his worship, the Mayor of Mossel Bay.

To At and Rianne: You have survived a most challenging first half of your term of office, and may we wish you a most successful second half as you lead this organization to the changes that it must make to position itself for the future. We, the Affiliates, will play our part in these changes.

Lastly, on a personal note, please allow me this opportunity of thanking the many friends that Elize and I have made during the past thirty years of our association with the AMEU. We trust that this friendship will continue for many years to come. And to Elize, my thanks for her support over the past forty years.

Thank you.

In his closing address of the 18th Technical Meeting Mr A.J. van der Merwe, President of AMEU, thanked the Sponsors and the Organisers for their support and help.

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HOPETOWN MUNISIPALITEIT	Mnr TJ Van Rensburg (053) 203-0008 (053) 203-0490	P/Sak X3 HOPETOWN 8750
HOWICK ELECTRICITY	The Electrical Engineer (033) 330-6124 (033) 330-4183	P.O. BOX 5 HOWICK 3290
JAN KEMPDORP MUNISIPALITEIT	Mnr J van der Westhuizen (053) 456-0111 (053) 456-0022	Posbus 241 JAN KEMPDORP 8550

City / Town E-mail	Head of Electricity Phone / Fax	Address
JEFFREYSBAAI ELEKTRISITEIT	Mnr AH du Plessis (0423) 93-1111 (0423) 93-1114	Posbus 21 JEFFREYSBAAI 6330
JOHANNESBURG METROPOLITAN pjsvniekerk@post.gjmelec.org.za	Mr Paul van Niekerk (011) 4907314 (011) 4907696	PO Box 699 JOHANNESBURG 2000
KAKAMAS ELEKTRISITEIT	Mnr MW Clarke (054) 431-0855 (054) 431-0785	P O Box 174 KAKAMAS 8870
KALAHARI ENERGY DISTRIBUTOR	Mr. G van der Merwe (012) 653-6035 (012) 653-2688	P O Box 11201 CENTURION 0046
KEIMOES ELEKTRISITEIT	Mnr AJP Wells (054) 461-1016 (054) 461-1230	Posbus 8 KEIMOES 8860
KEMPTON PARK/ TEMBISA ELEKTRISITEIT	Mnr KGF Botha (011) 921-2334 (011) 975-4614	Posbus 13 KEMPTON PARK 1620
KENHARDT ELEKTRISITEIT	Mnr AB Marais (054) 651-0045 (054) 651-0279	P/Sak X05 KENHARDT 8900
KIMBERLEY ELECTRICITY	Mnr K Bogacwi (053) 830-6400 (053) 833-2508	P/Sak X5030 KIMBERLEY 8300
KING WILLIAMSTOWN ELECTRICITY	Mr P Harpestad (040) 639-2061 (040) 639-2075	P.O.Box 124 BISHO 5608
KLERKSDORP ELEKTRISITEIT	Mnr Wynand Viljoen (018) 462-9851 (018) 464-1221	Posbus 99 KLERKSDORP 2570
KNYSNA ELEKTRISITEIT	Mnr LR Richardson (044) 382-5066 (044) 382-5551	Posbus 21 KNYSNA 6570
KOFFIEFONTEIN ELEKTRISITEIT	Mr John Sinden (053) 205-0007 (053) 205-0128	P.O.Box 7 KOFFIEFONTEIN 9986
KOKSTAD ELEKTRISITEIT	Mr Denis Barker (039) 727-3133 (039) 727-3676	Posbus 8 KOKSTAD 4700
KOMGA ELEKTRISITEIT	The Electrical Engineer (043) 831-1028 (043) 831-1306	P.O.Box 21 KOMGA 4950
KOPPIES MUNISIPALITEIT	Mnr PJJ Uys (056) 77-1819 (056) 772745	Posbus 14 KOPPIES 9540
KROONSTAD ELEKTRISITEIT	The Electrical Engineer (056) 216 9283 (056) 216 9284	PO Box 302 KROONSTAD 9500
KRUGERSDORP ELECTRICITY	Mnr Frikkie Erasmus (011) 951-2250 (011) 665-2666	Posbus 94 KRUGERSDORP 1740

City / Town E-mail	Head of Electricity Phone / Fax	Address
KURUMAN ELEKTRISITEIT	Mnr Theo Pretorius (053) 712-1095 (053) 712-3581	Posbus 4 KURUMAN 8460
KWA-DUKUZA-STANGER TLC	Mnr LF Klopper (032) 551 3091 (032) 551 5500	Posbus 72 STANGER 4450
LADISMITH ELEKTRISITEIT	Mnr J de Jongh van Arkel (028) 551-1023 (028) 550-1766	Posbus 30 LADISMITH (WP) 6655
LADYBRAND ELEKTRISITEIT	Mnr HD Potgieter (051) 924 0654 (051) 924 0305	Posbus 64 LADYBRAND 9745
LADYSMITH ELECTRICITY	Mnr W Albertyn (036) 637-6905 (036) 637-2592	Posbus 56 LADYSMITH 3370
LEKOA/VAAL METROPOLITAANSE RAAD	Die Elektriese Ingenieur (016) 450-3257 (016) 455-4522	Posbus 471 VEREENIGING 1930
LEKOA/VAAL METROPOLITAANSE RAAD	Mnr E Van Helden (016)450-3257 (016) 455-4522	Posbus 471 VEREENIGING 1930
LEKOA/VAAL METROPOLITAN COUNCIL	Mr M Tshabalala (016) 450-3256 (016) 455-4522	PO Box 471 VEREENIGING 1930
LOUIS TRICHARDT ELEKTRISITEIT	Mnr E Joubert (015) 516-0212 (015) 516-1195	Posbus 96 LOUIS TRICHARDT 0920
LYDENBURG ELEKTRISITEIT	Mnr GG Verster (01323) 2121x152 (01323) 5-1108	Posbus 61 LYDENBURG 1120
MALMESBURY ELECTRICITY	Mnr Roelof du Toit (022) 482-2996 (022) 482-2935	P/Sak X52 MALMESBURY 7300
MATATIELE ELECTRICITY	The Electrical Engineer 737-3135	P.O.BOX 35 MATATIELE 4730
MELMOTH ELECTRICITY	Mr P Hamalainen (035)450-2082 (035) 450-3224	P.O.Box 11 MELMOTH 3835
MESSINA ELECTRICITY	Mnr JAP du Toit (01553) 4-0211 (01553) 2513	P/Sak X611 MESSINA 0900
MIDDELBURG ELEKTRISITEIT	Mnr JA Kok (049) 842 1104 (049) 842 2252	Posbus 55 MIDDELBURG 5900
MIDRAND ELECTRICITY	Mnr GR Teunissen (011) 256-8501 (011) 256-8523	Private Bag X20 HALFWAY HSE 1685
MONTAGU ELECTRICITY	Mnr J Mostert (023) 614-1112 (023) 614-1841	Posbus 24 MONTAGU 6720

City / Town E-mail	Head of Electricity Phone / Fax	Address
MOOI RIVER TLC	The Town Electrical Engineer (033) 263-1221 (033)263-1127	P O Box 47 MOOI RIVER 3300
MOORREESBURG ELEKTRISITEIT	Mnr TF Rossouw (022) 433-2246 (022) 433-3102	P/ Sak X08 MOORREESBURG 7310
MOSSELBAAI ELEKTRISITEIT	Mnr Ockert Bothma (044) 691-2215 (044) 691-1903	Posbus 25 MOSSELBAAI 6500
MUN. VIR DIE GEBIED VAN FRANSCHHOEK	Mnr Floris Koegelenberg (021) 876-2055 (021) 876-3297	Posbus 18 FRANSCHHOEK 7690
NABOOMSPRUIT	Mnr CP Cloete (014) 743-1111 (014) 743-2434	P/Sak X340 NABOOMSPRUIT 0560
NELSPRUIT ELECTRICITY	Mnr CL Rossouw (013) 759-2230 (013) 752-7168	P.O.Box 45 NELSPRUIT 1200
NEWCASTLE LOCAL COUNCIL	Mr. RJ Mallinson (034) 312 1296 (034) 312 9697	P/Sak X6621 NEWCASTLE 2940
NORTHERN ELECTRICITY	Mnr CGN Huysen (09264-67) 22-2244/3 (09264-67) 22-2245/55	P.O.Box 891 TSUMEB NAMIBIA
NYLSTROOM ELEKTRISITEIT	Mnr JJ Kasselman (014) 717-5211 (014) 717-4077	P/Sak X1008 NYLSTROOM 0510
ODENDAALSRUS ELEKTRISITEIT	Mnr W Sephton (057)398 1733 (057) 398-1756	Posbus 21 ODENDAALSRUS 9480
OOSTENBERG MUNISIPALITEIT	Mnr HDJ Mostert (021) 900-1569 (021) 900-1559	P/sak X16 KUILSRIVIER 7579
ORKNEY MUNISIPALITEIT	Mnr. LH Strydom (018) 473-1451 (018) 473-3364	P/sak X8 ORKNEY 2620
OTJIWARONGO ELECTRICITY	George Hanssen (09264) 67 30-2231 (09264) 67 30-2098	Private Bag X2209 OTJIWARONGO NAMIBIA
OUDTSHOORN ELEKTRISITEIT	Mnr JJG Nel (044)272-2221 (044)272-3512	Posbus 255 OUDTSHOORN 6620
PAARL ELEKTRISITEIT	Mnr JE Coetzee (021) 871-1911 (021) 872-4074	Posbus 12 PAARL 7620
PARYS ELEKTRISITEIT	Mnr HW Coetzer (056) 811-2131 (056) 817-6343	Posbus 359 PARYS 9585
PHALABORWA TLC	Mnr JI Ten Cate (015) 781-0111 (015) 781-0726	P.O.Box 67 PHALABORWA 1390

City / Town E-mail	Head of Electricity Phone / Fax	Address
PIET RETIEF ELEKTRISITEIT	Mnr R Rieseberg (01782) 2211 (01782) 5-0330	Posbus 23 PIET RETIEF 2380
PIETERMARITZBURG ELECTRICITY	Mr PE Fowles (033) 355-1400 (033) 355-1559	P.O. Box 399 PIETER- MARITZBURG 3200
PIETERSBURG ELEKTRISITEIT	Mnr DET Potgieter (015)290-2270 (015)290-2249	Posbus 111 PIETERSBURG 0700
PLETTENBERG- BAAI ELEKTRISITEIT	Mnr PJ Opperman (04453) 3-2050 (04453) 3-3485/7	Posbus 26 PLETTEN- BERGBAAI 6600
PORT ALFRED ELECTRICITY	Mnr Billie Patterson (046) 624-1140 (046) 624-4872	P.O.Box 13 PORT ALFRED 6170
PORT ELIZABETH ELECTRICITY	Mr David Michie (041) 392-4101 (041) 392-4333	P.O.Box 369 PORT ELIZABETH 6000
PORT SHEPSTONE MUNICIPALITY	The Electrical Engineer (039) 682-1100 (039) 682-1131	P.O.Box 5 PORT SHEPSTONE 4240
PORTERVILLE ELECTRICITY	Mnr JJ Erasmus (022) 931-2100/2101 (022) 931-3047	Posbus 50 PORTERVILLE 6810
POSTMASBURG ELEKTRISITEIT	Mnr MPL de Jager (0591) 3-0343 (0591) 7-1602	Posbus 5 POSTMASBURG 8420
POTCHEFSTROOM ELEKTRISITEIT	Mnr SJ Steyn (018) 299-5351 (018) 297-5130	Posbus 113 POTCHEF STROOM 2520
POTGIETERSRUS ELEKTRISITEIT	Mnr EJ van der Horst (0154) 491 2244 (0154) 491-5142	Posbus 34 POTGIETERS- RUS 0600
PRETORIA ELEKTRISITEIT	Mnr J Ehrich (012) 308-4100/1 (012)308-4149	Posbus 423 PRETORIA 0001
PRIESKA MUNISIPALITEIT	Mnr CN van Wyk (053) 353-3002 (053) 353-1386	Posbus 16 PRIESKA 8940
PROV. ADMIN. FREE STATE DEPARTMENT OF HOUSING	Mnr HP Pretorius (051) 405-4730 (051) 405-5008	Posbus 517 BLOEM- FONTEIN 9300
PROVINSIALE ADMINISTRASIE OOS-KAAP	Mnr A Didloff (041) 390-4167 (041) 33-7417	P/Sak X6005 PORT ELIZABETH 6000

City / Town E-mail	Head of Electricity Phone / Fax	Address
PROV. N-KAAP ELEKTRISITEIT	Mnr CH Schoeman Dept Behuising/ Plaaslike Reg. (053) 830-9529 (053) 831-2904	P/Sak X5005 KIMBERLEY 8300
RANDFONTEIN ELEKTRISITEIT	Mr JJ Donaldson (011) 411-0216 (011) 412-3424	P.O.Box 218 RANDFONTEIN 1760
REITZ ELEKTRISITEIT	Mnr CP Wickham (058) 863-2811 (058) 863-2523	Posbus 26 REITZ 9810
RICHARDS BAY ELECTRICITY	Mnr DJ van Wyk (035) 901-5350 (035) 901-5444/5/6/	P/sak X1004 RICHARDSBAAI 3900
RIVERSDALE ELECTRICITY	Mnr Gert Mans (028) 713-2418 (028) 713-3146	Posbus 29 RIVERSDALE 6670
ROBERTSON MUNICIPALITY	Mnr Johan Rossouw (023) 626 3112 (023) 626 2426	Posbus 52 ROBERTSON 6705
RUSTENBURG ELEKTRISITEIT	Mnr JD Algera (014) 590-3170 (014) 592-0108	Posbus 16 RUSTENBURG 0300
SABIE ELECTRICITY	Mnr D Bester (013) 764-1241 (013) 764-2860	Posbus 61 SABIE 1260
SASOLBURG PLAASLIKE OORGANGSRAAD	Mnr HJ van Wyk (016) 976-0029x2258 (016) 976-0029x2263	Posbus 60 SASOLBURG 9570
SENEKAL / MATLWABENG TLC	Mnr AJ Addinall (058) 481-2142 (058) 481-5154	Posbus 20 SENEKAL 9600
SOMERSET EAST ELECTRICITY	Mnr DW Jordaan (042) 243-1333 (042) 243-1548	P.O.Box 21 SOMERSET EAST 5850
SOUTH PENINSULA MUNICIPALITY	Mr. Neil Croucher (021) 400-2500 (021) 421-5088	P O Box 82 CAPE TOWN 8000
SPRINGS ELECTRICITY	G Bau (011) 811-2290 (011)811-2562	Posbus 45 SPRINGS 1560
ST FRANCIS BAY MUNICIPALITY	Mr DW Pennels (042)294-0309 (042)2 94-0312	P.O.Box 137 ST FRANCIS BAY 6312
STADSRAAD LICHTENBURG ELEKTRISITEIT	Mnr C Geldenhuys (018) 632-5051 X 2201 (018) 632-5247	Posbus 7 LICHTENBURG 2740
STANDERTON ELECTRICITY	Mnr D Lottering (017) 712-5200 (017) 712-6808	Posbus 66 STANDERTON 2430

City / Town E-mail	Head of Electricity Phone / Fax	Address
STELLA MUNISIPALITEIT	Mnr Samuel du Toit (053)983-0042 (053)983-0106	Posbus 82 STELLA 8650
STELLENBOSCH ELEKTRISITEIT	Mnr Barry Naudé (021) 808-8404 (021) 808-8409	Posbus 17 STELLENBOSCH 7599
STEYNSBURG MUNISIPALITEIT	Mnr F Joubert (048)884-0034 (048)884-0386	P/Sak X4 STEYNSBURG 5920
STUTTERHEIM ELEKTRISITEIT	Mnr JC Moerdyk (043) 683-1100 (043)683-1127	P/Sak 2 STUTTERHEIM 4930
SWAKOPMUND ELECTRICITY	Town Electrical Engineer (0926464) 410-4270 (0926464) 410-4211	P O Box 53 SWAKOPMUND NAMIBIA
SWAZILAND ELECTRICITY BOARD	Mr Bruce Farrer (MD) (09268) 404 6638 (09268) 404 0962	Posbus 258 MBABANE SWAZILAND
SWELLENDAM ELEKTRISITEIT	Mnr Dirk Wheeler (028) 514-1330 (028) 514-2458	Posbus 20 SWELLENDAM 6740
THABAZIMBI ELECTRICITY	Mnr Louwrens Dreyer (014) 777-1525 (014) 777-1531	Posbus 90 THABAZIMBI 0380
THEUNISSEN ELEKTRISITEIT	Mnr Mnr Oosthuizen (057) 733-0106 same as phone	Posbus 8 THEUNISSEN 9410
TLC MIDDELBURG	Mnr R Grunig (013) 249-7220 (013) 243- 2550	Posbus 14 MIDDELBURG 1050
TULBAGH ELECTRICITY	Mr ST Young 0232301020 0232301250	P.O. Box 3 TULBACH 6820
TZANEEN	Mnr P van den Heever (015) 307-1411 (015) 307-1507	Posbus 24 TZANEEN 0850
UITENHAGE ELEKTRISITEIT	Mnr GF Ferreira (041) 994-1262 (041) 994-1335	P.O.Box 45 UITENHAGE 6230
UMTATA ELECTRICITY	Mnr P Bezuidenhout (047) 501-4304/5 (047) 531-2704	P.O.Box 57 UMTATA TRANSKEI 5100
UPINGTON MUNISIPALITEIT	Mnr HA Auret (054) 332591 (054) 331 2909	P/Sak X6003 UPINGTON 8800
UTRECHT MUNISIPALITEIT	Mnr NM Dekker (034331) 3041 (034331) 4312	Posbus 11 UTRECHT 2980
VELDDRIF ELEKTRISITEIT	Mnr Gerrie Lucas (022)783-112 (022) 783-1422	Posbus 29 VELDDRIF 7365

City / Town E-mail	Head of Electricity Phone / Fax	Address
VENTERSDORP ELEKTRISITEIT	Mnr CP Terblanche (018) 264-2051 (018) 264-2051	Posbus 15 VENTERSDORP 2710
VENTERSTAD TRANSITIONAL COUNCIL	Mnr JW Visser (051) 654-0224 (051) 654-0374	Private Bag X2 VENTERSTAD 9798
VICTORIA-WES MUNISIPALITEIT	Mnr G Stopforth (053) 621-0026 (053) 621-0368	P/Sak X 329 VICTORIA-WES 7070
VILJOENSKROON	Mnr CL Engelbrecht (056) 343-3148 (056) 343-2505	P/Sak X02 VILJOENSKROON 9520
VIRGINIA ELECTRICITY	Mnr SH Jansen (057) 212-3111 (057) 212-2885	P/Sak X7 VIRGINIA 9430
VOLKSRUST ELEKTRISITEIT	Hoof Elektro-Tegniese Dienste (017) 735 5141 (017) 735 3004	P/Bag X9011 VOLKSRUST 2470
VREDENDAL ELEKTRISITEIT	Mnr JH Viljoen (027)213-1045 (027)213-3238	Posbus 98 VREDENDAL 8160
VRYHEID ELEKTRISITEIT	Mnr JG Tupper (034) 982 2947/2133 (034) 980 8822	Posbus 57 VRYHEID 3100
WALVIS BAY ELECTRICITY DEPARTMENT	Mr G Coeln (0926464) 20-3664 (0926464) 20-4574	P/Bag X5017 WALVIS BAY NAMIBIA
WARMBAD ELEKTRISITEIT	Mnr VJ de Souza (014) 7362111 (014) 7363288	P/sak X1609 WARMBAD 0480
WELKOM OORGANGSRAAD	Mnr GJ Meyer (057) 391-3339 (057) 391-3112	Posbus 708 WELKOM 9460
WELLINGTON ELECTRICITY	Mnr JA Venter (021) 873-1121 (021) 873-2524	Posbus 12 WELLINGTON 7655
WEPENER OORGANGSRAAD	Mnr JSF Groenewald (051) 583-1131 (051) 583-1201	P/sak X5 WEPENER 9944
WESKUS SKIEREILAND O.R. ELEKTRISITEIT	Mnr Johan du Plessis (022) 701-7050 (022) 715-1518	P/Sak X12 VREDENBURG 7380
WESSELSBRON ELEKTRISITEIT	Mnr JJ Heimans (057) 899-1818 (057) 899-2631	Posbus 6 WESSELSBRON 9680
WESTELIKE GAUTENG DIENSTERAAD	Mnr GJ Booysen (011) 411 5000 (011) 411 3663	Private Bag X033 RANDFONTEIN 1760

City / Town E-mail	Head of Electricity Phone / Fax	Address
WESTONARIA LOCAL COUNCIL	Mr FN Quinn (011) 753-1121 (011) 753-4176	P.O.Box 19 WESTONARIA 1780
WINBURG ELECTRICITY	Mnr FC Meyer (051) 881-0 003 (051) 881-0 003	Posbus 26 WINBURG 9420
WINDHOEK ELEKTRISITEIT	Mnr FA Diener (0926461) 290-2455 (0926461) 290-2494	P.O.Box 5011 WINDHOEK NAMIBIA
WITBANK ELEKTRISITEIT	Mnr D Patterson (013)690-6400 (013) 690-6450	Posbus 3 WITBANK 1035
WOLSELEY ELEKTRISITEIT	Mnr JA Kok (0236) 31-1021 (0236) 31-1361	P/Sak X4 WOLSELEY 6830
WORCESTER ELEKTRISITEIT	Mnr AG Wearne (0231) 2-1050 (0231) 7-3671	P/Sak X 3046 WORCESTER 6850
YZERFONTEIN PLAASLIKE O.R	Mnr PJ Uys (022) 451-2366 (022) 451-2453	Posbus 1 YZERFONTEIN 7351
ZASTRON ELECTRICITY	Hoof Elektriese Ingenieur (051) 673-1018 (051) 673-1550	Posbus 20 ZASTRON 9950
ZEERUST ELECTRICITY	Mnr JG Joubert (018)642-1081 (018)642- 2618	Posbus 92 ZEERUST 2865

Associate Members

City / Town E-mail	Member Phone / Fax	Address
ALBERTON	Mnr JGG Dreyer (011) 861-2389 (011) 861-2048	Posbus 4 ALBERTON 1450
BENONI	Mnr BC Lamprecht (011) 741-6361 (011) 741-6372	P/Sak X014 BENONI 1500
BENONI	Mr AT Smit (011) 741-6362 (011) 741-6372	P/Bag X014 BENONI 1500
BOKSBURG	Mnr LDM de Wet (011) 899-4021 (011) 892-4806	Posbus 215 BOKSBURG 1460
BULTFONTEIN	Mnr RC Smit (0525) 3-1333 (0525) 3-1664	Posbus 3 BULTFONTEIN 9670
CAPE TOWN	Mr GWF Munro (021) 400-2210 (021) 421-5088	P.O.Box 82 CAPE TOWN 8000
CENTURION STADSRAAD	Mnr LC Muller (012) 671 7535 (012) 671 7356	Posbus 14013 LYTTELTON 0140
DURBAN	Mr AJ Dold (031) 300-1002 (031) 300-1010	P.O.Box 147 DURBAN 4000
DURBAN	Mr Alan Gower (031) 300-1006 (031) 300-1010	P.O.Box 147 DURBAN 4000
DURBAN	Mr Sewraj Harilal (031) 300 1122 (031) 300 1010	P O Box 147 DURBAN 4000
DURBAN	Mr Keith Moulder (031) 300-1013 (031) 300-1010	P.O.Box 147 DURBAN 4000
DURBAN	Mr Raymond Sharp (031) 300-1301 (031) 300-1010	P.O.Box 147 DURBAN 4000
DURBAN METRO ELECTRICITY	Mr Charles Bitcon (031) 300-1911 (031) 300-1010	P.O.Box 147 DURBAN 4000
DURBAN METRO ELECTRICITY	Mr RF Wienand (031) 300 1003 (031) 300-1010	P.O.Box 147 DURBAN 4000
ELLISRAS	Mnr MF Loots (01476) 3-2193 (01476) 3-5662	P/Sak X136 ELLISRAS 0555
GREATER JOHANNESBURG METRO COUNCIL	Mnr AG Booyzen (011) 490-7309 (011) 490-7317	P/Sak X30 ROODEPOORT 1725
HEIDELBERG (GP)	Mnr Louis Kruger (011) 906-1009 x226 (011) 906-5000	Aquarius W/S 10 Jordaanstraat HEIDELBERG 2403
HELDERBERG	Mnr IP Botha (021) 850-4395 (021) 850-4435	P O Box 3 STRAND 7139
HELDERBERG	Mnr JJ von Willigh (021) 850-4396 (021) 850-4435	P O Box 3 STRAND 7139
HELDERBERG	Mnr HJ Wiid (021) 850-4392 (021) 850-4435	Posbus 19 SOMERSET WES 7139

City / Town E-mail	Member Phone / Fax	Address
KEMPTON PARK	Mnr CJ du Plessis (011) 921-2400	Posbus 868 KEMPTON PARK 1620
KLERKSDORP	Mnr FJ Goosen (018) 2-2835 (018) 64-1780	Posbus 1046 KLERKSDORP 2570
KRUGERSDORP	Mnr CP Odendaa (011) 951-2260 (011) 665-2666	Posbus 941 KRUGERSDORP 1740
LICHTENBURG	Mnr J Wille (01441) 2-5051	Posbus 7 LICHTENBURG 2740
OOSTENBERG	Mnr J Kaltwasser (021) 900-1573 (021) 900-1559	Posbus 68 KUILSRIVIER 7580
PIETERMARITZ-BURG ELECTRICITY	Mr. Lubasi Mbumwae (033) 355 1498 (033) 355 1559	P O Box 399 PIETERMARITZ-BURG 3200
PRETORIA	Mnr H Lubbinge (012) 308-4110 (012) 308-4149	Posbus 423 PRETORIA 0001
RANDBURG	Mr CE Cooper-Chadwick (011) 793-1105 (011) 793-6816	PO Box 136522 ALBERTON NORTH 1456
STELLENBOSCH	Mnr WFJ van der Walt (021) 808-8405 (021) 808-8409	Posbus 17 STELLENBOSCH 7599
STILBAAI	Mnr IJ Rust (028) 75-41577 (028) 75-41140	Posbus 2 STILBAAI 6674
UITENHAGE	Mnr WFT van Reenen (041) 994-1111 (041) 994-1335	Posbus 45 UITENHAGE 6230

Affiliate Members

Member E-mail	Contact Phone / Fax	Address
3M SOUTH AFRICA (Pty) Ltd	Mr Ben Wagner (011) 922-2100 (011) 922-2440	P.O.Box 926 ISANDO 1600
ABB ELECTRICAL SYSTEMS	Mr G Brown (011) 236 7544 (011) 236 7545	P/Bag X37 SUNNINGHILL 2157
ABB INSTALLATION MATERIALS	Mr Grant Gardiner (011) 653-3500 (011) 653-3506	P O Box 7760 HALFWAY HOUSE 1285
ABB POWERTECH TRANSFORMERS	Ms Jacqui Burn (012) 318-9911 (012) 327-1249	P.O.Box 691 PRETORIA 0001
ABB TRANS-MISSION & DISTRIBUTION	Mr Clive Burchell (011)236-7373 (011)236-7374	P/Bag X37 SUNNINGHILL 2157
ABERDARE CABLES (Pty) Ltd	Mr TP van Niekerk (011) 456-4413 (011) 456-4349	P.O.Box 1679 EDENVALE 1610
Aberdare Group	Mr L Steyn (011) 456-4375 (011) 609-4739	P O Box 1679 EDENVALE 1610
ADO MANUFACTURING	Mr Dave Smith (021) 712-0307 0217122613	P O Box 19061 WYNBERG 7824
AFRICAN CABLES Ltd	Mr Nick Visagie (016) 430-6119 (016) 430-6000 (016) 423-4205	P.O.Box 172 VEREENIGING 1930
AFRICON	Mr HH Nel (012)427-2310 (011)427-2344	Posbus 905 PRETORIA 0001
ALCOM SYSTEMS (Pty) Ltd	Mr Victor Hoch (011) 235-7650 (011) 807-5428	P.O.Box 5574 RIVONIA 2128
ALLYSON LAWLESS (Pty) Ltd	Mrs Allyson Lawless (011) 476-4100 (011) 678-7518	P.O.Box 73285 FAIRLANDS 2030
ALSTOM Electrical Products (Pty) Ltd	Mr Alf Searle (011) 873-8555 (011)873-4409	GERMISTON P.O.Box 678 1400
ALSTOM T&D	Mr Herman Broschk (011) 820-5260 (011)820-5220	P/Bag X4 WITFIELD 1467
ALUEX (Pty) Ltd	Mr Derick Botha (013) 246-1741 (013) 246-2146	Posbus 3135 MIDDELBURG 1050
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AP BURGER	Pretoria
JD DAWSON	Uitenhage
DH FRASER	Durban
PC PALSER	CapeTown
1989	
PJ BOTES	Roodepoort
MPP CLARKE +1998	Randburg
EG DAVIES	Pietermaritzburg
*JA LOUBSER	Benoni
1991	
AHL FORTMANN + 1998	Boksburg
1993	
FLU DANIEL	Cape Town
JE HEYDERYCH	Middelburg, Tvl
BENNIE VAN DER WALT	General Secretary
1995	
CE ADAMS	Port Elizabeth
B MADELEY	Iso-Tech Systems
1997	
JD ALGERA	Rustenburg
HR WHITEHEAD	Durban
F VAN DER VELDE	NER
1999	
JG MALAN	Kempton Park

* Deceased/Oorlede
\+ Citation/ Erkenning

Past Members

Member/Lid	Address/Adres
Mnr CA Anderson	Bellisstraat 6 KILNER PARK 0186
Mr WH Afferidge	PO Box 13149 HUMEWOOD PE. 6013
Mnr RV Bailey	"The Lodge" Private Bag X5 BRYANSTON 2021
Mr JJ Barrie	82 First Avenue DUNVEGAN, EDENVALE 1610
Mr BF Berwyn-Taylor	3 Thornton Road DIEP RIVER 7800
Mr KH Bobek	PO Box 10203 MARINE PARADE 4056
Mnr JJ Boshoff	Posbus 616 VANDERBIJLPARK 1900
Mr IF Boyack	44-15th Street MENLO PARK 0081
Mnr JG Brummer	Adriaan Moreesstr 7 STELLENBOSCH 7600
Mr CR Burton	54 Memorial Road KIMBERLEY 8301
Mr AR Campbell	PO Box 3 IMPENDHELE 4545
Mr C Clare	2 Verona Crt, 196 Innes DURBAN 4001
Mnr DJR Conradie	Posbus 188 VILLAGE OF HAPPINESS 4280
Mnr WJ Cronje	Wenningstraat 37 GROENKLOOF 0181
Mnr EE de Villiers	Impala Park 23, Impalaweg IRENE 1675
Mr GS de Vries	3 Manuel Villet Street GEORGE 6530
Mnr HC Dreyer	Kommissarisstraat 107 WELGEMOED 7530
Mr JAD Foubister	5 Willlow Way PINELANDS 7405
*Mr JS Gamble	203 Santos Haven MOSSEL BAY 6500
Mr R R Gilmour	26 Barling Crescent FISH HOEK 7975
Mnr A Greyling	Posbus 361 STANDERTON 2430
Mr RB Gwilt	34 Cornelia Avenue FRAMESBY 6045
Mr K Halliday	PO Box 5 PORT SHEPSTONE 4240
Mr PH Harvey	PO Box 581 GREYTOWN 3500
Mr M Hoffenberg	PO Box 10239 PORT SHEPTSTONE 4240
Mr GT Honniball	PO Box 17031 GROENKLOOF 0027
Mr AHW Hugo	P O Box 68218 BRYANSTON 2021
Mr Nat Kirschner	37 Murray Str WAVERLEY 2090
Mnr Kobus Lochner	Posbus 4 BENDOR 0699
Mnr HAL Louw	Altenburglaan 1 SUIDER PAARL 7646
Mr J McGibbon	PO Box 156 UMBOGINTWINI 4120
Mr EW Mole	PO Box 39663 BRAMLEY 2018
Mr Peter J Muller	8 Ribble Terrace THREE RIVERS 1939
Mr KJ Murphy	6 Gable Street SOMERSET WEST 7130
Mnr JJG Nel	Jan van Riebeeckweg 300 OUDTSHOORN 6620
Mnr Gawie Nortje	Garnetweg 14 ALBEMARLE 1401
Mnr PVE Pagel	Tuinstraat 72 DOORNKLOOF, 7310
Mr ER Polkinghorne	33 Whittaker's Way BEDFORDVIEW 2007
Col WJ Reichert	20 Brander Avenue BLOUBERGRANT 7443
Mr JB Rheeder	PO Box 176 KENTON ON SEA 6191
Mnr CJ Scherman	PO Box 32437 GLENSTANTIA 0010
Mr TP Schreuder	PO Box 591 VREDENDAL 8160
Mnr TA Theron	Posbus 156 BADPLAAS 1190
Mnr AJ van den Berg	312 Voortrekker Weg NOORDHEUWEL 1739
Mnr RJ van der Berg	14 Danstraat OLIFANTSFONTEIN 1666
Mnr FJ van der Merwe	Posbus 74087 LYNNWOODRIF 0040
Mnr GA Venter	Ligtenstraat 8 MEYERTON 1960
Mnr JA Venter	Fairtrees Affree-Oord 50Kingfisherweg DURBANVILLE 7550

Past Presidents

1915-17	*JH Dobson	Johannesburg
1917-19	*J Roberts	Durban
1919-20	*B Sankey	Port Elizabeth
1920-22	*TWC Dodd	Pretoria
1922-24	*GH Swingler	Cape Town
1924-26	*J Roberts	Durban
1926-27	*B Sankey	Johannesburg
1927-29	*JM Lambe	East London
1929-31	*R Macauley	Bloemfontein
1931-33	*LL Horrell	Pretoria
1933-34	*LF Bickell	Port Elizabeth
1935-36	*GG Ewer	Pietermaritzburg
1936-37	*A Rodwell	Johannesburg
1937-38	*JH Gyles	Durban
1938-39	*HA Eastman	Cape Town
1939-44	*IJ Nicholas	Umtata
1944-45	*A Rodwell	Durban
1945-46	*JS Clinton	Zimbabwe (Harare)
	*JW Phillips	Zimbabwe (Bulawayo)
1946-47	*GJ Muller	Bloemfontein
1947-48	*C Kinsman	Durban
1948-49	*A Foden	East London
1949-50	*DA Bradley	Port Elizabeth
1950-51	*CR Hall6	Pietermaritzburg
1951-52	*JC Downey	Springs
1952-53	*AR Sibson	Zimbabwe (Bulawayo)
1953-54	*JC Fraser	Johannesburg
1954-55	*GJ Muller	Bloemfontein
1955-56	*DJ Hugo	Pretoria
1956-57	*JE Mitchell	Zimbabwe(Harare)
1957-58	*A van der Walt	Krugersdorp
1958-59	*CG Downie	Cape Town
1959-60	*RW Kane	Johannesburg
1960-61	*RMO Simpson	Durban
1961-62	*C Lombard	Germiston
1962-63	*PA Giles	East London
1963-64	*JC Downey	Springs
1964-65	RW Barton	Welkom
1965-67	*D Murray-Nobbs	Port Elizabeth
1967-69	GC -Theron	Vanderbijlpark
1969-71	*HT Turner	Umtali
1971-73	JK von Ahlften	Springs
1973-75	JC Waddy	Pietermaritzburg
1975-77	E de C Pretorius	Potchefstroom
1977-79	KG Robson	East London
1979-81	PJ Botes	Roodepoort
1981-83	DH Fraser	Durban
1983-85	W Barnard	Johannesburg
1985-87	*JA Loubser	Benoni
1987-89	AHL Fortmann	Boksburg
1989-91	FLU Daniel	Cape Town
1991-93	CE Adams	Port Elizabeth
1994-95	HR Whitehead	Durban
1995-97	JG Malan	Kempton Park
1997-99	HD Beck	East London

* Deceased/Oorlede

Past Recipients of AMEU Certificates of Merit

12th Technical Meeting September 1988

Mr Bokkie Boshoff	Vanderbijlpark
Mr Gerhard Gerber	Affiliate: Zellweger
Mr Ian L Hobbs	Uitenhage
Mr NAT Kirschner	Affiliate: Reyrolle
Prof Ryno G Kriel	Bloemfontein
Ald Ben Steyn	Boksburg
*Mr Theunis C Stoffberg	Eskom

13th Technical Meeting September 1990

*Mr ACT Frantz	Cape Town
Mr. JAD Foubister	SABS
Mr F Prins	Public Works
*Mr. WP Rattey	Strand
Prof K van Alphen	SABS, Pretoria University
Mr. Jan A Venter	CapeTown

14th Technical Meeting October 1992

Mr William Lashley	Affiliate: GEC
Mr Emil E de Villiers	Rustenburg

15th Technical Meeting August 1994

*Ald Frikkie Kotze	Port Elizabeth
Mr J van Soelen Lochner	Pietersburg
Mr William Tindle	Affiliate: Reyrolle

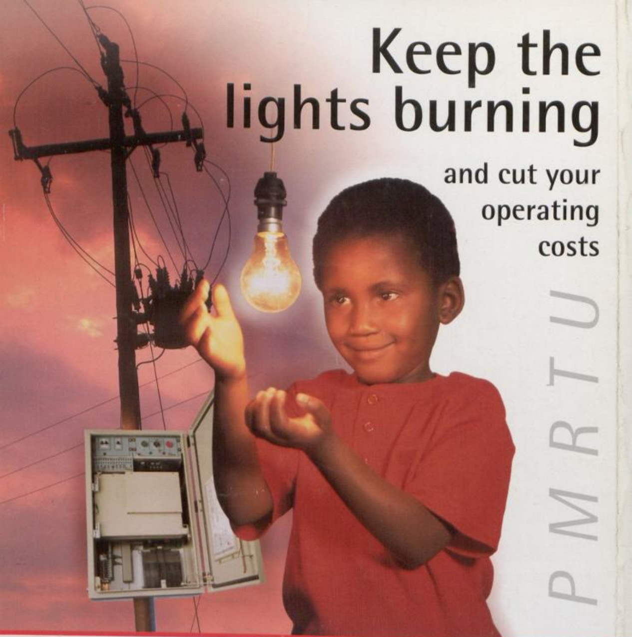
16th Technical Meeting October 1996

Mr KJ Murphy	Somerset West
Mr PJ Muller	Affiliate: African Cables
Mr AJ van den Berg	Krugersdorp

17th Technical Meeting September 1998

Clive Burchell	Affiliate, ABB Powertech

** Deceased/Oorlede*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