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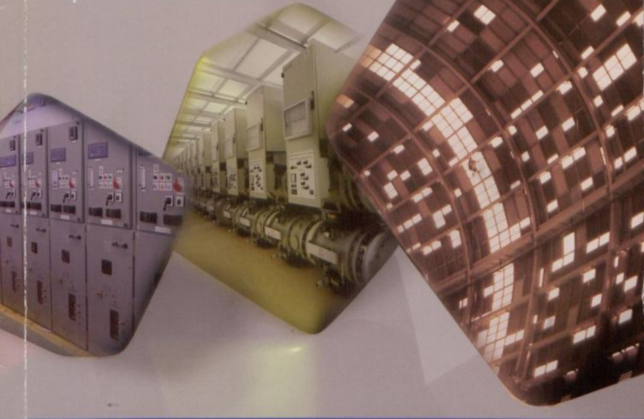
2009

Special AMEU Proceedings edition



LEADING THE ELECTRICITY DISTRIBUTION INDUSTRY

AMEU

AMEU Convention 2009

The 22nd AMEU TECHNICAL CONVENTION

"Improving the management of our electricity resources"

28 - 30 September 2009 - hosted by Nelson Mandela Bay Municipality

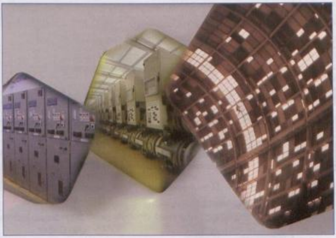





ABW


ACTOM companies partner with local municipalities to strengthen service delivery

ACTOM (formerly Alstom South Africa) is a proud partner and supplier to the country's municipal sector. After rebranding to ACTOM in early September 2009, South Africa's largest electrical engineering group was a major sponsor at this year's AMEU conference and showcased their range of relevant product and service offerings to delegates during the four-day event held in Port Elizabeth.



Despite the recession, the majority of South Africa's larger municipalities recognise the importance of continuing their housing expansion programmes to benefit poorer, less advantaged communities. There has also been a need to replace aging equipment in their electricity distribution networks to avoid supply interruption and improve service delivery. Several of ACTOM's business units have benefited from this forward thinking and have continued to supply product and services to municipalities.

ACTOM MV Switchgear, for example, the country's leading manufacturer of indoor switchgear and miniature substations, for which municipalities are major customers, expects to maintain and even grow its large market share in this sector. "We find that municipalities are still planning ahead and placing orders on main intake boards for new substations that haven't yet been built," said Greg Whyte, the company's marketing and customer services strategy manager.

"Several large municipalities are at present requesting tenders for their annual requirements. It is generally felt that the smaller municipalities will have to start investigating spending money on replacement of old gear as these units have surpassed their life expectations. We have the ability to extend the life of the old oil-type switchgear by replacing old circuit breakers with type-tested vacuum circuit breakers.

Whyte added that the company's products have been developed around local practices. "One of the widespread local practices is use of three-core cable and an illustration of how we cater to this is that our locally manufactured switchgear is made to accommodate both single- and three-core cable terminations, thereby simplifying installation on site.

"We also manufacture internally arc classified minisubs and bulk metering units, which both form an integral part of municipal networks," he added.

Similarly, ACTOM Electrical Products (formerly Alstom Siyakha), the group's distribution arm that has 11 branches around the country, is continuing to experience consistent demand from municipalities for most of its product offerings.

Mike Ullyett, the company's marketing manager, said: "We've been glad to see the government placing more emphasis on service delivery by municipalities. We want to be a part of the focus on reducing the huge backlog in infrastructure development, which includes the development of low-cost housing that many municipalities are undertaking. We have seen demand from industry, mining and retail decline, but demand from the municipalities has been sustained, chiefly because of the 2010 soccer stadium projects."

Ullyett said that over the years ACTOM Electrical Products has built up excellent relationships with its customers, municipalities included. "Not only do we have the most extensive distribution network among all companies operating in our field, which enables us to have regular contact with our customers and attend to their specific needs, but we also have solid longstanding ties with our suppliers, which is a big factor that enables us to remain competitive.

"A third major factor in our favour is that we have excellent first-line technical staff within the company to attend to customers' requirements, backed up by sound in-depth technical support from our suppliers," he added.

ACTOM Electrical Products has also achieved good growth in its lighting business by recently landing a number of annual lamp and lighting contracts with the support of its supplier, GE Lighting.

At the other end of the scale, however, the curtailment by municipalities of expenditure on new projects has had an impact on substation contracting companies, including ACTOM Power Systems.

"Municipalities are the mainstay of our business, so with hardly any new substation projects being launched at present we are shorter of work than normal," commented John McClure, the company's general manager. "We are however fortunate to have several substantial municipal substation projects still on the go. In addition, we have a couple of large non-municipal projects in neighbouring countries, which are also helping to see us through the current period."

Municipal contracts on which the company is engaged include a large contract with the City of Tshwane Metropolitan Municipality encompassing the upgrading of three existing 132/11 kV substations serving Pretoria suburbs, comprising Die Hoewes, Eldoraigne and Waterkloof substations.

As with the first two companies mentioned above, ACTOM Power Transformers continues to receive regular contracts from many of the larger municipalities.

"Municipalities with which we have contracts in progress or have completed recently include most of the major metropolitan centres, plus a number of others that include Pietermaritzburg, George and Knysna," said general manager Ronnie Russell.

"Our ability to cater to the municipal market has been broadened with the upgrading – forming part of our latest factory expansion – to produce higher powered transformers. Our top-rated power transformers are now 160 MVA, raised from the previous highest level of 45 MVA."

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Published by EE Publishers (Pty) Ltd
P O Box 458, Muldersdrift, 1747
Tel 011 543-7000, Fax 011 543-7025

Welcome address at the AMEU Convention 2009

I trust and sincerely believe that like my predecessors, I can also rely on the Association of Municipal Electrical Undertakings as an important stakeholder, especially at this time as we grapple with the challenges that the electricity sector faces. I am sure that all of us will agree that the moment is indeed critical. The electricity sector has never been as vulnerable as it is today.

On the supply side, our power stations are performing sub-optimally as they edge closer to their end of life. We have started to see a declining system performance not inconsistent with 30-and 40-year old plant. This happens at the same time that we seek to spur economic growth to levels that are important for job creation and poverty eradication, as well as in a period that we are spearheading action as government to steer our country out of the economic recession that challenged us so severely in recent times.

We must stimulate growth at any cost, and, on the other hand, to do that depends largely on our ability to provide reliable electricity supply.

We have responded to the supply side problem by embarking on the biggest capital expansion programme in the history of this country, to build new power stations. This exerts upward pressure on electricity tariffs, and it happens at a time when about 24% of our households remain un-electrified. As mentioned earlier, this also happens in the wake of the biggest economic decline the world has seen since the Great Depression of the 1920s.

Ladies and gentlemen, we all know about the malaise of unemployment in South Africa, against which the president has mobilised the state machinery.

Unequal services to a captive domestic and industrial, user. This legacy stems from the political process of rationalisation of municipalities. For those that do not remember, just a mere 10 years ago, we used to have more than 400 local authorities that provided municipal services.

The disparity in the service provision takes a number of dimensions, worth noting here are elements such as:

- Credit-worthiness of municipalities
- Tariff levels
- Service standards
- Maintenance backlogs
- Free basic electricity provision
- Quality of customer service

Honourable Minister Elizabeth Dipuo Peters, minister of energy

I am told that the total cost of the municipal electricity distribution infrastructure backlogs is R27-billion. How are we going to deal with the estimated R27-billion, or the estimated R5-billion in bad debts due to the low consumer payment rate and related credit control problems? These are ticking time bombs and clearly need our combined efforts to consolidate municipal electricity undertakings, so that we can maximise economies of scale and provide reliable electricity supply.

We must disentangle the relative significance of external factors on investment from those that are internal to the sector.

Electricity services are a key revenue generator for municipalities and therefore need to be prioritised. We need to work together with all, to make sure that the REDS process is concluded in the best interest of all electricity distribution beneficiaries e.g. industry and households.

Municipalities must treat electricity supply as a jersey cow that gives the milk. For it to continue producing milk you must get it the best pastures and care for it well, so that it can continue giving milk for many more years. Let electricity supply provide revenue and also have good and reliable infrastructure so that the supply is not disrupted.

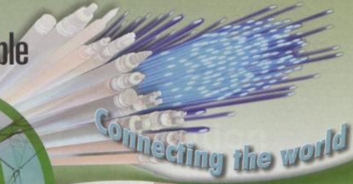
Can you imagine the impact of a power disruption in June next year, right in the middle of the World Cup?

We have heard about loss of power in Mthatha, Johannesburg and many other areas. These really have become so commonplace that they are symptomatic of a deep-seated problem.

The regulator NERSA is overwhelmed by the sheer number of reports, that the regulatory provisions under the Electricity Regulation Act are undermined, particularly licence conditions. I am sure that you will agree with me that the point of introducing laws is that they must be enforced! Surely there must be some normalisation of this situation, for the sake of the electricity user and our economy.

When NERSA announced a 34% tariff increase after the Eskom application this year, municipalities prudently passed this

General Cable



Sub Sahara Africa

General Cables – Sub Sahara Africa with manufacturing facilities in 46 countries, (Africa included) has the ability to manufacture cables to 500 kV. Therefore, industries have access to global networking units and manufacturing facilities.

Through our stocking and distribution company – National Cables (Pty) Ltd we have the ability to supply locally and into Sub Saharan Africa.

Copper and aluminium cables such as XLPE, PILC, PVC, ABC, AAAC, ACSR and OPGW are sold to utilities for generation, overhead and underground transmission and distribution of power. Also available for the energy sector, cables such as submersible, submarine, fibre optics, building wire, HO7 rubber retardant, low smoke and smoke free cables are manufactured to various local and international specifications such as SABS IEC and are tested by Kema and Bureau Veritas to mention a few. We are also able to offer cables manufactured to qualify duty free for SADC and Ecowas countries.

Clients belong to sectors such as Eskom, utilities, mines, electrical contractors and wholesalers, oil and gas, developers building and construction, mines, telecommunication and renewable energy sectors. Our main exports are into Sub Saharan Africa.

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increase on to the electricity consumer. I am raising this matter critically, as it relates to the way municipalities could have cushioned the indigent from this increase.

I am referring to a tariff structure that provides cross-subsidies between industrial consumers and domestic consumers, in terms of which the revenue requirement emanating from the Eskom increase is drawn more from non-domestic rather than from domestic consumers or industries.

Talking about FBE, we all know that this instrument was introduced more than 5 years ago to moderate poverty. Whilst one cannot exaggerate the important role that FBE plays in the lives of poor South Africans, is the instrument sharp enough though, or could we do better?

The extent to which FBE benefits leak to non-qualifying households is a matter of concern. Or benefiting those who it should not be benefiting. An analysis of the FBE submissions by metropolitan municipalities indicates that whilst access and penetration are satisfactory, up to 50% leaks, our economy cannot sustain this inefficiency sector!

Ladies and gentlemen, the low electricity tariff has also worked against efforts to use electricity more efficiently, particularly in the industrial sector.

Some could argue that this seemingly perfect storm is part of the cycle that is not unfamiliar to the South African electricity sector. When the 1986 De Villiers Commission recommended that tariffs must be nationalised, it was in response to the disparate manner in which local nuances were applied as the network expanded.

Be that as it may, in the post-apartheid era, we are now faced with concurrent supply and demand side problems which municipalities are central in resolving. Our infrastructure is deteriorating faster than we can put measures in place to halt the degradation. We need to work together more closely to address this.

Programme Director, in my maiden budget vote speech on 23 June 2009, I made a number of commitments and I align the building of new power stations with government policy. I indicated that we will be promulgating a new regulation relating to the planning framework for new power stations, the procurement process and the roles and responsibilities of the respective players.

The Integrated Resource Plan, or Country Electricity/Power Plan, will be gazetted soon. This plan will indicate both the supply side options, for example power stations of various technologies, and demand side options, particularly energy efficiency interventions. I intend to introduce 1-million solar water heaters by 2014 as a clean energy initiative that intends, as far as possible, to displace domestic water heating from the electrical load. Energy efficiency interventions at the domestic level can only be effected with municipal collaboration.

Invariably the renewable energy projects are located in areas where the biggest need for employment and infrastructure development are located. Municipalities could play a key role in ensuring access to land, environmental impact assessment, connection to the distribution network, local community mobilisation etc.

The socio-economic potential and impact of renewable energy must be maximised through collaboration with municipalities.

I also intend to introduce, under the auspices of the National Electricity Response Team (NERT) of which the AMEU is part, a framework for power conservation, the "standard offer". In this way, we hope to achieve our target or an aggregate saving in current electricity consumption levels.

I also want to take this opportunity to thank and congratulate all municipalities that have converted all households to CFLs and encourage all others to follow suit. At the same time I would like to indicate that the Nelson Mandela Metro is a good example of a local government which intends to introduce solar water geysers to reduce the cost of heating water with electricity. We all know that geysers use the bulk of the household energy or electricity supply.

The application by Eskom for an increase in the wholesale electricity tariff is a matter that needs to be put into proper perspective, in order to address latent concerns about the impact on the indigent.

Ladies and gentlemen, I must re-emphasise that I do not agree that tariffs must rise rapidly, as this will lead to unintended consequences, not least of which would be adverse economic impact in the face of the recession we are currently experiencing. As indicated previously, we have started a process to provide a cushion for the indigent, through the elaboration of the pricing policy framework to structure tariffs such that the indigent are insulated from increasing electricity tariffs.

As I have also indicated, this strategy requires that we must work together with municipalities so that we do not undermine our efforts.

My appeal to all municipalities is that we should communicate clearly how the tariff is structured and what informs the percentage they charge.

Ladies and gentlemen, my address would be incomplete if I did not update you regarding the REDs process. As you might be aware, the Constitution 17th Amendment Bill is now in the parliamentary process.

Parliament will communicate the process that must be followed to engage with stakeholders as rigorously as required under our Constitution.

We are all aware that there are approximately 2000 different tariffs in this country and we need to consolidate that. You cannot have this many price structures for the same service in one country.

As we do this, the need for consolidation in the distribution sector must not undermine either municipal viability or their mandate.

Our point of departure is that municipal undertakings are not viable in the current dispensation. We must address municipal concerns where they are raised, and common ground must be sought to move forward.

Municipalities occupy a very critical part of the electricity value chain, and in my opinion the electricity distribution function needs to be executed in a consolidated manner with improved regulatory oversight.

To the leadership of the AMEU, I want to pose a number of challenges as you assume your new role:

Will you be able to ensure that even the most remote of municipal electricity undertakings has the critical mass of skills necessary for prudent service provision?

Is it possible for you to ensure that you exert your influence in ensuring that energy efficiency becomes an integral part of your programme of action and what will you do to avert supply shortages in the short term?

With regard to maintenance backlogs in the sector, how can we improve the quality of service to the electricity user?

Is it your intention to work closely with my department on issues of common concern?

The participation of the AMEU in NERT (National Electricity Response Team) structures and various other electricity related forums is critical as we jointly seek answers to the problems that South Africa faces.

I want to invite you to use the first opportunity to engage with my department on any issue that seeks my attention, and I remain open to any suggestions that will improve service delivery and the creation of a better life for all our people.

Opening speech by AMEU president

It is indeed an honor, privilege and blessing for me as the President of the Association and on behalf of the members of the Executive Committee to extend a warm welcome to you all to this 22nd Technical Convention of the Association of Municipal Electricity Undertakings of Southern Africa, (AMEU)

It is a pleasure to see so many delegates in this warm and friendly city of Port Elizabeth.

Ladies and gentlemen, this conference themed, "Improving the Management of Our Electricity Resources" comes at a time when we have numerous challenges in our industry.

Some of the major issues we are addressing revolve around the power constraints in the country with the associated need to reduce energy consumption via the power conservation programme or PCP, the implementation of energy efficiency and DSM initiatives, as well as IPPs, co-generation and renewable energy feed-in tariffs. The supply side requires the planning, funding and construction of new generation capacity with the resultant pressure to increase tariffs which is not popular amongst our customers.

This is facing us as our country tries to deal with the impact of the global economic decline, associated job losses, safety issues and the threat of climate change to complicate our lives.

And this is not all. The financial viability of many municipalities is an increasingly worrying trend as we deal with the possible impact of the 17th Constitution Amendment Bill that is designed, among other things to speed up the restructuring of our industry to create the six REDs. The major capacity problems, be they energy, financial or human resources, make managing our resources as well as attracting, retaining and training our scarce skills a huge challenge.

Arising from the national debates on these issues, it is quite clear that there is an immense amount of effort on the part of the stakeholders involved in these debates and we at the AMEU are proud to say that we are actively participating in many of them with a representative or more on each of these formal committees.

Ms Sy Gourrah, AMEU President

Partnerships amongst the stakeholders are of utmost and crucial importance for the sustainability and transformation of the industry, especially in light of the current energy and skills shortage and with the daunting task and challenges that lie ahead.

I trust that the papers and discussion at this convention will assist us in forging these partnerships and the management of our resources.

This convention is not all about serious discussion and the AMEU has also provided some fun and enjoyment as we get to know each other better. Yesterday with the sports events, the most enjoyable "pirates beach party" hosted by our wonderful affiliates last night, tonight the Executive Maybr of Nelson Mandela Bay Municipality will be hosting the civic reception followed by our "Broadway" gala evening tomorrow. Our spouses have a wonderful two days of enjoyment ahead as we tackle the industry issues.

I look forward to the keynote presentation from our new Minister, Her Excellence Ms. Peters who is passionate about restructuring, renewable energy, electrification and maintenance backlogs.

I would like to thank her for accepting our invitation. Also Her Excellence, The Mayor of Nelson Mandela Bay Municipality for hosting this national event in this beautiful city, the excellent team from the Electricity and Energy Directorate who have worked with such dedication to make this event a success, the affiliates, the executive council, secretariat, sponsors, stakeholders in the industry, speakers, delegates and colleagues.

I welcome you again to this conference and I hope that it will prove to be informative, interactive and a useful platform to exchange ideas.

Once again a warm welcome to Nelson Mandela Bay and I hope you have a memorable stay and an excellent conference.

"We are made wise not by the recollection of our past, but by the responsibility for our future." (George Bernard Shaw)

CBI electric

CBI-ELECTRIC PLATINUM SPONSOR OF THE 22nd AMEU TECHNICAL CONVENTION 2009

The CBI-electric Group has been in existence for over one hundred years and as a result, our greatest resource is our experience. We have built a diversified group of highly vertically integrated companies, each with a major footprint in different sectors of the electrical and telecommunication industries.

One of the key competitive capabilities of the CBI-electric Group is our commitment to the continual development of new technology and intellectual property. This commitment is enhanced through our structure, which facilitates the sharing of information. Together we can analyse the latest trends in technology, current and future market conditions as well as the economy. This allows us to provide the best possible solutions for our customers.
The CBI-electric Group is a set of four companies united by a common vision:

To be your partner in infrastructure development.

CBI-electric was the proud Platinum sponsor of the AMEU 2009 Technical Convention, in the following categories:
- Registration center and welcome desks – Branded Laptop bags and Lanyards
- CBI-electric Spouses Programme
- Gala Dinner

The event draws all Municipalities nationally, and CBI has been involved with this function for a number of years. On arrival delegates registered their names, and were issued a CBI-electric branded laptop bag and a lanyard for the name tags CBI-electric made a tremendous mark at the Convention. The visibility of the brand could not be missed with the stand layout and design, which attracted a large number of the delegates, which was especially beneficial to CBI-electric's image.

The Second day Spouses programme has always been the highlight of the AMEU and CBI-electric has been sponsoring this event for many years. This year the ladies were taken through a different experience, on a train ride to Chelsea and each lady received a goody basket filled with delectable snacks. The sponsorship of Kruger Rands at the Gala evening was the biggest draw card for all the delegates and is now well known. Three lucky winners walked away with a full Kruger Rand, Half and a Quarter.

Patrick Sekete and Nancy Austin handing over the first prize - a Full Kruger Rand.

Gideon Malotane handing over the second prize - a Half Kruger Rand.

Nancy Austin handing over the third prize - a Quarter Kruger Rand.

CBI-electric will continue to be the proud sponsor of this prestigious event.

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Asset management: interface between the business and the system used

An integrated asset management structure is the key to the success of any structure or business. Without a formal framework in place, you will not succeed in getting the benefits required from the system.

by H Mostert, City of Cape Town

One of the reasons that service delivery fails in a municipal environment is that it does not work with an integrated system (a lot of stand alone systems) or the system in use is not correctly implemented. The system that we use does not support the management of assets. It gives preference to financial issues rather than make sure that the building blocks integrate and support each other and focus on master data. Definition of master data: stable data that remains constant, reflects as – built configuration and is used for preventative maintenance plans.

Despite numerous requests to increase the maintenance of assets, the question still remains "Why does it not improve?" This is across the board, not only relating to electricity. Why don't we use the system as part of the decision-making process? The answer is clear, we cannot trust the information for decision-making purposes and this is why businesses start to buy stand alone systems.

The bottom-line is that the focus is not about master data in all aspects. We must make certain that what we do is built around master data, to ensure that the confidence level is such that it is trusted and used by all. Due to the volumes of data, one cannot perform asset management without a system which supports your business and when using a system, make sure it is correctly packed to support your business. What we want is to use the system data to take business decisions.

The effects are clear:

- No common data base.
- Implementation of an asset scrapping process. To identify assets on the system is virtually impossible, due to there being no one-to-one match on the different modules, misalignment between technical and financial view of the asset.
- Life cycle cost of assets cannot be determined.
- No forward planning, especially at the lower levels.
- Stay in re-active mode (when it breaks, fix it.).
- Cannot take strategic decisions regarding budget cuts, staffing levels, training, tariffs and equipment replacement.
- Cannot do budgets from zero base.

In 2003 the City of Cape Town changed over to a new system. Four years later a risk assessment was performed after it was discovered that we could not get proper reports from the system. Each unit operates on its own and the confidence level on data is extremely low. Although there are pockets of excellence in the system, it is not across the whole system. We identified medium voltage (MV) and low voltage (LV) as a pilot project to identify the problem areas and to drill-down into the problems.

Risk assessment

Cannot follow a top-down approach to report on our assets

Include:

- No common approach
- Cannot determine total number of assets
- No financial reports on assets
- Value of assets
- Progress reports (work orders – open/close)

Cannot determine full life cycle cost of assets:

- Engineering does not have an accurate centralised database to work from
- No centralised database on load profiles

Cannot determine tariffs (tariff structure) if:

- Your asset database is not in place

Cannot do pro-active maintenance if:

- Database is not in place
- There is no proper planning
- It results in each department creating its own database

Equipment tracking:

- Any equipment developing a problem – corrective action needs to be taken (unknown where it is installed).

Do not have a common database to work from (no integrated system):

- Finance has its own database (assets)
- Insurance
- Plant maintenance (PM)
- Departments work in silos
- GIS

Processes do not support our business:

- Restructured half-way, then stopped
- No common approach to capture data

Cannot determine number of staff required

- Asset database is supposed to predict number of staff required

What do we want to achieve?

- To have one source available to capture data
- To maintain equipment
- Draw statistics
- Get reports from (performance data)
- Data available to all

Can only have an accurate version of the truth.

Developing a business plan – SAP system for City of Cape Town

Master data management

- Functional location structure and coding convention
  - Off-line governance and design documentation (master data control)
  - Classification of functional locations (nameplate data)
  - Responsibility areas and actual set-up in SAP
  - Measuring points defined at appropriate levels for conditional assessment
  - Catalogue defined for FMECA (failure mode, effect cause analysis)
  - Task list assigned based on classification
  - Scheduled maintenance
  - SAP roles: re-profiling and role design
- *Spares management*
- *Outsourcing master data*

Process design

- Asset acquisition/disposal
  - Asset take-overs
  - Construction via project
  - Replacement upgrade
  - Asset disposal

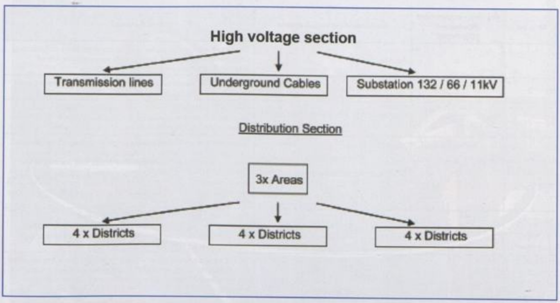


Fig. 1: Existing operational structure.

Districts	Demand MW	Protected sub	Unprotected sub	Minisubs	MV line	MV cables
Atlantis	97	21	94	168	82	99
City	275	189	256	147	10	38
Mowbray	284	160	361	250	0	55
Vanguard	148	86	105	110	12	60
Gugulethu	52	16	63	204	86	122
Mitchells Plain	148	57	365	250	59	292
Muizenberg	134	84	291	315	40	182
Wynberg	175	119	308	308	2	353
Bloemhof	264	96	296	1051	50	781
Helderberg	122	25	30	831	24	449
Oostenberg	135	50	215	845	12	538
Parow	162	81	276	597	0	486

Table 1: Districts data (MV).

- Maintenance and operation
  - Corrective maintenance
  - Preventative maintenance (PM)
  - Condition based maintenance (CBM)
  - Refurbishment
  - Work clearance management
- Alignment between register
  - PM to functional locations
  - AM asset register
  - Insurance register

Key performance indicators (KPI)

- Maintenance performance analyses (MPA)
  - FMECA (damage analyses)
  - Object stats (how much of what?)
  - Planner group analysis (planner efficiency and number of breakdowns)
  - Manufacturer analysis
  - Backlog of orders
  - Mean time between repairs (MTBR) and mean time to repair (MTTR)
- Accounting standards (GAMAP/GRAP)
  - Asset value
  - Remaining useful asset life

The interface with the system that you use

What is the key to a successful interface?

- You must have a clear-cut framework to start the process
- You must work with a team that knows how the system operates and with those within the business. (Specialists within the business and from the system.)
- Business must live up to the system
- The system must support the business
- Support teams that constantly monitor system activities and business requirements, continuous business improvement, essential to drill in the importance of accountability.
- The confidence level must be the same across the field
- Management must be involved.

If you don't have a common goal (that all departments focus on), specifically master data, don't start as you are wasting your time.

What we have found is that those people (in the organisation) who drive the system must give clear-cut guidelines on a high level regarding:

- Key staff your business requires
- Processes that must be in place to support the business

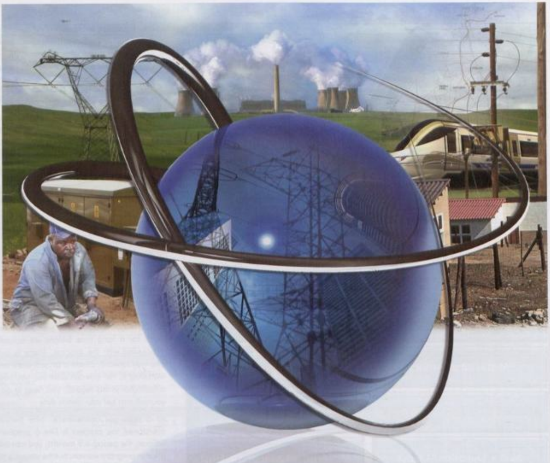
You will find that the business creates a structure that suits the business, but it does not line up with the system you use.

If you like it or not, on a high level the system you use dictates how you need to structure your business.

Departments get themselves consultants on board, collect and pack their data, just to find that after a couple of years they must

Step no.	Go-live requirement (R)equired (O)ptional	Business data requirement	Purpose
1	R	Asset hierarchy	To structure technical assets for the purpose of grouping and reporting. Core master data for asset management serves as container or placeholder for many other types of master data.
2	R	Technical asset classes	To add another dimension to reporting and to provide a starting point for capturing more industry specific data.
3	O	Nameplate data (e.g. KVA rating, Input voltage etc)	Detailed technical specification for the purpose of making informed decisions with regards to planning for equipment upgrade/modification as well as other functions such as searching for replacement equipment.
4	R	Ex-maintenance department responsibilities	Departments or people responsible for a technical object (functional location). For example a Scada responsibility may need to be notified before work order completion to restore Scada links are restore after Circuit breaker was replaced by maintenance. During planning of new capital equipment non-maintenance departments need to approve work requests or be notified on completion in order to update complimentary systems like GIS, for example.
5	O	Document links to technical objects / notification	The following type of document needs to be linked to the asset hierarchy: Tenders, operating manual, safety plan/risks. In addition to master data, equipment breakdowns may require pictures of the technical object(s) to be stored in the notification.
6	O	Floc-to-floc links	To indicate the network aspect of technical objects, i.e. a breaker panel in a protected substation may link to a incomer panel in a unprotected sub via a feeder cable (3 technical objects are linked in such an example)
7	R	MV fault report codes	Problem/damage codes, cause codes, object parts, activity codes
8	R	Condition assessment criteria and voltage measuring points	Master data required to perform condition assessments and enter measuring documents for technical objects.
9	O	Spares list per technical object	To ensure that proper spares management can be done. Without PM/MM integration on master data level, re-order point planning and integrated transaction processing benefits cannot be realized.
10	R	Artisans	Technical skills can be grouped by work centres and individual personnel numbers can be assigned to a work centre. Capacity planning/monitoring cannot be done without accurate work centre definitions
11	R	Maintenance planner/ planning office	Maintenance planners are responsible for detailed planning of capital and maintenance projects as well as the week-to-week schedules and prioritisation of work orders in general. This type of person requires a high level of system knowledge or a willingness and aptitude to learn if such knowledge is lacking.
12	R	Task list	Task lists are used to define preventive maintenance / inspections and other repetitive maintenance tasks. The operations defined should be defined to prevent failures or alert maintenance personnel of an impending failure (condition monitoring)
13	R	Maintenance plans	Maintenance plans and items relate maintenance tasks to technical objects and allow the planner to schedule task list operations as part of a maintenance plan.
14	R	Reports	Several standard reports are available to PM. Some sight changes may be required to realise the full benefit of the afore-mentioned steps.
15	R	BPM	Business process management would require a review of existing business processes with a view of streamlining and improving the integration aspects of such processes. Improved quality of master data will only result in streamlined transactions if the transactions are configured to take advantage of the cleansed master data.
16	R	Role definition/mapping	A BPM review may results in a better focus in some areas (maintenance planning) whilst reducing non-value add activities in other areas (manual or double capturing of time confirmation data). These individual steps in a process chain will need to be mapped to business users whilst ensuring that said users have to capacity and capability to perform such tasks. Role definition is also the core input required to setup authorisation for users.

Table 2: Electricity – key activities for system restructuring.



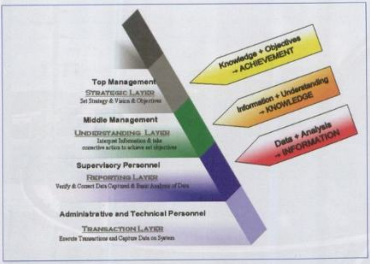


Fig. 2: Maintanance hierarchy.

Fig. 3: Asset management functions.

start all over again because the system does not support the business and the correct processes are not in place to guarantee a high confidence level.

Asset management fails in most instances because the business does not know how to put the building blocks together. The building blocks operate in silos and there is no integration between the building blocks; meaning that data which has been captured is duplicated and most important there are no one-to-one matches.

The focus is wrong. Where at the moment each department focuses on their own department, making life easier for themselves without determining the impact on the other departments. This focus must change to master data, in other words it must be able

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to take a problem to a person and not blame the system. The impact at the end of the day is that line, or those who must execute the work, suffer. The aim is to throw one ball at them – not a lot of balls.

Framework

This is the key, and in my opinion, one of the most important building blocks needed to be in place before starting the process, especially the technical asset hierarchy. This forms the basis of the project, without it you are doomed.

A word of advice:

- Don't underestimate the magnitude of the project
- Don't rush it
- Get the commitment of top management

The different philosophies, standards and processes from the formal municipalities (before restructuring into bigger municipalities) play a major role. This is where we were stuck for a long time before we actually proceeded with the process. There is only one way forward, create a project team and workshop it. No-one can assist you (you need a facilitator in this regard); you need to do it yourself and get your hands dirty.

At a previous conference, one person mentioned the process is like a pregnant woman, the period is 9 months, you can add another pregnant woman, but the period is still 9 months. If you want to rush the process, you are going to make mistakes and the mistakes are going to cost money. Municipalities have diverse functions, the core asset management process can only follow one standard. The big danger is when each utility wants to develop its own framework. There needs to be one set of processes for all, but tailor-made to fit each business.

What we want to achieve:

- Framework in place which makes reporting in any format/information requested possible.
- Put a process in place to make sure the confidence levels of data/capturing of data, reflects what happens at ground level.
- Framework in place that supports other modules in the system which we use.
- Makes reporting possible at all levels.

Asset hierarchy structure

Due to the magnitude of the project, different methodology, it is important to put a framework on top of the existing structures to make sure that you have only one reference number. Without a asset hierarchy it is not possible to advance the system or create a proper reporting structure or link your assets to other

City of Cape Town: Electricity services: MV fault report — ANNEXURE D

A. KNOWN INFORMATION

Notification No.: ____ Work Order No.: ____
Fault Detail: ____ Operational Area: ____
Substation Name: ____ Start Time: ____ Feeder Name: ____
Functional Location: ____ Finish Time: ____
Equipment nr: ____ Date: ____

Staff Attend:	Staff No.:	Activity No.:	Vehicle Reg No.:	KMs Travelled:	Vehicle Activity Type:

B. Equipment fault

☐ Substation Protected	☐ Panel MV	☐ Breaker Oil	☐ Switch Line	☐ Transformer Distribution	☐ Feeder Cable
☐ Substation Unprotected	☐ Panel Protection	☐ Breaker SF6	☐ Switch Fuse	☐ Transformer Current	☐ Feeder OH Line
☐ Mini-Substation	☐ Panel Scada	☐ Breaker Vacuum	☐ Switch Ringmain Unit	☐ Transformer Voltage	
	☐ Battery Charger	☐ Auto Recloser	☐ Switch Air Break	☐ Metering Unit	

C. Technology history

COMPONENT PART			SCENARIO/DAMAGE	CAUSES		ACTIVITIES
☐ Aerial	☐ Conductor	☐ Oil Insulating	☐ Blown	☐ Adverse Weather Condition	☐ New Equipment / Project	☐ Adjusted
☐ Alarm	☐ Connector / Clamp	☐ Operating Linkages	☐ Broken	☐ Cooling Loss / Reduction	☐ No cause observed	☐ Assisted
☐ Arcing Horn	☐ Damper	☐ Pole	☐ Burnt	☐ Consumer Fault	☐ No maintenance	☐ Cleaned
☐ Band Joint	☐ Danger Signs / Notices	☐ Relay	☐ Contaminated/Water/Ingress	☐ Contamination	☐ Overload	☐ Filtered / Re-Gassed
☐ Battery	☐ Earthing	☐ Seal / Gasket	☐ Dirty	☐ Contractor Damaged	☐ Safe Switching	☐ Fluid added
☐ Blade	☐ Fence / Gate	☐ SF6 System	☐ Knocked	☐ Deterioration due to Age	☐ Sealant / Gasket Failure	☐ Inspected
☐ Breaker	☐ Filter	☐ Structure	☐ No Damage	☐ Excavation	☐ Settings Incorrect	☐ Installed
☐ Breather	☐ Fire Extinguisher	☐ Switch	☐ Punctured	☐ External Object	☐ Short Circuit	☐ Issue Permit
☐ Building	☐ Fuse	☐ Tank	☐ Ripped	☐ Fauna / Flora	☐ Temperature Abnormal	☐ Lubricated
☐ Busbar	☐ Fuse Carriage	☐ Termination	☐ Ruptured	☐ Fire	☐ Theft	☐ Operational Conditions MOD
☐ Bushing	☐ Hardware (Bolt / Nut)	☐ Wiring	☐ Rusted	☐ Inferior Workmanship	☐ Tracking	☐ Painted
☐ Cabinet/Housing/Enclosure	☐ Insulator	☐ Transformer Current	☐ Seized	☐ Insulation Failure	☐ Vandalism	☐ Problem referred to Other
☐ Cable	☐ Joint	☐ Transformer Voltage	☐ Tripped	☐ Lightning	☐ Voltage Incorrect	☐ Removed
☐ Cable Box	☐ Locking Device	☐ Yard / Grounds	☐ Wear and Tear	☐ Loose Connection	☐ Wear and Tear	☐ Repaired
☐ Circuit Board	☐ Meters (Volt / Amp)					☐ Replaced
☐ Coil (Trip / Close)	☐ Monoblock					☐ Reset
						☐ Rewired
						☐ Routine Maintenance Perf.
						☐ Sample for Analysis
						☐ Spray Weedkiller
						☐ Switching / Operating
						☐ Testing Performed
						☐ Unable to Correct Problem
						☐ Unable to Detect Problem

D. REMARKS

Refer to: ☐ HV Department ☐ Engineering Support ☐ LV Department ☐ Protection ☐ SCADA ☐ Electricity Support ☐ Engineering
Date Referred: ____ Time Referred: ____
Materials used: ____
Remarks:

E. EQUIPMENT CONDITION ASSESSMENT

☐ 1. Very Poor ☐ 2. Poor ☐ 3. Fair ☐ 4. Good ☐ 5. Very Good ☐ 6. New

Record feeder loading: ____ (A) and Voltage: ____ (V) (If applicable)
If applicable: Voltage: R____ W____ B____
SIGNATURE: Loading: R____ W____ B____

Fig. 4: MV fault report.

modules e.g. GIS, insurance, bar-coding or financial asset management structure, and most important of them all – if you want to go the route of automisation of the system, it is not possible, your asset hierarchy must first be in place. Codification of assets and establishing family tree structure. Capable of reporting on maintenance matrix which includes costs, breakdown and meantime to repair.

The important part is to develop the structure in such a way that it is possible to report or draw statistics on all the different assets installed.

The compiling and data collection of assets is time consuming and all efforts need to be made to ensure that data is correctly captured.

Classes

Due to the different reporting requirements, it is essential that the structure must be built to allow for different requirements. One unique item from our structure is the diversity of the different reporting formats, most important being horizontal reporting.

Classification

In most instances, the capturing of classification data was neglected, or the processes implemented are such that the data is not constantly updated. Without classifications (name-plate data) it is impossible to do life-cycle costing, implement a replacement policy, perform condition assessments, scrapping or dictate where problem equipment is installed to do batch replacement.

Your classification data is the key for a capital replacement programme and obviously reflecting to determine tariffs and the implementation of them. The classification structure is also important for condition reporting.

Catalogues and measuring points

If you want to measure the performance of your assets or network, it is clear that your system must be set up and correct templates need to be provided for data to be captured. Without data, you cannot measure and without data, you cannot take corrective steps. Fig. 4 shows the spreadsheet/template that we use to capture reactive maintenance. The aim is that maintenance staff must only work with one of two spreadsheets; the proactive or reactive schedule. For measuring purposes, the key is that all data has been captured. This is one discipline that must still be drilled into staff and this is why performance data is not regularly available. It is especially bad when it comes to the history of data, by having measuring points operating and performance data can be provided.

Task list and maintenance plans (one of the key building blocks of the system)

The main aim is to put a framework together in order to start using the NRS specifications which relate to maintenance, as the basis for performing proactive maintenance. One word of advice – changes to data or maintenance plans must be done centrally and access to the data must be limited – only key personnel to have access!

Business process management and role definition

Do not implement any system or re-engineer if your business processes are not sorted out. Each staff member related to the process needs to know exactly what they must do.

Do not commit your data to the system unless all asset life cycle processes and policies are firmly in place.

One of the biggest mistakes that constantly occur is that your business processes do not link up with the system you use and the result is that you are constantly rebuilding your data over and over. It is a must that the processes you implement are fool-proof, that you have evidence of acknowledgement by all and that data has been captured.

Master data

It is important that your system data reflects the as-build configuration of the network, otherwise your data integrity will suffer and you will have to build your master data after each couple of years.

The focus in the organisation must be around master data and the processes must be built around master data. Any organisation which succeeds in this philosophy will gain the benefit of the system and will succeed in their outputs. If you implement the correct framework, there is no need to operate your business in silos.

The correct framework will lead to:

- Increased productivity
- Better decision-making
- Correct staffing level requirements
- Accurate reports
- Improved budgeting
- Reduced operating costs
- Improved maintenance of equipment

Master data collection, purification and verification

Do not underestimate the value of verification of the data entered into your system. Due to the large volumes of data and constant changing of data on the system it is essential that any data you enter into the system for master data is correct. Also, from the management and reporting side you want to know about the changes.

Master data quality/responsibility (once codification is completed)

- Master data should reflect maintenance organogram for maintenance responsibility for installed assets
- Should indicate critical assets
- Structure must be flexible to changes in maintenance organisation
- Master data installed should support business processes

Conclusion

- Want to work towards visibility of budget requirements
- Ability to optimise maintenance tactics (condition monitoring, reduce maintenance costs and increase uptime of network)
- Need stability on the core system to start continuous business improvements
- To establish a foundation which has been change managed across the enterprise in order to reduce future change management efforts
- Finally, to our ERP PM Team, Martin Aldrich, Hannes van Zyl and Chris Pluddemann for their support, patience, dedication and assistance in starting the building process

Further detailed information is available from the author.

Engineering contribution policy and effective implementation

NRS 069 is published and available since 2004 to guide distributors on the correct implementation of engineering contributions for electrical services. Over and above these guidelines, an approved policy from council is required together with a sound methodology representing the unique arrangements of each specific distributor to ensure successful implementation.

by Dwayne Baker and Danie van Wyk, uMhlathuze Municipality and Motla Engineering

This paper intends to address the importance of a council approved policy being harmonised with a sound engineered methodology as well as the importance to draw these principles through into the services agreement between local authorities and developers.

The importance to ensure consistency and apply the same principles and basis of costing when assessing the cost of a new township development, a new service connection or an upgrade of an existing supply is fundamental in successful implementation. Applying sound principles of engineering contributions within the policy framework where the interests of all parties are equally protected ensures that an optimum solution and mechanism is developed and implemented. This will further ensure sustainability by means of controlled NMD applications, minimum stranded capacity, optimum utilisation of capital investment and limit inflated electricity tariffs.

The paper makes specific reference to case studies where pitfalls, benefits for successful implementation and experience are shared for delegates to learn and initiate the processes within their licensed area of supply.

Engineering contributions deals with the recovery of capital for infrastructure development to service developments and future customers in a sustainable way. Key to the success lies in the optimum balance where developers contribute capital for infrastructure that will be recovered from property sales, and customers and rate payers finance to maintain engineering infrastructure at an acceptable level of service and attract new developments.

The purpose of this paper is also to introduce a policy that is both fair and transparent whereby exorbitant property and consumption rates are reduced and the costs of infrastructure is recovered by means of clearly defined promulgated engineering contribution tariffs.

The City of uMhlathuze has been implementing and enforcing engineering contributions to their customers for the past two decades which has resulted in sustaining an affordable and attractive basket of services. Most municipalities do not charge engineering contributions let alone have a policy guideline for the implementation thereof.

This paper highlights the lessons learnt and why a policy in this regard is important. It can be accepted that the current poor state of existing municipal infrastructure is as a result of not charging engineering contributions in the first place. A good infrastructure network with adequate capacity can be achieved by implementing and promulgating a range of engineering contribution tariffs, well defined and calculated using acceptable industry norms and standards.

Definitions

Engineering contributions is the financial recovery of shared municipal infrastructure, whether this infrastructure exists or is required for the future. It is not the service or link connection to a customer. It is important to clearly define the infrastructure and understand the difference between infrastructure and the service or link connection.

Shared municipal infrastructure (as illustrated in Fig. 1) is the components within a distribution network that service a multitude of customers. Thus this infrastructure is shared in terms of individual demand requirements. These components are typically large and expensive such as high voltage lines or cables, high and medium voltage substations. It is important to understand that the cost of the shared infrastructure is over and above the charge for the direct link or service connection to a single customer. It must also be clearly noted that the internal services of a private development such as a housing estate is not classified as shared infrastructure as the developer typically pays for and installs all internal services until such time as the internal services are handed over to the municipality to operate and maintain.

The service or link connection is the direct connection from a customer to the shared infrastructure. It can be supplied at any distribution voltage depending on the nature and size of the customer.

For the purpose of a uniform policy, customers are typically defined as follows:

- Single residential
- Single commercial
- Single industrial
- Complex – bulk supplied, individually metered such as townhouses, residential estates and malls

Single residential is further classified into the three known forms of housing:

- Low cost housing, which is typically Municipal Infrastructure Grant (MIG) funded
- Medium cost housing, where the average price of the property including dwelling does not exceed R750 000
- High cost housing, where the municipal value of the property exceeds R750 000

Legislation and standards

Engineering contributions are payable in terms of the Town Planning and Township Ordinance, Ordinance 15 of 1986 and Development Facilitation Act, Act No 67 of 1995.

The policies relating to electricity service provision applied by municipalities and is regulated by NERSA which should be consistent with the NRS 069 standard being established by the Electricity Suppliers Liaison Committee (ESLC).

Policies and implementation must be in line with both national and international industry best practices. It is a known fact that the principle of engineering contribution has already been in force in many countries around the world for decades.

Implementation should always be based on sound business principles where a win-win situation is established for all parties to add value and encourage future developments.

Types of developments

Developments can primarily be categorised as follows:

- Township development/extension of boundaries of townships.
- Rezoning/change of land-use right/ Special or Temporary Consent of Greater Tzaneen Municipality/Permits.

- Subdivision of property.
- Increased services requirements exceeding the original designed and provided services limits.

Although rural networks are significantly different from urban networks, the principles and methodology to calculate engineering contributions are similar with the latter being more capital intensive.

Principles for determination of engineering contributions

The following points form the basis of the electricity engineering contribution policy and guidelines:

- A consistent approach should be applicable throughout.
- The approach should be in harmony with sound practices employed within South Africa and internationally.
- The approach should be consistent within different utilisation and zoning categories.
- Contributions for each service should be financially ring-fenced.
- Contributions should be targeted at developers to service properties up to the full capacity according to the new zoning.
- Contributions should be charged to customers exceeding the designed capacity being contributed by the developer or that associated with the zoning.
- No double charging of services through tariffs and engineering contributions must be allowed.
- Assets financed by engineering contributions remain the property of the distributor.
- contributions may be used for other customers.
- The principle of contestability of dedicated networks being funded by customers should be supported.
- Recognition must be given in the long term to community benefits from all network extensions for the utility to gradually extend and expand distribution networks effectively to the benefit of all.
- The standards must be transparent in the way they are set out and applied.
- The approach should be relatively easy to implement and practical.

Calculations must be based on the fundamental principle that customers or subsequent customers should not benefit from a new development at the cost of the developer, or that the developer should not benefit at the cost of customers.

Establish a uniform basis for the calculation of engineering contributions in the municipality's area of jurisdiction as a whole. Calculation of engineering contributions is based on specific applications and guidelines to be set out for the various services.

Capital components in the consumption tariffs should be limited to spare capacity that will eventually be recovered from future engineering contributions. It is the municipalities' responsibility to ensure the level of spare capacity is limited as this places risk and an unfair burden on to customers.

Customers, who have funded bulk infrastructure networks in full through engineering contributions, should be compensated with the additional pro-rata contribution once other developments pay engineering contribution or sharing of infrastructure by other customers is increased. Refunding of contributions should be avoided where possible and be limited to a set window period. A window period of five years is proposed to be used by NRS 069.

Developments sharing bulk or link infrastructure should be done on a pro-rata basis and based on infrastructure cost and capacity.

Infrastructure

Shared municipal infrastructure can be illustrated using Fig. 1

Typically it can be shown that a connection from any primary, secondary or reticulation substation or a low voltage consumer distribution unit (CDU) will be based on the available capacity at the point of supply and the up-stream networks. For example, a shared connection at a reticulation substation such as a miniature substation will be dependent on the capacity of the miniature substation, the cable ring network feeding out from the secondary substation and the high voltage supplying the secondary substation.

The connection relationship

The connection relationship will be based on how a customer connects to the shared infrastructure and how it is paid for.

Single residential – not within a private estate/development

Typically the municipality sells the property to a customer, which does not include a service connection. Engineering contributions towards the entire shared infrastructure is recovered in the initial land sale. This means that the municipality pays upfront for the infrastructure and recovers the costs from individual residential customers through the land sale transaction. For example, the selling price of the stand will include the cost of the up stream capacity that is made available to that site. The customer pays up front for the engineering contributions over and above the service connection. If a customer sells to another customer, the property is sold with the connection including the allowable demand. If the new customer requires an increase in supply, the additional demand is payable at the prevailing promulgated engineering contribution tariff. Typical increases are from 60 A single phase to 60 or 80 A three phase.

Single residential – within a private estate/development

A developer pays for and installs all the internal services within the development. In addition to the internal services, the developer pays for a bulk connection to the municipality's shared infrastructure (external to the development) and pays engineering contributions towards the shared infrastructure. This should be covered in a separate services agreement to the sale agreement. The land sale to the end customer will thus include the cost of internal services, bulk connection costs and engineering contributions. The following illustrates how a developer recovers all these costs:

$$ESC = \frac{x+y+z}{\sum p}$$

where:

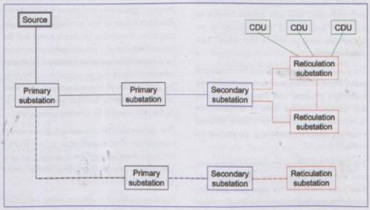

Fig. 1: Distribution supply schematic.

ESC is the electrical servicing cost per stand/property,

x is the engineering contribution paid by the developer to the municipality,

y is the bulk connection cost to the shared infrastructure (external of the development),

z is the internal servicing costs, and

p is the total number of properties within the development

Commercial/industrial

For low and medium voltage commercial/industrial customers, the same principles apply. The only difference will be the tariff itself as the connection is taken at a higher voltage level, which means less infrastructure between source and customer.

Why and how much should customers pay engineering contributions?

Infrastructure as defined above, is typically shared among all classes of customer. If for example a private developer does not pay engineering contributions for a private development, then the question is asked who then pays? Is it fair or justified that the local external rate base should then pay for the shared infrastructure that will service the private development? Engineering contributions are thus structured to recover shared infrastructure servicing costs based on existing and future capacity.

The size of engineering contributions is dependent on the location of the connection to the shared infrastructure. Fig. 2 attempts to illustrate this statement:

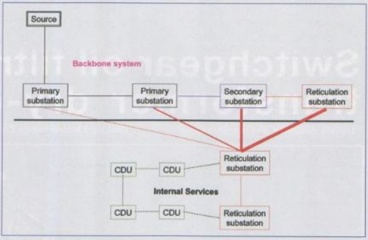

Fig. 2: The effects of adding CDUs.

If a connection is taken from a primary substation close to the source, then the total engineering contribution payable will be based on the demand requirement at a promulgated tariff at a higher voltage level while a connection taken from a reticulation substation will result in a total engineering contribution based on a demand requirement at a promulgated tariff at a medium or low voltage level. Hence, the high voltage tariff payable will, obviously, be less than the medium and low voltage tariffs depending on the cost of the infrastructure between the source and point of connection. Promulgated engineering contributions should be well developed in terms of a sound framework and industry norms.

Policy guidelines

One of the important challenges is the correct application of engineering contributions that will attract the correct customer or developer. Thus a municipality should develop a uniform policy applicable to all classes of customer.

Low cost housing

Low cost housing development is normally 100% MIG funded due to the social upliftment of disadvantaged communities. In addition to other services, electrification is funded through the National Electrification Fund. In many cases the bulk infrastructure can also be funded through the same fund made available from the Department of Energy. In this case, end customers do not pay engineering contributions, as their connection is totally subsidised.

Medium cost housing

There is no known policy on how engineering contributions should be applied to medium cost housing. The definition for medium cost housing has never been well defined. For the purposes of this paper, the author has selected a value of R750 000 or less inclusive of property and dwelling. This is based on the current economic climate (2009) and can vary from municipality to municipality. This housing market is typically aimed at the middle income group.

The proposal is to charge at least 65 – 75% of the promulgated engineering contribution tariff and cross subsidise the remaining balance from the local tax base, which will strike a good balance between affordability and an extra rates generating base.

High cost housing

If medium cost housing is defined as R750 000 or less, then any property in excess of this value should be charged the full promulgated engineering contribution tariff with no cross subsidisation from the local rate base. This housing is aimed at individuals or families who can afford and demand the luxury of a full basket of services.

Commercial/industrial

A great challenge in attracting commerce and industry is the availability of services and the supporting infrastructure. A key issue facing any developer or investor is the engineering contributions and the locality of the development. Normally a well sited development close to existing infrastructure makes it easier and more economical than a development which is far removed from the existing infrastructure. Large commercial developments apply the same principle of engineering contribution cost recovery as residential estates. For example, a shopping mall may recover the cost through market related rentals, which includes a portion of engineering contributions. In many cases the size of the demand results in a large contribution payable, some amounting to millions, which can be structured to suit both developer and local authority. If for example a shopping mall requires a final demand of 10 MVA, with only 5 MVA required in the first 3 years, then the developer pays for 5 MVA up front. The remaining 5 MVA is then paid by the developer after year 3 at the prevailing promulgated tariff.

Large industrial giants are unique in that their demand requirements command large infrastructure systems. In this case the municipality may not charge a separate engineering contribution but enforce a proportional payment for the cost of new or upgraded infrastructure depending on the demand requirement. For example, a Ferrochrome smelter located 5 km away from the nearest infrastructure, requiring 150 MW will pay 100% for a dedicated substation located on the boundary of the plant and 50% of the cost for a new 300 MW substation that is required to serve this plant. The balance that the municipality funds will then be recovered through future contributions as and when capacity is taken up.

Implementation issues

Engineering contributions due by the developer shall be a condition for granting development/ subdivision/rezoning approval.

Engineering contributions should be calculated and charged as soon as possible in the application process.

Payments should in all cases be made as follows:

- Townships, extension of boundaries of a township and rezonings: Prior to proclamation of the town/extension of boundaries/amendment scheme.
- Special, written or temporary consent of council: Within a period of thirty (30) days from date from approval by Council
- confirming that all conditions imposed by council relating to the approval have been complied with.
- Permits: Within a period of thirty (30) days from date of issuing a permit by the Department of Local Government and Housing.
- Any consent given by council which may require upgrading of the network.

The manner in which payments are made for each service must be flexible but should be agreed upon at the time of the signing the services agreement, alternatively it should be determined in the resolution of council, letter of approval issued by council, etc. Acceptable alternatives are:

- The provision of a bank guarantee provided that it makes provision for escalation to the planned date of construction.
- Cash payment.
- Phasing of the payment according to predetermined milestones such as pro-rata contribution per phase, subject to acceptable bank guarantee for the balance of the amount.
- The physical provision of infrastructure to the value of the calculated contribution required for that service, forming part of the services agreement.

Contributions will be applicable for developments exceeding the original designed capacity for each development as per approved contribution fees.

The zoning can be changed during the planning process, based on new information/ requirements. Where a downgrading of zoning takes place after payment of contribution was made, no rebate will be made of contributions already paid. The supply requirements may however increase in future up to the original service level, without any further contribution.

The municipality must refer to the respective supply authority for the conditions to be met in respect of the electricity service certificates.

The electricity contribution fees should be published with the annual municipal rates and tariffs.

A developer has the right to contest a quote from the utility and use a contractor to do the work to the utility's prescribed standard.

Enforcing the policy

Municipality should formulate a sound framework for the implementation of engineering contributions. This framework will provide the basis of calculating the tariffs based on local conditions and industry norms. The municipal council should approve a clear and transparent policy once this has been completed. Once the tariffs have been calculated, the process of approval as dictated by the Municipal Finance Management Act (MFMA) should be followed to allow the municipality to effectively promulgate and implement the tariffs.

The tariffs must be enforced at all levels of customer. In specific, private developments following the Development Facilitation Act (DFA) route are required to enter into service agreements with the municipality. The services agreement provides a clear indication of responsibilities in terms of all the services required. The same agreement is used to enforce the payment of engineering contributions.

Conclusion and recommendations

Engineering contributions are driven mostly by the electricity departments in isolation at this stage. The municipality should coordinate and adopt a uniform consolidated approach to harmonise engineering contributions for all municipal services to have a clear understanding of all the costs involved for developments. This includes electricity, water and roads as storm water is regarded to be an integral part of the roads infrastructure.

A mechanism must be introduced to ensure that all contributions are paid before development, change in land-use, etc. are approved as outlined above.

Accepting the policy and introduce contributions will in a consistent way assist to prioritise areas where pressure exists for development and confirmation that bulk engineering services are available or could be made available, and will also assist with developments in harmony with the municipality's IDP.

The electricity consumption tariffs should be aligned with the implementation of the Electricity Engineering Contributions to ensure that the capital component in the consumption tariffs is reduced with the reduction of outstanding loans and capital allowance.

Equipment replacement values must be updated and contribution fees recalculated annually to keep trend with realistic replacement costs.

When applying this policy in a consistent and justifiable approach to all developments where the interests of both parties are protected, an optimum sustainable solution and mechanism will be implemented. This will also ensure controlled NMD applications, minimum spare capacity, optimum utilisation of capital investment and limit inflated electricity consumption tariffs.

This policy should not cover socio-economic impact nor incorporate subsidies between categories of customers. It must be based on technical facts and costs and mechanisms to ensure a sustainable recovery of capital expenditure required to service developments. Council may however adopt specific resolutions to waive or reduce the engineering contributions for socio-economic developments. The advantage of this policy is that it will assist council to assess the true value of such resolutions. It will further assist council to make quantify applications for grant funding for subsidised developments.

Perceptions that engineering contributions will hamper developments must be carefully considered and the lessons learnt by municipalities that have successfully implemented and apply engineering contributions. It must be emphasised that engineering contributions paid by developers are recovered in the selling price of properties. Where no or under-recovery of engineering contributions takes place, the burden will be transferred to rate payers and recovered from all customers via consumption tariffs and developers gain this as profit. Fundamentally this is the reason for recovery of capital contributions to prevent cross subsidisation and was also ruled by the Venter commission to be avoided.

Experience from municipalities who have effectively implemented engineering contributions has demonstrated that infrastructure leads development.

Ukubona: Leading the way with switchgear, and high voltage projects

Ukubona, a formidable player in the medium and high voltage sectors, has reached new heights in the industry based on the quality of their work, performance and cost effective solutions. Ukubona experience, expertise and excellence have enabled it to play a great role in the refurbishment of the South African electrical infrastructure network.

Ukubona started operation in 1989, from small premises in Edenvale, employing only four people, with a key focus on electrical switchgear. The scope of operation was installation, testing, commission and maintenance of the switchgear.

Today Ukubona serves both South African and international markets and has grown to an employee complement totalling 64. Its mission is to be the preferred solutions provider in respect of medium and high voltage electrical equipment to both the public and private sector.

"At the helm is executive chairman, Imtiaz Abdulla who has guided the company through the myriad opportunities that have presented themselves as a result of the infrastructure development on the South African landscape," says Subash Dowlath, a director at Ukubona.

Ukubona has partnered with a technologically advanced partner to transfer the technology and knowledge to South Africa

Ukubona was awarded one of the first electricity infrastructure orders for the Gautrain Rapid Rail Link Project. It was tasked to relocate 44kV electrical cabling in the Ekurhuleni Metropolitan Municipality. It was also awarded the reticulation of the Midrand Station for the Gautrain project.

The company has the ability to re-instate the supply of electricity in emergency situations. It has completed three such emergencies in the past two years. This includes the Kempton Park main electricity supply station where Ukubona had six days from being commissioned to re-instating the supply of electricity. The job required Ukubona to:

- Remove 27 11kV panels and rewire them
- Refurbish the substation
- Install 5km of 11kV cable

Long running contracts at OR Tambo International airport and Ekurhuleni municipality have enabled the company to build strong relationships with these two major entities. For the past 12 years the Airports Company of South Africa (ACSA) has contracted Ukubona to service and maintain the entire medium voltage network at the airport. A maintenance contract for Ekurhuleni municipality's entire medium voltage cable network has also been running for the past two years.

Ukubona's footprint has grown significantly with contracts throughout Africa, India, the Middle East, Mauritius and the United States. In India it was commissioned by Tata Steel to supply and joint a 132kV cable project.

International partners

The recent surge in the need for various products in the electrical sector, spurred Ukubona to source products worldwide to satisfy its customers' needs. The highest standards are required in its international partners and their products, to meet the company's quality standards.

Value add

Although switchgear is at the core of Ukubona's business spectrum, the company has cast itself as a specialised player in various other areas such as maintenance, specialised projects and supplying high voltage cables and transformers to suit clients' needs. This enhances Ukubona's edge in providing a total service for the range of requirements that may arise.

The company provides EPC solutions for switchgear, cables and power transformers.

1. Switchgear

Ukubona's switchgear division is capable of design, supply, installation and commissioning of medium voltage switchgear. The switchgear range comprises a distribution and transmission type with a fault rating at 20kA-25kA, and a generation type with a rating 25kA-50kA. Ukubona has been installing and maintaining a wide variety of switchgear since 1995. This broad experience places Ukubona in a prime position to render a world-class service.

2. Cables

Ukubona's highly skilled employees have rare jointing skills, which include cable jointing up to 400kV on various types of cables. Examples are XLPE and oil filled cables. In addition, Ukubona is also a preferred maintenance contractor with regards to design, cable repairs and assistance with diagnostics.

3. Power transformers

As a result of its involvement in turnkey substation projects, Ukubona has sourced and supplied power transformers from its partners around the world. It has:

- International accreditation
- Pfisterer certification
- CCC certification

Product capabilities

Ukubona's metrical capabilities include the following:

- Turnkey product management relating specifically to the following products:
  - Reticulation
  - Sub stations
  - Emergency repairs
- Designing, manufacturing, testing, installing, commissioning and maintaining of MV switchgear.
- The designing, supplying, testing, commissioning and maintaining of MV (11kV) to EHV (400kV) cables.

Empowerment within society

The management and staff at Ukubona have pledged a commitment from within the company to contribute in a positive and meaningful way to empowerment within society.

Transformation policy

Ukubona subscribes to BEE and gender equity, having already received a level 3 BEE score. It is Ukubona's stated intention to improve its BEE score every year. In this regard, a transformation committee has been formed to ensure that the goals and objectives of measurable action plans are met.

Skills development

Skills development is a core component of Ukubona's HR Development Strategy. The dynamic nature of the business provides staff with continuous on-the-job training. Training occupies between 5% and 20% of the working week and varies between technical and management courses.

As part of its mission of meeting the objectives set out by the AsgiSA initiative, the company has developed structures, which incorporate black women as shareholders/partners.

Switchgear and associated equipment training centre

Ukubona has recognised the dire need for training and has developed a plan to open a training facility for switchgear and associated equipment. It has earmarked R4.2 million for the establishment of the centre.

"This will be a perfect opportunity for black females to be trained overseas as trainers, in order to provide locally based training, under supervision,

to all prospective equipment operators. We have internationally respected engineers who will assist with the initial establishment of the centre and ensure a smooth and solid base for the women who plan to own and operate the facility," says Dowlath.

Wiring team

Ukubona already has numerous female panellists on its wiring team. Its intention is to formalise the team into a company whereby the female panellists would be shareholders and manage their own business. The Ukubona management team will assist the team with business guidance and marketing.

Technology development and transfer

One of the major advantages of Ukubona's partnership with leading international switchgear company Gelpag/Huadian is the skills transfer that is taking place. Gelpag/Huadian has agreed to transfer their state-of-the-art switchgear production, which has been jointly designed and developed by German and Chinese design engineers, to South Africa for local manufacturing for an agreed period. Gelpag/Huadian have committed to training and developing 50 people from South Africa at their offices in China. The intended objective is for those team members to then transfer their acquired skills and knowledge to the rest of the team at Ukubona.

In the past this type of switchgear has been imported. "We believe that this technology can and should be manufactured locally. It is for this reason that Ukubona has partnered with a technologically advanced partner to transfer the technology and knowledge to South Africa."

Ukubona employees share ownership plan

Ukubona is in the process of establishing an employee share ownership plan, which will be a shareholder of Ukubona Holdings (Pty) Ltd. All Ukubona employees that have spent more than three years in employment will be eligible. A central component of the plan, which is in its final stages of completion, is to include black females who will own a share in Ukubona Holdings.

Project Ikaya

Ukubona has taken the initiative to ensure a better quality of life for all of its long serving employees, by purchasing a block of seven flats to house employees with over ten years of service. The flats, which became operational in 2007 already accommodates 20 employees in Germiston. •

UKUBONA

BEE Profile

Subash Dowlath

Dowlath is an admitted lawyer by profession who joined Ukubona 18 months ago on a full time business. He has interests in other industries, but chose to harness his skills and networks for the development of Ukubona. His prior work in the local government sector means that he is poised for penetration into the municipal and parastatal market, for the benefit of Ukubona. Dowlath has a BA LLB LLM and Diploma ADR, which assist him in integrating his role as Ukubona's director of business development and legal oversight.

Imtiaz Abdulla

Currently the Executive Chairman, and sits on various other Boards in various sectors of Industry. He brings to the table his vast knowledge on government, and strategic insight into Company development and transformation. He is also a 7th Dan Martial arts expert that encourages focus and discipline in terms of the Ukubona work ethic, to ensure that Ukubona employees, produce at their optimum at all times. Under his leadership, Ukubona has already experienced many successes and is poised for much more.

Trevor Besten

Trevor is the Chief Operations Officer, with experience from the Entertainment and Media environment. His scope for oversight is Corporate Services, which includes Administration, Finance, Human Resources and Legal. Trevor is hands on and ensures that Ukubona does not lose momentum.

Facts and figures

- Total number of employees – 64
- Construction Industry Development Board (CIDB) rating – 8EE
- ISO rated – 9001: 2000 certified
- Winner of Business Partners Entrepreneur of the Year award 2007
- 50% growth per annum for the last three financial years

This article was commissioned by Ukubona. For more information please call 011 608 4736 or fax 011 608 4741. Alternatively, email info@ukubonaelectrical.co.za or visit www.ukubonaelectrical.co.za

Reinventing old grids – taking steps to assess the risk of failure

Most South African networks have been underutilised for years which led to low level of maintenance. With the economic boom in the country, these networks have seen massive increase in loading and this increase has triggered puncture failures that were hidden during the low loading period.

by X Lembede and S Xulu, City Power Johannesburg

These weakest points in the networks have led the utilities to re-look at their investment criteria. Due to this sudden increase in loading, utilities have seen massive increase in expansion and replacement programmes and this has put massive strain in manufactures.

New equipment deliveries have reached their worst lead times posing a risk on service delivery.

Most electrical networks have reached an operating age where some equipment has reached or exceeded it original design life. Restoring the integrity of distribution networks throughout South Africa to an acceptable level thus seems to be a mammoth task. A systematic and focused approach should be adopted in identifying and implementing strengthening and refurbishment requirements that will ensure long-term, sustainable infrastructure. The approach should follow sound and holistic asset management principles and must take into account several issues.

There are cases where equipment should be replaced with new, but there are other situations, where repairing/refurbishing an existing equipment is the better choice.

Preventative measures

The current state of the electricity supply industry points towards the need for an accelerated approach to asset management to ensure that system reliability is adequate for the entire country in the medium to long term.

There are a number of measures that a utility can look at to improve network performance.

Preventative maintenance

For the network to work properly, every piece of the network must work properly. Preventative maintenance concerns anything that can be done to prevent any equipment failure on the network.

The utility need to develop a maintenance procedure and schedule for each installed equipment. The best preventative maintenance programme starts with careful thought about the quality of the items you buy and the effort made to install service and keep track of those items.

Why use preventative maintenance?

Research shows that the cost of maintaining and operating equipment over the lifetime of the components can be at least double that of the initial outlay for purchase of the equipment. An effective preventative maintenance programme can drastically reduce the cost associated with the day-to-day operation of the equipment.

Implementing a preventative maintenance programme will enable the utility to detect and prevent many problems before they become incidents by ensuring that the individual items that comprise the network are operating as reliably as possible.

Some of the benefits you can expect are:

- Reduced network downtime
- Increased life expectancy of network components, eliminating premature replacement of parts
- More economical use of technical staff because they are working to a schedule rather than on reacting to repair breakdowns
- Timely routine repairs mean fewer large-scale repairs
- Lower repair costs, because there will be fewer secondary failures (when parts fail in service they often damage other parts)
- Identification of equipment with excessive maintenance costs, indicating the need for corrective maintenance, operator training or replacement of obsolete equipment
- Improved safety conditions and quality.

Combining your preventative maintenance programme with effective network monitoring will also provide a means of measuring the effectiveness of the maintenance activities.

Replacement

Replacement provides similar benefits to refurbishment. It's a best way of investment provided the funds are easily accessible. Replacement takes out completely the old equipment and replaces it with new equipment and this prolongs the life of the network.

The replacement is usually assigned to the OEMs. The only disadvantages are cost and lead times.

Refurbishment

To ensure minimal disruption to service delivery and to curb the exponential increase in capital expenditure, refurbishment has been sees as a better form of revitalising the network at a fraction of replacement cost and time.

Due to cost associated with the maintenance of strategic spares, it became apparent that this type of stock has to be kept to minimal. The impact of minimising stock compromises the network and this repair/ replacement period has to be kept to minimal. Another equipment failure will mean that that particular equipment has to stay out of service until a repair or replacement is done.

Looking at this scenario, it will mean that the service provider has to minimise the refurbishment time to absolute minimum. This can be achieved through the establishment of long term contracts with a certain number of service providers who are required to keep a minimum stock of critical components.

Investment decisions are based on a number of criterion and these are not only based on the replacement cost but on the economical impact and the risks involved with that particular equipment. On a decision to refurbish, the refurbishment cost must be less than 50% of the replacement cost. Reliability analysis has to be thoroughly done and the risk weighed accordingly.

When doing these refurbishments it's very important to look at the surrounding environment. It is this environment that determines the size of the risk which leads to the appropriate investment option.

Equipment condition assessment

Aging equipment is undoubtedly one of the primary concerns for asset owners. Failure rates increase as equipment ages and requires proportionally more inspection and additional maintenance cost than new equipment. A life extension or refurbishment program that permits continued economical operation of the electrical system and improved reliability by reducing failures must address both:

- Individual substation facilities as they approach design life, and
- Individual equipment on a system wide basis.

Asset specific assessment normally provides a systematic estimate of the remaining life in substation and line facilities. In conjunction with the life extension methodologies, it can further provide a planned programme to extend that life to meet future needs. The output from an equipment condition assessment study should clearly indicate:

- Assets posing an immediate safety hazard or those that require immediate to short-term attention based on assessment outcomes or policy (critical assets).
- Assets that require monitoring or testing to assess actual conditions (concerning assets).
- Assets that operate satisfactory under intended conditions (normal assets).

It is important that asset replacement and renewal strategies should be executed in conjunction with strengthening and expansion strategies.

Figs. 1 and 2 show a typical equipment age profile in a utility.

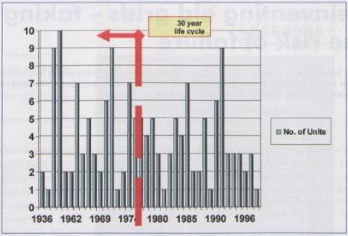

Fig. 1: Transformer typical age profiles.

Different methods used to determine the equipment condition are listed below.

Condition based monitoring

Condition monitoring or CBM (condition based monitoring) is an effective form of predictive maintenance (PdM) where, as you may have guessed, you monitor the condition of specific areas of plant and equipment. This can be done automatically with the use of instrumentation such as machinery vibration analysis and thermal imaging equipment or manually. In automatic CBM when any monitored and predefined condition limit is exceeded, a signal or output is turned on. This output can be sent directly to a work management centre so that a work order is generated automatically. This is particularly suited to continuous process plants where plant failure and downtime can be extremely costly.

Oil sampling

Another method used especially on transformers is oil sampling. Each operating part in an oil lubricated circuit has a normal wear rate. As these parts wear they introduce particles into the oil, generally these are very small but through an oil sampling and analysis programme these can be monitored. If there is an increase in the amount and size of the particles the analysis will highlight these and be able to pinpoint the source. This gives the owner/operator the opportunity to take preventative action before a failure can occur.

The samples are analysed through the lab and they tell the condition of a transformer. This analysis gives the condition of insulation medium which tells the behaviour of that particular equipment. From good analyses one can estimate the remaining life of that equipment. From these analyses, a decision to maintain, refurbish or replace is taken.

Regular oil sampling is a low cost preventative maintenance tool that enables owners/operators to see what is happening inside the machinery. By implementing an oil sampling and analysis programme companies can:

- Reduce operating costs
- Pinpoint potential problems
- Plan manpower and maintenance schedules
- Plan service schedules
- Maintain productivity
- Save downtime costs
- Keep minor repairs from becoming major repairs
- Reduce oil and filter change costs
- Reduce waste products

Infra red scanning

Infrared scanning (IR) accurately identifies the presence of abnormal heat in electrical and mechanical systems, which can help predict equipment failure. Infrared scanning can save you money. Electrical and mechanical connections usually do not fail quickly or without warning. They fail over time, generating heat and infrared radiation that although invisible to the naked eye is easily detected with infrared thermography equipment. Utilities can use infrared scanning equipment to detect "hot spots" areas in electrical or mechanical equipment indicating the equipment could fail. Usually hot spots appear to deteriorating electrical connections that must be repaired or replaced in order to prevent expensive unplanned downtime.

Challenges

The refurbishment programme comes with its own challenges. It's important that the

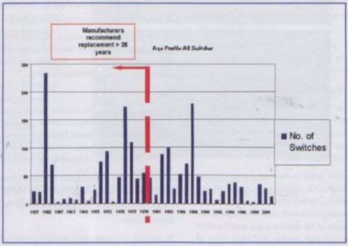

Fig. 2: Switchgear typical age profiles.

Integrated Safety, Health, Environmental and Quality Policy

In keeping with the vision of City Power Johannesburg Pty (Ltd) as a 'World-class Electricity Distributor', we commit ourselves and all our employees to adhere to the guidelines of ISO 9001: 2008, ISO 14001: 2004 and OHSAS 18001: 2007 as Integrated Management Standards and in conformance with the requirements, expectations and needs of all our employees, customers, suppliers, service providers and other stakeholders.

In order to achieve this, City Power is committed to the:

- Deployment of the City Power Mission, Values and Operating Principles.
- Deployment of the 'City Power Leadership Charter'.
- Elimination, prevention, mitigation and management of all potential Safety, Health, Environmental and Quality Impacts relative to the transmission and distribution of electricity and the maintenance of the network.
- Prevention of pollution and the provision of a safe and healthy work environment through the continuous improvement of our Safety, Health, Environmental and Quality Management Systems and by the review of our objectives, targets and management programmes.
- Compliance with the relevant safety, health and environmental legislation, regulations and any other standards and requirements.

The commitments made in this Policy, through the responsibility placed upon the Management and Staff of City Power, shall be ensured through the application of the requirements of the ISO 14001: 2004, OHSAS 18001: 2007 and ISO 9001: 2008.

General Manager SHEQ
Joe Ledile Tefu
03rd August 2009

Managing Director
Silas Mzingeli Zimu
03rd August 2009

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a world class African city

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Johannesburg

parties concerned deal with these challenges upfront. The common challenges are:

Warranty

The fact that this refurbished equipment is not new, the service provider find it difficult to give warranty to the equipment as a whole but can only give a limited warranty to only those portions that the work was done. Even on this work it's very difficult to negotiate favourable warranty as they feel the untouched components can sometimes lead to the failure of the refurbished equipment.

This scenario somehow pushes the utility to get the service provider to look at a complete overhaul of that particular equipment. To get a better warranty, the service provider concerned has to be certified by the original equipment manufacturer of that particular equipment.

Design

The game comes with its own politics that cannot be ignored. It's a known fact that most organisations are reluctant to hand their designs to a third party organisation citing breach of intellectual property policy. To get the original design is always an issue as the original manufacturers lose the old designs as new technologies come to the market.

This poses a big challenge with these service providers having to maybe come with a modified design to fit in with the old equipment. Some OEMs no longer exist and to refurbish these equipment pose a big challenge.

Factory capacities

With the increasing demand on expansion programmes, most OEMs prefer to deal with the production of new equipments rather than embarking more on refurbishing existing equipments. This has led to the need of companies only looking at the refurbishment programmes. These companies have to ensure that they establish good relationship with the OEMs for support and design sharing.

Conclusion

Due to rising need in capital expenditure to address expansion and network rejuvenation, refurbishment seems like a quicker solution to address the backlog in ageing infrastructure. A proper plan needs to be developed and has to be aligned with the service provider's schedule and the financial allocation to the utility.

Compact substation solutions

Substation designs have generally followed air insulated technology or gas insulated technology. When faced with space constraints or the need to reduce the investment cost of substations, creative adaptations of air insulated substation designs like transformer feeders and Jericho schemes together with smaller protection schemes have been used successfully.

by Chris de Kock, ABB South Africa

Space constraints often emerge when substations need to be extended to cater for local load growth requirements, more flexible switching arrangements or to allow for more sophisticated protection systems.

Hybrid switchgear, utilising the advantages of SF6 gas insulation and multi-functional switchgear has provided the opportunity for resolving these space constraint challenges for some time now.

Mixed technology switchgear (MTS) is defined by the installation and functionality considerations of the switchgear and uses AIS, GIS or Hybrid IS technologies.

The considerations affecting the technology choice are the substation location, the equipment design and manufacturing, engineering, construction, impact on the environment, impact of the environment, on-site time efforts, operation and service, availability, testing, flexibility, personnel safety, physical security and life cycle costing.

Examples of four applications of MTS will be presented showing a substation upgrade from 66 kV to 132 kV on the same footprint, a greenfield substation using combined AIS switchgear, a substation retrofit creatively using double busbar hybrid switchgear and a greenfield substation using double busbar hybrid switchgear at both 66 kV and 132 kV voltage levels.

Fig. 1: AIS devices of surge arrestors, instrument transformers and circuit breakers.

Fig. 2: GIS switchgear in an indoor substation.

Technology options for substations

The different design technologies for high voltage switchgear can be clustered into three groups; conventional air insulated switchgear solutions, conventional gas insulated switchgear solutions and hybrid insulated switchgear solutions.

Some of the drivers for the technology choices are the need to optimise the investment costs, space constraints and the need for redundancy and high reliability of the single line layout.

AIS (air insulated switchgear)

Switchgear of which the bays are fully made from AIS technology components. The insulating medium is air.

The conventional AIS devices of surge arrestors, instrument transformers and circuit breakers are shown in Fig. 1.

AIS switchgear has the flexibility to be configured into all types of substation layouts.

GIS (gas insulated switchgear)

Switchgear of which the bays are fully made from GIS technology components. Only the HV connections to overhead lines or cables, etc. can have external insulation. The insulating medium is normally SF6 or an SF6 mixture.

GIS switchgear can be configured in single busbar, double busbar or 1 and 1/2 breaker layouts.

The indoor GIS shown in Fig. 2 is a SBB layout.

Hybrid IS (hybrid insulated switchgear)

Switchgear of which the bays are fully made from a mix of AIS and GIS technology components.

Hybrid switchgear can integrate many functions into one unit.

The PASS MO unit shown in Fig. 3 integrates disconnectors, earth switches, current

Fig. 3: Hybrid switchgear combining both AIS and GIS technologies.

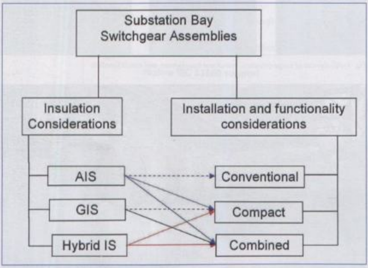


Fig. 4: MTS showing insulation, installation and functionality considerations.

transformers and a circuit breaker to give a complete bus section bay.

Switchgear standards

The IEC 62271 suite of standards for "high-voltage switchgear and control gear" covers AIS, GIS and MTS switching devices.

IEC 62271 – 100: High voltage AC circuit breakers

IEC 62271 – 102: AC disconnectors and earthing switches

IEC 62271 – 108: High voltage AC disconnecting circuit breakers

IEC 62271 – 203: Gas insulated metal enclosed switchgear

IEC 62271 – 205: Compact switchgear assemblies

Part 205 of this standard has been developed to cater for the new arrangement possibilities that have been developed by manufacturers and to ensure that the complete switchgear assemblies are covered by a single standard [1].

Definitions according to Cigré Working Group B3-20

The Cigré Working Group B3-20 is developing a brochure which evaluates different switchgear technologies for rated voltages of 52 kV and above. The following definitions are used to describe the switchgear [2].

Conventional switchgear: Switchgear of which bays only include conventional components

Compact switchgear: Switchgear of which at least one or more bays are compact bays, i.e. in which at least some components share common support structures and cannot be placed individually.

Combined switchgear: Switchgear of which at least one or more bays are combined bays, i.e. in which at least some components are multifunctional.

Mixed technology switchgear (MTS): Switchgear assemblies which incorporate a mixture of the insulating characteristics of both AIS and GIS and/or which implements traditionally discrete functions (devices) in a compact and/or combined design in such a way that they can no longer be considered for the purposes of design and testing, in isolation.

Examples of MTS (DCB, WCB, compass and pass)

Mixed technology switchgear can thus be made up one of the following combinations:

- AIS in compact and/or combined design
- GIS in combined design
- Hybrid IS in compact and/or combined design

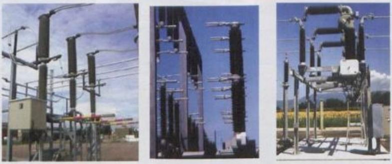
Assembled together and using a common structure in order to minimise the installation time. Typical examples of MTS assemblies are shown in Fig. 5.

Mixed technology switchgear considerations

When the various technologies of AIS, GIS and MTS are compared, the Cigré document [2] rates the following aspects to guide utilities and customers in the correct technology choice:

- Location (outdoor rural, outdoor urban, indoor, underground or container)
- Equipment design and manufacturing (conceptual design, material, manufacturing from factory perspective, manufacturing from site and commissioning perspective)
- Engineering (complexity, SLD, schedule, specification, layout, civil work and secondary system)
- Construction (site, transport, foundations, erection, impact on existing services, commissioning)
- Impact on the environment (aesthetics, noise, EMF/EMC, nature, leakages)
- Impact of the environment (climatic conditions, pollution, corrosion, seismic activity)
- On-site time efforts (preparation time, erection time, commissioning time, repair time, maintenance time)


LV Motors
Excitation
ABB
Best in class



Disconnecting circuit breaker
Combined AIS

Withdrawable circuit breaker
Compact AIS

COMPASS unit
Compact AIS

PASS unit
Hybrid IS

Fig. 5: Various examples of MTS assemblies.

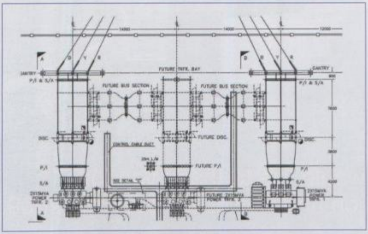


Fig. 6: Layout for the original 66 kV substation.

Fig. 7: Bus coupler bay using the 132 kV pass M0 hybrid unit.

- Operation and service (control, condition monitoring, expected lifetime, replacement of components, dependence on OEM)
- Availability (maintainability, reliability)
- Testing (type tests, routine tests, on-site tests, test equipment)
- Flexibility (extendibility, upgrading, refurbishment, mobile or temporary)
- Personnel safety (injury risk during service, maintenance and in the case of catastrophic failure)
- Physical security (security against terrorist threat, vandalism and metal theft)
- Life cycle costing (cost of acquisition, ownership and disposal)

MTS shows clear advantages in less space required for the same SLD, extended SLD in the same space, higher flexibility of layout, easier engineering and integration with the secondary systems and reduced maintenance efforts and costs.

Examples

The following four examples are intended to show the suitability of MTS for AIS substation upgrading, extensions and greenfield projects with space constraints.

Newton Park substation (66 kV to 132 kV upgrade)

- Scope: Newton Park substation was an existing 66 kV substation located on the top of a hill with a steep slope. There were two incoming lines directly feeding onto transformers. These transformer feeders were used to reduce the initial investment costs of the substation and no HV circuit breakers were installed.

When the initial 66 kV layout was designed, the future need for this to be upgraded to a 132 kV substation was not considered. If the substation platform were to be increased to allow for a 132 kV AIS substation, there would be considerable civil work expense in backfilling to extend the platform or develop a multi-level substation.

- *Solution:* The busbar spacing had to be increased to allow for the required 132 kV clearances. The same bay width was maintained as this was determined by the transformer plinth spacing. The PASS MO 132 kV hybrid switchgear was used for the incomers and the bus section.

  The work could be completed without a total outage. There is now a greater level of flexibility with the busbar and bus-section bay installed.

Gull substation (greenfield 132 kV substation)

- *Scope:* Gull substation is a greenfield 132 kV substation in the built up residential area of Lonehill in Johannesburg where there has been a large increase in load in the area and there is insufficient space for a conventional AIS technology substation. The substation layout was SBB with 2 x incoming circuits, 2 x transformer circuits and a bus coupler.
- Solution: The COMPASS 132 kV compact technology switchgear was used in all the substation bays. This MTS solution demonstrates the clear advantages of less space required for the same SLD.

Bloemendal substation

- *Scope:* The existing substation layout shows an overhead line going in and out of the substation via two parallel paths, one path through two disconnector switches and the other path through two disconnector switches with a circuit breaker between them. The two transformers are connected to each end of the two parallel paths via transformer disconnector switches.

  The requirements for the Bloemendal substation retrofit project was to take the existing 132 kV AIS substation and construct a complete incomer bay (consisting of a line disconnector and earth switch, circuit breaker, current transformers and surge arrestors) for each of the overhead line in and out bays. The transformers would still be fed via transformer disconnector switches and the overhead lines are still connected via two disconnector switches and a circuit breaker.

The customer constraint was to implement the solution within the boundaries of the existing substation. No outage for any part of the substation could be more than 24 hours duration.

- *Solution:* The MTS solution implemented here used 2 x PASS MO 132 kV double busbar units connected together with an AIS circuit breaker between the PASS units. The bus section switch on each side of the AIS circuit breaker is within the PASS unit. This solution also allows the flexibility to earth the transformers or the overhead lines or the bus section switch through the PASS unit circuit breakers.

  When the redundant existing equipment is removed, there will be sufficient space to place more transformers in the same existing substation area if required.

Briers substation (greenfield 132 kV DBB and 66 kV DBB substation)

- Scope: Briers substation has a DBB layout at both 132 kV and 66 kV voltage levels. The 132 kV side has 2 x OHL incomers, 2 x transformer feeders and a bus coupler. The 66 kV side has 2 x

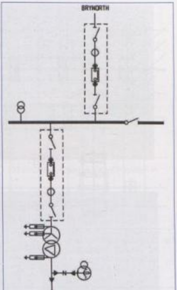


Fig. 8: SLD showing the MTS solution comprising an OHL incomer bay, the transformer bay, AIS busbar VTs and an AIS bus section disconnector.

Fig. 9a: MTS incomer bay using a COMPASS unit.

Fig. 9b: MTS transformer bay using a COMPASS unit.

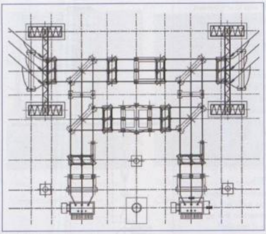


Fig. 10: Existing substation layout.

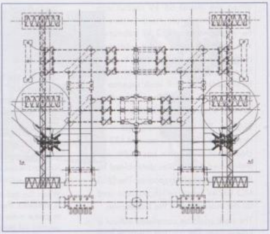


Fig. 11: New substation layout using MTS.

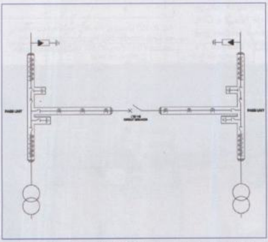


Fig. 12: MTS Solution using PASS MO DBB units combined with an AIS CB.

Fig. 13: MTS PASS MO DBB unit.

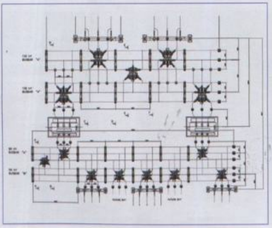


Fig. 14: Substation layout using MTS.

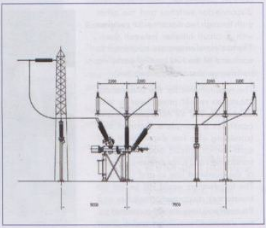


Fig. 15: Side elevation of MTS for the OHL incomer bay.

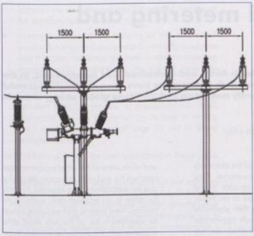


Fig. 17: Side elevation of MTS for the transformer bay.

transformer incomers. 3 x OHL feeders and a bus coupler with provision for 2 x future bays.

- *Solution:* MTS was selected as the appropriate technology because of the space constraint for the substation. It was not possible to design an equivalent AIS technology substation within the same available area.

Conclusion

Mixed technology switchgear has been defined in relation to AIS, GIS and Hybrid IS with the advantages clearly shown. Four different examples demonstrating the implementation of mixed technology switchgear have been discussed and this has demonstrated some of the practical applications of this technology. There are still many further applications that can be discussed.

MTS shows clear advantages in less space required for the same SLD, extended SLD in the same space, higher flexibility of layout, easier engineering and integration with the secondary systems and reduced maintenance efforts and costs.

Fig. 16: PASS MO 132 kV DBB unit used as the MTS solution in this application.

Fig. 18: PASS MOO 66 kV DBB unit used as the MTS solution in this application.

References

[1] IEC 62271-205: High-voltage switchgear and control gear – Part 205: Compact switchgear assemblies for rated voltages above 52 kV.

[2] WG B3-20 Brochure: Evaluation of Different Switchgear Technologies (AIS MTS. GIS) for Rated Voltages of 52 kV and above.

The evolution of pre-paid metering and load control systems

Pre-paid electricity metering systems have a 20-year history in South Africa and centralised load management, in the guise of so-called "ripple control systems", much longer than that. Both technologies have been extremely successful over the years in their respective domains, but the world is constantly moving on and the whole global energy scenario today looks vastly different from what it did even ten years ago.

by Andy Stoner, Landis+Gyr

We've seen the global energy crisis driving up costs across the board, there's been a growing recognition that many of the planet's resources that we've come to depend upon absolutely are non-renewable, and environmental expectations and so-called carbon-footprint awareness are becoming ever more pressing by the day. And here at home in South Africa, of course, we have fairly recently woken up to the fact that we, as a result of our own special circumstances, have some additional energy capacity constraints to contend with.

So where does all this leave our old friends "prepaid" and "ripple"? Let's start our journey by looking at the needs of the various stakeholders. And we'll start with...

The consumer's needs

Yes, a little unfashionable perhaps, but we're very deliberately going to discuss the consumer's needs before mentioning the utility's needs, in order to emphasise the global sea-change that is simultaneously occurring in perceptions of citizens' rights. This movement started a good while ago in the so-called developed countries, but is slowly yet surely becoming a significant factor on the socio-political landscape of the developing world as we experience it today.

Here in South Africa, Batho Pele, which is a Sotho expression meaning "People First", is a very serious government initiative to get public servants to be service orientated, to strive for excellence in service delivery and to commit to continuous service delivery improvement.

And individually, people want to feel that they are getting a fair deal and being treated with respect. The recent violent service delivery protests in various parts of the country should serve as a reminder to us, if indeed any is needed, of the strength and depth of people's feelings on these matters.

So, what does our 21st-Century electricity consumer need from us? And here I want to stress, up front, that whatever the answer to this question, the solutions clearly have to be achievable with minimum inconvenience and lifestyle disturbance.

- First and foremost, consumers need to be able to manage their energy costs and, more specifically, the cost of the electricity they and their families consume. This means that they need to be able to see in real time and, above all in an easily understandable way, how their electricity is being consumed – which appliances use the most electricity and which use very little.
- Then they need to be able to control their electricity consumption patterns in order to minimise costs. Sounds easy? Yes and no – remember what we said earlier about convenience?

Next, let's spend some time looking at...

The utility's needs

Utilities, not surprisingly, have rather different needs from their customers. We'll look at their specific technical needs in a moment, but, in the prevailing spirit of Batho Pele, let's first mention one or two of the softer issues:

- At the end of the day, the modern utility supplier needs to have its customers on its side. The days are gone (or very soon will be) when a take-it-or-leave-it attitude is acceptable. Effective marketing campaigns, promoting an image of innovation, being perceived as employing the latest technologies for the benefit of the consumer... these are vital components in the all-important public relations roadshow.
- Another of these touchy feely subjects is the question of access to consumer's premises. For various reasons this has become more and more difficult over the years and its not going to get easier any time soon – we really do need to evolve metering and load management solutions that require a bare minimum of utility-owned equipment to be installed on the consumer's premises.

From a financial perspective:

- As always, there's a constant need to keep down the cost of the solutions we implement. Here we really need to be talking overall solution costs – cradle-to-grave – and not just the spot price of an individual meter or load switch or one-year's software licensing fee.
- The preservation of investment is a very important requirement – we mentioned at the outset that utilities have been investing in prepaid metering and load management systems for many years now and while some of this older equipment has reached the end of its economic life and is due for replacement, it is essential that this be done in an economically sustainable fashion. New systems and equipment must be specified to be (at the very least) able to coexist with the old and preferably to be fully backward-compatible. This applies to metering equipment, load (ripple) control units and to the supporting back-office infrastructure.

And now, at last, to some real technical requirements (at least, from an engineer's perspective):

- An obvious need is that a utility needs to be able to manage its loads: firstly, on a recurring/cyclic basis to ensure optimal utilisation of plant and to be able to derive best value from wholesale tariff structures which are inevitably based on maximum demand.
- And secondly, because reserve capacity is (and will continue to be) under pressure, there will be an ongoing need to be able to reduce load on an ad hoc basis whenever emergency conditions prevail.
- Last, but most certainly not least, there is an urgent need for help in the fight against energy theft. You've all heard the figures – electricity theft in South Africa is variously estimated at between 10 and 15 GWh per annum. This is totally unsustainable and must be vigorously tackled at all levels, not least at the meter.

Standardisation

Nowadays, standardisation plays a very significant role in determining how technologies evolve. The importance of international collaboration on open global standards can be summarised in terms of the following:

- *Coexistence:* Our equipment is going to have to co-exist comfortably with a plethora of multi-part consumer-purchased equipment in the domestic environment. Home automation and personal energy management are just two of the buzz phrases that we'll be hearing a lot more of in the future. Already taking off in the United States and in Europe – it won't be long before these products are ubiquitous here in South Africa.
- *Compatibility:* With existing investment – we mentioned this important requirement a little earlier. Assuring compatibility

between old and new requires the relevant framework for standardisation to be in place.

- *Interoperability*: AMM systems of the future will inevitably comprise components from multiple sources and it is clear that these all need to operate together, synergistically, in order for the overall system to function successfully.
- *Conformance assurance*: This is actually slightly different from the process of standardisation itself, but none the less important in its role in aiding the successful integration of large (or not so large) complex systems.

Two additional drivers for standardisation in these areas are:

- The very important legal framework for our activities – especially when we're talking about such sensitive issues as load management (under exactly what circumstances may you interrupt supply to a consumer?), metrology and revenue management – is very much easier to set up (and maintain) with the relevant standards firmly in place.
- And a related topic: the consumer's right to equal treatment. DME regulations published in September 2008 require categories of domestic consumers to be treated differently, depending on their level of monthly consumption. There's a debate (we won't go into it here) as to exactly what "equality" means in this context, but whichever way it pans out, standards form a crucial element in ensuring that fairness can prevail.

Whilst on the topic of standardisation, how will the technical developments that we're talking about affect, or be affected by, the Standard Transfer Specification as it stands and any enhancements to it? My own view (and I hasten to add that this is my personal opinion and does not necessarily align with that of the board of directors of the STS Association, nor of the STS Association as a whole) is that developments will be driven by the needs of the industry in such a way as to remain fully compatible with the STS as it stands. The speed with which the Standard Transfer Specification evolves formally to keep up with, and support, these developments will depend entirely on the amount of effort that our industry as a whole (not only the manufacturers, but the users as well) is prepared to commit to this task. Standardisation is not cheap – we all stand to benefit by it and we should all share the responsibility of ensuring that the work is done timeously.

Technology and solutions

So, we've looked at some of the drivers in our present situation – what new and improved prepaid and load management technologies and solutions can we expect to see emerging over the next couple of years?

Firstly, AMI, STS (conventional prepaid) and LMS technologies are already converging into utility-defined advanced multipart systems, and this trend will most certainly continue in the future. Here at home we've recently seen the publication of NRS 049 which includes requirements for all three of these elements.

Multipart systems, starting with the simple "split meter", have been around for several years now and, even in their most basic form, are becoming increasingly popular for their proven abilities in countering the challenge of electricity theft. An important feature, in the light of something we said earlier, is that these systems eliminate the need for "home invasions" for auditing purposes.

Advanced multipart metering systems, with upstream communications abilities, are starting to appear in the field and the fact that the IEC has mandated the development of standards for multipart systems (IEC62055-32) is indicative of a significant interest and awareness in the marketplace.

Generally, when we talk about AMI and the future of smart metering systems, we automatically take bi-directional communication (between back-office and meter) as a given. This is certainly true in the case of full-blown AMI "smart metering systems", but not necessarily so in some simpler scenarios. It is quite feasible to add some extremely useful "advanced" functionality to a simple (unidirectional) prepaid system without the expense and complication of adding a back-channel communications infrastructure. Some of our local Metros have recently been doing some very interesting work in drawing up preliminary specifications for just such a system and I believe we can expect to see some significant developments in this area in the months ahead.

The concept of subscribed service levels may be worthy of consideration. Here the consumer chooses what level of service he wants and can afford to pay for. As an example (there are many possible variations on this theme) a premium ("always-on") tariff would be more expensive than a standard (subject to load shedding during emergencies) tariff which, in turn, would be more expensive than a basic tariff (subject to a regular load reduction program, in addition to emergency load shedding).

Load management functionality can be considered in several variations:

- It can be centralised, as in traditional "ripple control" applications for the switching of geysers, street lighting etc. But now that our meters are all microprocessor-based, there's no technical reason why they couldn't also detect and react on these broadcast signals for some additional, more innovative, purposes – think tariff switching, clock synchronisation, etc.
- Load management could also be implemented in a distributed fashion where, for example, local area controllers in street kiosks might autonomously control load switches on the consumer's premises, or dynamically adjust the load limit in his meter.
- Consumer-owned load switches, perhaps available in different categories and paired with the meter or a local area controller, used in conjunction with a subscribed service level scheme as described above, would enable the consumer to adapt his load profile to suit his lifestyle (and his pocket).

The ability for a utility to remotely disconnect /reconnect a consumer is an obvious enhancement to include in any simple AMI system, but another, perhaps less obvious, feature would be the ability to switch the operating mode of a domestic meter from prepaid to credit metering or into "energy limiting mode" – in fact this feature is already available in certain meters available locally.

We briefly mentioned (two-way) communications technologies earlier: these range from non-realtime systems, using physical tokens based on smartcard or RFID technology, to realtime PLC (powerline carrier) technologies using narrow- or broad-band techniques, and of course a whole gamut of rf-based solutions (Zigbee, Bluetooth, Wi-Fi, GPRS...). There's work going on, as we speak, in all of these areas and no doubt in the long run some favourites will emerge. There's also a good argument to be made that there's no one-size-fits-all solution and that the ultimate system will require a multiplicity of communication techniques. Right now I would simply urge you to be cautious and bear in mind particularly the coexistence issues that we highlighted earlier.

Trusted partnerships

Here's one final suggestion as to something that we're likely to see a lot more of in the next few years. We've seen how complex the challenges are in our industry, we know how sophisticated our utilities have become in their attitudes to their business and I can assure you that our suppliers are just as committed to developing truly innovative and effective solutions for the benefit of all. But how do we bring all of this creative energy together most effectively?

My proposal is that we should be giving serious consideration to the concept of trusted partnership between customers and their suppliers.

What does this concept of a trusted partnership really mean? Is it a pretty euphemism for a monopoly or a lock-in, an excuse for bribery and corruption, or is there something more to it?

What we're talking about is a situation where supplier companies aspire to become reliable collaborators with their clients, so that the clients look to them for advice and dialogue about issues of common concern. Here the focus is less on achieving immediate sales and more at ensuring that a firm's products and services will receive positive consideration when the time comes to make decisions about purchases.

Importantly, this doesn't need to happen in an exclusive, anticompetitive or monopolistic way. The current EDF / ERDF AMM pilot project in France is a good example. Here the customer has teamed up in a trusted partnership with three major meter suppliers and an I.T. facilitator to roll out a 300 000 meter AMM pilot project. The main project rollout, expected to run for a period of five years commencing in 2012, will involve a total of 35-million smart meters, installed at rates of up to 35 000 meters per day! All of the players stand to benefit "materially" from this project and all will undoubtedly gain invaluable experience from their involvement.

Conclusion

Traditional load management and prepaid metering systems in South Africa have a long history and considerable investment behind them, but the electrical generation and distribution scenario today looks vastly different from what it did just a few short years ago.

Nowadays consumers have rights (Batho Pele!), they need to be able to understand their consumption patterns and control them with minimal impact on their lifestyle.

Utilities, on the other hand, need to be able to effectively manage their loads and reduce opportunities for electricity theft, while keeping total lifecycle costs down, preserving the value of their existing investments and recognising the importance of ongoing standardisation activities.

Likely (in some cases even definite) developments over the next few years include advanced multipart systems with upstream communications ability. Also, low-end AMI systems with a useful array of additional capabilities, but still based on unidirectional upstream communications.

The concept of subscribed service levels may very well gain ground, in conjunction with a variety of integrated load management methodologies.

Communications technologies are constantly evolving, but the jury is still out on which will turn out to be optimal in these environments in the long run.

And finally, given the complexity of these challenges, perhaps we need to give serious consideration to the concept, well recognised elsewhere in the world, of trusted partnerships between customers and suppliers.

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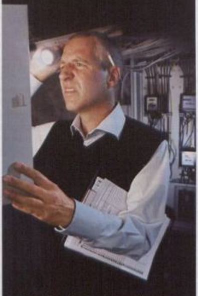

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Cinterion Wireless Modules is the world's leading producer of GSM/GPRS/UMTS/HSPA modules for machine-to-machine communication and is a preferred supplier to multinational automated meter reading (AMR) vendors. These modules are integrated into meters or terminals in order to automatically send metering data to service provider data centres.

Cinterion modules are used in electricity, gas, water and heat applications. In residential AMR solutions, modules are either in the meter for point-to-point GPRS connections or in the data concentrator, collecting the data from the metering end points and sending it to the information centre via GPRS.

In general, three major types of communication technologies are used in AMR installations: Proprietary RF solutions, Power Line Communications (PLC) and GSM/GPRS. Originally, the first GSM applications were industrial and commercial meter reading. In recent years, more and more residential AMR solutions using GPRS have been installed. Should real-time, bi-directional and future-proof communication be required, GPRS is the best option. It is the most widespread and cost effective solution due to the fact that GSM/GPRS is a global technology. With internet protocol capabilities to the remote device, the AMR market has evolved to include demand-side-management, smart metering capabilities and end-user home automation possibilities.

While proprietary RF solutions, due to various inherent disadvantages, are losing market share, PLC and GSM/GPRS/UMTS solutions are gaining and are often used together within one project.

The choice of technology for a utility or turnkey solution provider will depend primarily on the requirements (e.g. transmission speed, reliability of the communication lines, bidirectional communication, future proof technology etc.), network configuration (is point-to-point connection needed, does the PLC network support wireless integration), total cost of ownership and in the end on local legislation. Depending on these factors, a utility would either choose one technology or a mix of technologies within one local distribution area.

Pure PLC and RF technologies are mainly used in dense urban areas where the purpose is a simple readout of household metering data, usually once a month for billing purposes. In rural areas, where there are only few metering points connected to one transformer, PLC would be too expensive due to the high price of the PLC concentrator per transformer station. In many cases a GSM/GPRS device is used at the concentrator to communicate wirelessly to the data centre.

Comparing industries using GSM modules, metering is one with the highest requirements in terms of quality, longevity and reliability. Only OEM automotive solutions have similar requirements regarding ruggedness, thermal range and electro-static protection. The cost of failure in a metering solution is much higher than, for example, in a consumer device like a router, because a specialist will need to physically drive to the meter and exchange the whole meter in case of failure. Therefore the selection of a best-in-class communication product, like a Cinterion Wireless Module, is a key project decision.

Another important product selection decision is "ease of integration", which means that a wireless module customer should be able to integrate the GSM module easily into their AMR application. Cinterion is very well positioned here and offers a global support organization with a local support presence in 20 countries in order to support customers during this critical design-in process to improve their time to market.

About Cinterion Wireless Modules

Cinterion Wireless Modules is the worldwide leading supplier of cellular machine-to-machine (M2M) communication modules and combines unparalleled M2M engineering expertise and localized worldwide customer support with a strong portfolio of high-quality GSM, GPRS, EDGE, UMTS and HSPA products. Cinterion is a reliable partner and valued by many vertical market customers for its award-winning modules which enable machines, equipment and vehicles to communicate over wireless networks helping enterprises dramatically cut costs and increase productivity and efficiency. Cinterion products are carrier and FTA approved and used for industries including remote maintenance and control; metering; payment systems; industrial PDAs; routers and gateways; security systems; health care; automotive and eToll; tracking and tracing; environmental monitoring and more. The firm's global headquarters are in Munich, Germany with sales and support offices in local markets around the world.

The Cinterion Evolution Platform

The Evolution Products offer scalability, compatibility as well as an easy path to future upgrades and added functionality as technology needs expand. Portfolio benefits include maximum flexibility, high functionality, ease of integration, as well as backward and forward compatibility, which ensures a reliable, high quality and cost efficient solution that preserves the technology investment.

Power quality portal — a practical web based PQ management system

This paper analyses the current state of the South African Electricity Supply Industry (ESI) to motivate the importance of managing PQ on a daily basis. Different PQ management role-players are then identified and their PQ management strategies discussed to derive the user requirement of a Southern African power quality monitoring system.

by Willie van Wyk, CT Lab

The paper then introduces a practical strategy on how to manage PQ Incidents and voltage waveform quality parameters, as well as the main features of a web-based PQ Management System. Eskom was founded in 1923 by the government of South Africa in terms of the Electricity Act (1922). The widespread proliferation of electrical infrastructure and an interconnected network comprising generation, transmission and distribution followed during the next four to five decades. The South African Electricity Supply Industry (ESI) is therefore relatively young but simultaneously contending with distribution equipment that is relatively old in terms of life expectancy, as it has never been replaced in some networks.

Unique operating conditions exists in South Africa:

- Eskom recently had to resort to load shedding to attain safe operating margins in meeting demand levels which cause, amongst others, additional electrical stresses in ageing equipment and switchgear.
- Modern loads are much more complex than the traditional loads these networks were designed for. Non-linear loading is growing commensurately with the higher power levels being controllable by solid-state technology.
- The Power Conservation Programme (PCP) caused a new emphasis on energy saving measures to be implemented by both the supply and user industry.

We now play a new game – who is watching?

Voltage magnitude (for one) is an important PQ parameter in an ageing power system due to its known impact on equipment availability. Risk management is further complicated as the ESI is experiencing a world shortage of distribution equipment resulting in long lead-times and excessive prices.

Limited visibility exists on the impact of poor quality and the importance of PQ management is therefore not recognised by most utility managers .

A minimum standard in the quality of supply (QoS) at all times at the output of every primary transformer in a distribution network will optimise the availability of distribution (and end-user) equipment. For example, distribution equipment already accounted for in terms of capital value represents an excellent opportunity to maximise return-on-investment (ROI) values by means of extending the useful service life as far as possible. The latter requires that the energy converted by these transformers be of better quality than minimum compatibility levels.

Good quality electricity is therefore as important to equipment as proper maintenance!

Many South African utilities have limited SCADA functionality in the support of power system operation. Valuable power system operational information is available from a PQ monitoring system if proper systems engineering practises are employed. These PQ monitoring systems are not as capital intensive as SCADA systems, are easy to install and easy to operate.

PQ monitoring will never replace SCADA systems, but it does provide a low cost alternative where SCADA systems are not in place.

PQ management strategies

The Southern African ESI can be divided into different categories. Each category has adopted its own strategy on how to manage PQ.

Regulators

Electrical energy is recognised as a major role-player in sustaining economic activities and stimulating new growth in a developing country/region such as South Africa. The role of the energy regulator is of strategic importance to these issues as it has to evaluate

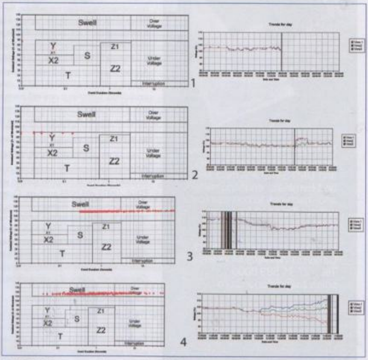

Fig. 1: Daily 10 min voltages for sites involved in high event count incidents.

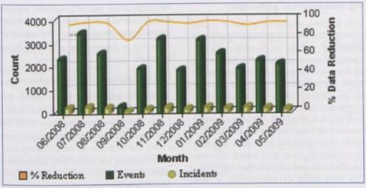

Fig. 2: Number of events and incidents per month, as well as the data reduction obtained by matching events to incidents.

the performance of role-players in the ESI and use the results in the formulation of policies to incentivise (or penalise) the ESI to achieve its desired national goals.

The electricity regulator traditionally requires annual submission of PQ statistics by licensees. This information is to be used in benchmarking the performance of licensees and to define characteristic values in PQ parameters on a national, regional and network-specific basis. Evidence thereof is not readily available.

To generate PQ performance information of practical value to business processes of licensees is not straightforward. The extent of the science and technology required to translate PQ data as recorded to useful information is easily underestimated.

It is first necessary to recognise that PQ data as obtained from field recordings is not press-ready.

Steady state network operating conditions can mask the 'true' PQ performance of a licensee. Practical examples are shown in [1]. Voltage regulation (for one) can affect the recording of sags and swells at a site (set-point near a high or low value).

Other steady state operational conditions such as specific voltage unbalance conditions are also shown in Fig. 1 to cause the recording of numerous sags.

Recognising that the "traditional" root cause of sags is network faults and that of swells the switching of network equipment and lightning, the flagging of data requires attention. Data acceptance evaluation is required and agreed-upon methodologies requires research and standardisation in order to generate PQ information that can be used to benchmark licensees against a national, regional and network dependent norm.

Regulators do require raw time-stamped profile and event data from each licensee to properly evaluate and benchmark the PQ performance of each licensee and not the statistics as currently the case.

PQ performance information is internationally shown to be an important contributor to a self-regulating PQ environment and the regulator could play a major role in facilitating access to such information. Regulators have to analyse the recorded data with the goal to publish annual PQ benchmarking statistics, to compile characteristic values (sags, swells and waveform quality parameters). This should be done for different type of networks for example as function of voltage level and geographical location. The regulator could also, from a national perspective, benchmark the performance of different utilities and indentify trends in development.

The above can be regarded as core services to be expected from the energy regulator in the acknowledgement of their responsibility to the national economy which relies on electrical energy at acceptable compatibility levels. Expertise needed for this service can then be hosted at the regulator, which allow local authorities (especially those with tight budgets) to rather focus on daily business such as maintenance and operation of electrical networks.

The regulator will have to support the utilities though by some extent with education and training in the use of PQ statistics to ensure it is of practical value.

Eskom

Eskom collects PQ statistics per region from a network of remotely installed instruments, one has developed powerful in-house PQ reporting tools capable of compiling key performance indexes (KPIs) from the raw data. A PQ representative (expert) is appointed to oversee the management of PQ in each of their regions. PQ management is a well established function within Eskom and PQ information is readily available throughout the organisation. It must be noted that Eskom is unique in its ability to be self-sufficient in the Southern African region.

Regional utilities

Regional utilities like NamPower and Tanesco have installed PQ instrumentation at most of their load-centres. Although they do not require many instruments, they do require a high level of diagnostic information to allow them to assess the origin and root-cause of each incident.

Regional utilities are plagued with PQ incidents as networks are exposed over large geographical areas. Regional utilities will typically appoint one or two PQ experts to investigate and manage PQ throughout the organisation. Broadband communication infrastructure and a central PQ database are required to collect and process data from remotely installed instrumentation. This database could disseminate PQ information throughout the organisation and to key customers by utilising the Internet.

Metros

Most metros have a high voltage backbone with a few large primary transformers feeding each load-centre. A small number of permanently installed voltage quality instruments is required to monitor PQ and only a few roaming instruments is required to investigate complaints. Metros will typically appoint one or two PQ experts to investigate and manage PQ throughout the organisation.

Metros will experience a lower number of PQ incidents per month compared to regional utilities as they are located in a smaller geographical area. Communication infrastructure and a central PQ database are required to collect and process data from remotely installed instrumentation. This database could also disseminate PQ information throughout the organisation and to key customers by utilising the Internet.

Metros buy electrical energy from regional utilities which means that some PQ incidents could have an external origin. But, metros are both client and supplier. The PQ database must be capable of classifying the origin (internal or external) of a PQ incident and assign a root cause in order to actively manage PQ events. Transformers in metropolitan networks are in general loaded near rated capacity which means the cost associated to a PQ monitoring system is dwarfed by the revenue sustained by these primary transformers.

Smaller municipalities

Unlike metros, most transformers within smaller municipalities are loaded to a lesser degree. Smaller municipalities mostly do not have a dedicated PQ management function. In many cases the amount of internal incidents is small compared to the amount of incidents imported from the supply network for many smaller municipalities being located at the end of long exposed rural lines. An outsourced business model could further the access to the resources and expertise in PQ management found in the bigger utilities.

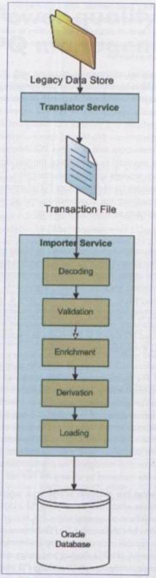

Fig. 3: Power quality portal.

End-users

Some end-users monitor both voltage and current of supply points and act upon an alarm if a deviation from the norm is detected. They can investigate and record the impact (technical and financial) of each PQ event. An annual report on the frequency, type of events and consequences will help to understand and identify sensitive equipment and possible mitigation procedures. A healthy relation between supplier and user is as a powerful PQ mitigation tool with less requirement on expensive PQ mitigation equipment to be installed locally.

PQ management philosophy

Little business integration of power quality management (PQM) is forthcoming amongst electrical utilities in Southern Africa. Restricted access to proper PQ information is the main reason. An integration of tools, procedures and people is required by an electrical utility to be operational in management of the quality of electrical energy. A web-based PQ management system can continuously disseminate PQ information extracted from data recorded at numerous sites distributed all over an electrical network in near real time. The time-value of information is thus exploitable.

Managing PQ incidents

Events simultaneously recorded by several instruments on the same network could be attributed to a common network incident. All measured events within a small time window are automatically assigned by the PQ portal to a single network incident.

The PQ engineer will have to investigate the origin, root cause and impact of each incident as and when it happens (on an ad hoc basis) regardless of its depth or duration.

The result should be visible throughout the organisation. Employees and managers must gain visibility on the impact of each incident to take corrective or preventative measures.

PQ incident management tool requirements

Recorded data has to be scrutinised for PQ events recorded within a pre-defined time window as it most possibly represent the same PQ incident. Detailed information on each incident must be made available in a reporting format in near real time. Alarms need to be raised to notify the engineer on occurrence of a network incident. PQ incident management tools must have the capability to report on and rank incidents according.

Managing trended PQ parameters

The NRS 048 documents define the limit and compatibility assessment methods for PQ parameters such as voltage regulation, THD and voltage unbalance. Each utility might have internal operational requirements for example in the lowering of the magnitude of voltage to residential customers to adjust the energy demand at specific times of the day.

The PQ engineer has to assess the 7-day sliding 95% CPF values on a daily basis to determine NRS 048 compliance and then to pro-actively implement corrective or preventative action.

Findings must again be made visible throughout the organisation to inform employees and managers on the impact of corrective or preventative actions (to learn from both mistakes and successes).

PQ trend management tool requirements

A daily PQ assessment report assists the engineer in identifying compliance issues. Subtle deviations from the norm must be identified. Visibility of these deviations assists the engineer in investigating and understanding the underlying parameters controlling the trends. Equipment adjustments and operational changes can be implemented to prevent exceedance of limits. Numerous reports on each parameter are required to assist the engineer to understand and identify the influence of different parameters on each other.

Power quality portal

Empowering people with appropriate tools and procedures in Power Quality Management by the creative application of modern technology is the goal of a web-based PQ Management system hosted at www.pq-portal.com. This virtual portal was developed to continuously disseminate PQ information extracted from data recorded at different sites in near real time. An overview of the automated services of this PQ portal follows below.

On-line communication network

Most of the management value of PQ information is lost if the data is not available in near real time. An on-line data retrieval system is required to accumulate recorded PQ data into a central database in near real time.

Importation of data

PQ data as obtained from field recordings is not press-ready. Normal operational criteria must be defined upfront and all data to be imported must be evaluated against pre-defined criteria before being accepted. For example, if a VT fuse is blown, one line voltage will be zero and voltage unbalance will be at 100% which is impossible for normal power system operation. The data importer will reject such data unless forced otherwise and motivated by the operator. By rejecting data according to pre-defined criteria representing normal operational conditions, the generation of false alarms and misleading statistics are minimised.

Enrichment of data

PQ Instruments store the minimum data to save disk space and to minimise data traffic between the instrument and the database. The database enriches the recorded data by additional information to be derived such as the voltage profiles in a % of the declared voltage. Another example is the derivation of three-phase power factor based on the recorded power per phase.

Calculation of daily 95% CPF values

The 7-day sliding 95% CPF values for each of the profiled parameters at the end of each 24 hour period is calculated from the recorded data and added to the database.

Grouping of events to incidents

The probability that more than one network incident occurs within a small time window is low. All PQ events as recorded at different instruments (and locations) and that have been time-stamped within a pre-defined time window are grouped together to indentify the occurrence of a network incident possibly causing these events. In the unlikely event of more than one (and different) incident automatically being grouped together, the operator has the ability to intervene and re-group. Incidents are classified according to two criteria:

- Origin of incident (internal, external or unknown
- Root cause of incident (lightning, equipment failure, theft, etc)

An alternative application of the NRS 048 scatter plot on sags and swells reveals powerful information on the nature of a PQ incident form a system perspective. Plotting all PQ events associated to a single PQ incident (regardless of voltage level) onto the same scatter diagram visually reveals the system impact. The penetration through the network is easily understood and the origin of the dip as being internal or external could be deducted (from voltage data only) with much more ease than studying each and every recorded event in detail which is more labour and experience intensive.

Generation of reports

The standard NRS 048 reports per recording site can be generated with a few mouse clicks and exported to various electronic formats. The PQ portal adds additional value in terms of informative reporting. Custom-made reports to support daily business processes, for example, is a mouse click away. A daily assessment report on the PQ performance of a pre-definable region is valuable in pro-active management of a power system. Not only PQ events that have occurred during the past 24 hours are extracted from the database, waveform quality parameters depicting compliancy to voltage magnitude, unbalance, distortion and flicker is valuable in the continuous

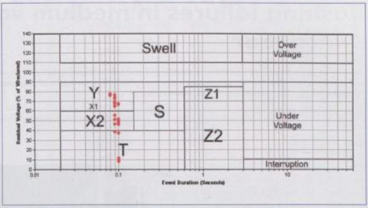

Fig. 4: Dip scatter plot showing visual fingerprint for dip source internal to utility's network.

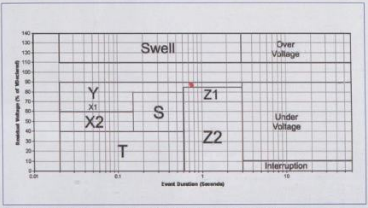

Fig. 5: Dip scatter plot showing visual fingerprint for dip source external to utility's network.

assessment of operational status of the power system under consideration.

PQ benchmarking

Benchmarking the PQ performance of sites against each other and against NRS 048 compatibility norm in terms of the power system as a whole, do not require a PQ expert as the expertise is already built into the PQ portal. Similarly, generation of the NRS 048 annual report that put a premium to the internal human and technical resources at a utility is a mouse click away.

Custom branding

The PQ web portal can host multiple Service Providers simultaneously. Each utility can request a unique URL that can be linked onto their existing website (e.g. www.pqportal.com/ekurhuleni). The top banner as well as the centre frame of this landing page is customisable. Public domain PQ information items such as the annual PQ report, the PQ charter, the NERSA dispute procedure and local contact details can be published on this site.

Conclusion

The management of PQ has become a priority in both supply and demand side markets. The economic benefits to be realised is significant, but is not widely recognised due to a lack of knowledge and leadership! PQ engineers and managers in South Africa are still inexperienced regarding the operation and implementation of PQ management programmes. Powerful tools are available, but proper training and ongoing mentorship from industry experts is mostly required.

References

[1] Johan Rens, "On the Development of a Power Quality Benchmarking Model", EPQU'09, September 2009, Poland.

[2] Tiaan Stander, Johan Rens," The Application of Modern Technology in Power Quality Management", EPQU'09, September 2009, Poland.

Bushing failures in medium voltage switchgear

The City of Cape Town has sustained a significant number of bushing failures in medium voltage switchgear, mostly effecting catastrophic damage to buildings and adjacent plant. The purpose of this paper is to share experiences regarding the causes of these failures and possible remedies.

by C van Heerden, City of Cape Town, and A Rogerson, EA Technology Services

With the expansion of SF6 and vacuum technology, manufacturers also replaced Bakelite paper bushings with resin cast bushings.

Advantages of resin cast technology would be:

- Better suited for mass production
- Superior fault toleration
- Scratch and mechanical damage resistant
- Cheaper

Contrary to the above, the City of Cape Town experience is that bakelite paper bushings outperform resin cast bushings by far.

Some manufacturers would redesign existing breakers to SF6 and resin cast technology to fit in the same panel as the previous generation oil breaker. The City of Cape Town utilises three models of SF6 MV switchgear rack in truck breakers from the same manufacturer, which are all interchangeable with previous generation oil breakers. A large number of bushing failures, mostly due to partial discharge activity across the surface of bushings, were experienced at least on two models of the same panel and manufacturer, while severe partial discharge activity, but no catastrophic failures on a third model of the same manufacturer.

Fig. 1: Langa Metrorail substation.

Fig. 2: Tygervalley Waterfront substation (Falls breaker) 2004. (Note the white phase bus bar side undamaged with different stages of degradation on other clusters and bushing.)

Fig. 3: Waterfront substation, Quarry breaker (Nov 05). (Note severe cluster damage.)

Some of the failures and observations made

Tygervalley waterfront

Some of the first recorded failures in the City of Cape Town were at the Tygervalley Waterfront substation. Staff entered the substation for switching operations. They experienced a strong smell of chlorine in the substation and on further investigation they found the "Falls" breaker with severe discharge degradation on bushing insulation and cluster contacts.

Santyger, Faasen and Junction

Bushing failures at Santyger, Faasen and Junction (see Figs. 5, 6 and 7) were in a similar fashion, at the earth screen layer within the resin of the insulation; the top of this screen being close to the vermin guard position.

five
things you need to know about
Partial Discharge activity

one
Partial Discharge (PD) activity is a factor in 85% of disruptive substation failures

two
Accurate measurement of PD in live assets identifies faults BEFORE they develop into FAILURES

three
PD data is the key to understanding the true condition of assets

four
Understanding condition is the key to more cost-effective asset management

five
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Fig. 4: Plaspack substation breaker failure.

Fig. 5: Bushing failure at Santyger substation.

Fig. 6: Bushing failure at Faasen substation.

Fig. 7: Bushing failure at Junction substation.

Fig. 8: Tracking, Southern sewing.

Fig. 9: Southern Sewing substation. (Note the severe degradation of insulators and cluster.)

Fig. 10: Bellaire blue phase busbar side bushing.

Fig. 11: Solway Orifice (female) bushing cut open in laboratory in England.

Fig. 12: Pores in Solway orifice bushing photographed in laboratory in England. (Note greasy appearance on breaker bushing; this is typical of nitric acid contamination.)

Fig. 13: Solway substation pores also visible beneath the skin of the resin photographed at laboratory in England.

Fig. 14: Solway substation, individual pore photographed in laboratory in England.

Fig. 15: Pores in Solway red phase bus bar bushing photographed at laboratory in England.

Fig. 16: Discharge between concertina boots.

Fig. 17: Discharge around breaker bushing due to misalignment of shutter boxes.

Fig. 18: Discharge around bushing due to misalgned shutter box – single bushing.

Fig. 19: Orifice bushing damaged by cluster.

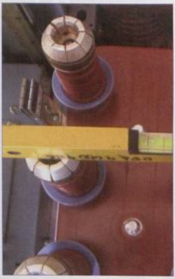


Fig. 20: Breaker supplied by manufacturer – misaligned on trolley.

Fig. 21: Misaligned shutter boxes, Cape substation.

Fig. 22: Discharge from shutter box to breaker top. Discharge corresponds to the shutter hinges from t he top of the breaker.

Fig. 23: Floor not level.

Fig. 24: Vermin guard. In many cases, degradation started between the breaker bushing and vermin guards.

Fig. 25: Solway (short) vermin guard showing shallow depth with extensive PD tracking which eroded through the guard.

Bellaire substation

The Bellaire blue phase busbar side breaker bushing was in the initial stages of PD damage and it can be clearly seen (see Fig. 10) that tracking was associated with the moulding seam line, similarly to most other cases.

Nqubulani substation

In Nqubulani Substation, there was discharge between the concertina boots (see Fig. 16.) These boots were originally fitted on request of the City of Cape Town to cover conductive parts, but are now retrofitted to solid shrouds, filled with compound, which provide a good airgap between phases.

Partial discharges: contributing factors of activity in breakers

Bushing design

Design must be ample. Safety factors must be built into bushing design.

The following must be taken into consideration:

- Environmental conditions and possible exceeding of expected conditions.
- Material used and possible quality variance of materials.
- Available skills to manufacture.
- Quality control during manufacture.
- Natural and industrial pollution.
- Maintenance skills available.

Effect of voids, pores and bubbles in moldings

Male and female bushings must be smooth and free of voids, bubbles and molding lines, each of which can create local regions of increased electrical stress thereby increasing the probability of PD activity.

Moisture

Humid air and especially droplets of moisture are exponentially contributory to the total PD activity in the bushing assembly. Moisture carried in air (humidity) modifies the dielectric properties of air, which in modern switchgear is a significant part of the insulation system. The reduced breakdown strength of the air increases the probability of partial discharge.

Most new switchgear panels are fitted with heaters ranging from 80 to 120 W, while some manufacturers specify panel heaters as optional.

The City of Cape Town monitored humidity over a 4-day period in the substations perceived to be the wettest. Substations monitored were within the specification of the manufacturer, although the manufacturer did not have a thorough specification.

Heaters are controversial as they can consume considerable amounts of energy. The City of Cape Town has 5497 MV protected breakers installed. If all panels are fitted with 100 W heaters, total yearly consumption will be 4 815 372 kWh. At the city's Medium Voltage Large Power Bulk Tariff, energy cost will be approximately R1,46-million per year, excluding VAT.

Heaters reduce the risk of condensation forming by increasing the temperature of the switchgear relative to the dew point of the air in the substation. As a result, heaters reduce the risk of condensation forming on the components they are warming. Dehumidifiers in a substation would reduce moisture content from the air and treat the whole environment and provide a more complete means of improving the electrical environment for the switchgear.

Where the substation environment is controlled with either heaters or dehumidifiers, it is important that this equipment is regularly checked during maintenance as there are known cases of heaters that tripped and catastrophic failures of breakers occurred within six months after installation.

Alignment of breaker or shutter box: shutter box design

Misalignment of breakers and shutter boxes may have following effects:

- Breaker bushings do not align with respective orifice bushings, resulting in an inconsistent electric field around the bushing due to irregular positioning of the shutter box apertures.
- Misaligned shutter boxes may have the same effect as the above.
- Misaligned breakers may also cause the orifice (female) bushing to be damaged and tracking may occur. These breakers may be dangerous to operate.
- Misalignment may lead to increased PD action within the cluster, but the exact contribution of this is not known.

Introduction of foreign objects – vermin guards

Silicon rubber vermin guards were added to seal the top part of the bushing assembly against vermin ingress.

These vermin guards could however add to discharge activity in the following ways:

- Proper adhesion between the silicon vermin guard resin breaker bushing is not achievable. As there are air gaps between the vermin guards and bushings, this will lead to increased PD activity.
- Dirt (surface contamination) is trapped between the poorly adhered vermin seal and the breaker bushing. This leads to increased PD activity in the area of the vermin seal.
- Adverse modification of the electric field in a region of potentially high stress.

Maintenance intervals and cleaning

Due to scarcity of skills, maintenance targets are very seldom achieved.

The introduction of gas insulated and vacuum technology with casing cast bushings created the expectation that maintenance intervals may be decreased.

NRS 089-3-2: 2005 (Draft) calls for a 5-yearly maintenance cycle for medium voltage SF6 switchgear. The manufacturer recommends a 1-yearly trip test and 5-yearly maintenance.

Recommended additional maintenance tasks are as follows:

- Yearly cleaning of breaker bushings when trip testing is done. Generally it is not recommended that cleaning solvents be used, but only when there are signs of PD tracking, a solution of sodium bicarbonate is recommended to clean off and neutralise possible acidic nitric acid, a possible by-product of PD activity on resin bushings.
- Monthly checking of heaters (with monthly inspection).

Cluster contact design

There may be increased PD activity within the air gaps in the cluster contacts. Changing to another model of cluster contacts may contribute to decreased PD activity at the cluster contacts.

Early detection of activity

Partial discharge is quite often audible when entering the substation and it is very often accompanied by a strong ozone smell, however sometimes neither of these is present. When the activity is this well developed it is of concern and significant access restrictions should be placed on that substation.

The City of Cape Town is currently using a handheld instrument, the Ultra TEV Plus, to detect and pinpoint partial discharges which may also be used for detecting PD discharges on transformer bushings, cable terminations, busbars, etc.

Similar equipment is available on the market.

If partial discharge activity is intermittent, recorders may be installed.

Permanently mounted discharge monitoring equipment may also be considered.

As a result, regular Ultrasonic and TEV PD survey with UltraTEV to determine the extent of PD activity within the switchgear should be carried out. This will identify issues significantly before they are failing and thus improve safety of staff required to work in the substation and also increase the reliability of the network due to reduced unplanned outages.

Partial discharge activity

Partial discharge is an electrical discharge or spark that bridges a portion of the insulation between two conducting electrodes.

Partial discharge can occur at any location within the insulation system (between the two electrodes) where the electric field strength exceeds the breakdown strength of that portion of the insulating material. Partial discharge can occur in voids within solid insulation, across the surface of insulating material due to contaminants or irregularities, within gas bubbles in liquid insulation or around an electrode in gas (corona activity).

Prominences or defects at conductor surfaces can lead to stress concentration. Partial discharge activity is a progressive mechanism in which an insulation system apparently operating within the intrinsic breakdown strength levels of the materials can progress to failure because of local concentration of the stress.

Voltage stress across insulation depends on the physical geometry and the relative electrical permittivity of the insulation components. Where components of differing permittivity are effectively in series, the stress will be higher across the components with lower permittivity. Gaseous gaps therefore tend to experience higher stress then the adjacent solid or liquid insulations. Small gaps are most susceptible to partial discharge activity.

The energy liberated at a partial discharge site will often degrade the insulation. It may form tree-like tracks through or over the surface of solid insulation. The tracks may be conductive, typically because of the presence of carbon from the degradation of the insulation, so that electrical stress is concentrated at the advancing tips of the trees. Partial discharge may occur in aged, defective or poor quality insulating and can propagate and develop until the insulation is unable to withstand the electrical stress leading to flashover and failure.

When partial discharge activity occurs, it emits energy in the following ways:

Electromagnetic : radio, light and heat.

Acoustic: audio and ultrasonic

Gaseous: ozone and nitrous oxides.

Conclusion

Most of the problems experienced are associated with partial discharge activity causing degradation across the surface of bushings.

Apart from possible design constraints, elevated moisture levels in substations are the greatest contributing factor to increased PD activity in the City of Cape Town case. Substations have to be dehumidified and/or panel heaters installed in all panels where breakers with resin bushings are used.

PD damaged bushings cannot be repaired.

During inspections, bushings with signs of partial discharge damage must be inspected, evaluated and replaced if necessary. It should be noted that partial discharge activity products may additionally be present on surrounding components. The use and function of vermin seals must be revisited. Alignment of breakers must be critically looked at. Damaged bushings must be replaced. Shutter boxes have to be realigned. On one particular model, the manufacturer is busy redesigning the shutter box altogether to provide increased clearance from the shutter box hinge to the top of the breaker and these shutter boxes have to replaced.

The maintenance frequency must be increased i.e. breakers must be racked out, inspected and cleaned at least once a year.

References

[1] Medium Voltage Switchgear Partial Discharge Investigation for The City Of Cape Town by A Rogerson of EA Technology Services.

[2] Paper on partial discharges by N Davies and A Rogerson of EA Technology Services.

South African Distribution Grid Code phase 2 implementation

This paper is a follow up and a rehash of the South African Distribution Code that was presented by NERSA in the 2007 AMEU convention held in Durban ICC. The presentation explained the approval of the South African Distribution Code by the energy regulator, as well as the phase 1 implementation process.

by Lucky Nhlanhla Ngidi, NERSA

This paper seeks to explain the details in the contents, purpose, management processes and compliance monitoring of the South African Distribution Code.

Originally the South African Grid Code was developed with a view that the South African Regional Electricity Distributors (REDs) will have come into place shortly, which amongst other things would make the regulation of the industry to be much more efficient and simpler. With the delay of REDs coming into place, NERSA had to review its regulatory strategies to suit the current industry environment. The Distribution Code is also driven by the need to ensure standard rules for participation in the electricity industry especially from independent power producers.

The South African Distribution Code development process took about 2 years, starting in June 2005, and the main participants were:

- NERSA – Chair.
- AMEU (main representation: Ekurhuleni, eThekwini and Cape Town).
- Energy Intensive User Group (EIUG)/ large customers.
- Department of Minerals and Energy (DME).
- Eskom (Distribution, Transmission and Generation).
- System operator (also secretariat).
- Independent power producers (Kelvin Power station).

In June 2007 the Grid Code Advisory Committee (GCAC) proposed the South African Distribution Code for the energy regulator to consider for approval. In August 2007 the final version 5.1 was approved by the energy regulator with the view of including it to the appropriate licenses as a license condition. Upon approval of the code, NERSA decided that implementation should be done in a phased approach, taking into consideration the dynamics of how the electricity distribution industry is, including:

- The high number of licensees being regulated (about 187 including Eskom).
- The differences in sizes of the licenses in terms of installed capacity, financial and human resources.

NERSA also agreed with the GCAC that the first phase of the Distribution Grid Code implementation will involve the licensees with the installed capacity greater or equal to 100 MVA.

The first phase implementation was workshopped with the licensees affected by the NERSA decision of the phased approach. The workshopping process started late in 2007, with a presentation at the AMEU conference until mid 2008. Phase 1 approach was two-fold. The first step was that each licensee will be given 12 months to make preparations during this period to ensure compliance with the requirements of the code. That included:

- Critical review and understanding of the code requirements.
- Assess areas where there is non-compliance such that a licensee can apply for temporary exemptions where necessary.
- Assess where amendments to the code may be necessary.
- Assess areas where there will be a need to apply for derogations.
- Follow the appropriate process (Governance Code of Grid Code) to apply for amendments or exemptions.

The second step is that on 18 November 2009 the Electricity Distribution Licenses will be amended to include the Distribution Grid Code as a condition to be complied with.

The observations from the regulator's point of view since the beginning of phase 1 were:

- There has been minimal or no response from the industry with regard to the process.

Because of this observation the energy regulator felt that this process needs to be rehashed and communicated properly in order to refresh the industry and alert them once again about the implementation process of this code.

Background

The main drivers of these initiatives were 1998 Energy White Paper & Electricity Regulation Act (2006) which required electricity supply industry reform in South Africa and introduction of independent power producers, regional electricity distributors and wholesale energy trading market.

Currently Transmission and Distribution Codes design attempt to achieve the vision of the 1998 Energy White Paper. NERSA remains the codes administrative authority as required by the Electricity Regulation Act with the right to develop and enforce electricity industry codes and approve all changes and exemptions to the codes.

The Distribution Grid Code objective

The Distribution Grid Code is an industry code of practice that defines detailed conditions for access to and use of the distribution system including basic rules, procedures and requirements that govern the operation and maintenance of the distribution system. The Distribution Grid Code will form part of the licensing conditions of the distribution network service providers. The restructuring of the electricity supply industry in South Africa will present significant challenges pertaining to the operation, planning and maintenance of the distribution system. The Distribution Grid Code is also intended to define the technical aspects of the distribution system which the Distributors and other users of the distribution system should comply with.

Mainly the Distribution Grid Code establishes reciprocal obligations of participants regarding the use, development and operation of the distribution system (DS)

It ensures:

- Non-discriminatory access to the distribution system.
- Adherence to minimum technical requirements for connection to the distribution system.
- Distribution system integrity and adequate service delivery.
- Clarifies accountabilities of all parties.
- Information availability.

The benefits that the code will have to the industry are:

- Provides a stable platform for the evolving ESI.
- For example, introduction of REDs and independent power producers.
- Sets foundations for future contractual arrangements.

- Improved efficiency and transparency of service providers.
- Harmonisation of industry standards.
- Improved regulatory measures.

The Distribution Grid Code needs to be updated through regular amendments to incorporate industry development and improved practices. Furthermore the required exemptions, derogations and amendments need to be administered. The future intention is to incorporate the distribution conditions into the South African Grid Code in order to have one grid code for distribution, transmission and generation.

The grid code for transmission (Tx) vs Distribution (Dx) code participants:

The codes under the distribution code are:

- Glossary of definitions – preamble
- Distribution network code
- Distribution system operating code
- Distribution metering code
- Distribution tariff code
- Distribution Info exchange code
- Code governance
- GCAC decided that current Tx governance code process shall apply but the governance code of the Distribution Grid Code is currently in draft stages

These codes can be downloaded on the NERSA website at www.nersa.org.za , select Electricity on the homepage then download the codes under compliance monitoring. The NERSA website is currently undergoing a revamp so that it can be much easier to find the codes, standards and other related documents.

Governance code

The governance code describes the provisions necessary for the overall administration and review of the various aspects of the distribution code. This code shall be read in conjunction with the relevant legislation, the licenses issued to generators, transmission companies and distributors and other NERSA adopted codes of conduct that relate to the electricity supply industry (ESI).

The accountabilities of various entities in the governance of the distribution code are sketched in Fig. 2.

Distribution Grid Code amendment, derogation or exemption procedure

NERSA is the approval authority for the distribution code. Any amendments to, derogation to or exemptions from the distribution code shall therefore be approved only by NERSA as guided by the GCAC.

Any participant, member of the GCAC or NERSA may propose amendments to the distribution code.

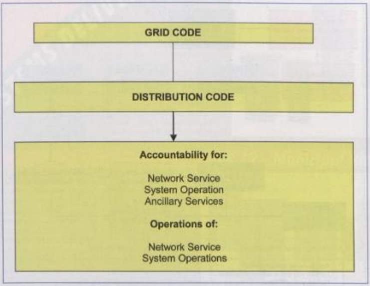


Fig. 1: Describes the structure of the South African Electricity Industry Codes of practice content.

NERSA	Approval & Governance
Grid Code Advisory Committee	Recommendation
Expert Teams	Expert opinion
Grid Code Secretariat	Administration
Service providers	Implementation
Expert Drafters	Expert drafting

Fig. 2: Grid code: assigned accountabilities.

Any participant can apply for an exemption or derogation to the distribution code requirement. Exemption and derogation from complying with provisions of the distribution code may be granted by NERSA for the following reasons:

- To provide for existing equipment that has not been designed with consideration for the provisions of the distribution code.
- To facilitate transition through interim arrangements.
- To facilitate temporary conditions necessitating exemption.

All exemption applications should clearly indicate the following:

- The reason for the non-compliance.
- The current capability (even if this is less than what the code specifies).
- The duration of the exemptions.
- Action plan put in place to fix the non-compliance.
- Any other information that can be used to justify why the exemption should be granted.
- With the application, a project plan to address the non compliance will be required.

All derogation applications should clearly state the following:

- The reason for the non-compliance.
- The current capability (even if this is less than what the code specifies).
- The suspensive condition upon which the validity and the duration of the derogation depends.
- Any other information that can be used to justify why the derogation should be granted.
- With the application, a project plan to address the non compliance will be required.

All amendment applications should clearly state the following:

- The current clause to be amended.
- Proposed changes.

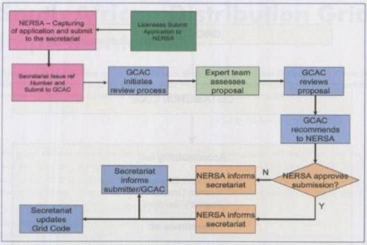


Fig. 3: Distribution code amendment/exemption and derogation approval process.

- Acknowledge receipt thereof
- Furnish you with a reference number
- Furnish you with the name / names and contact details of the personnel dealing therewith
- Advise the applicant on the duration after which they can expect feedback

Applications/ Draft Proposals shall be sent to: Attention Electricity Regulatory Reform Department

Post to:	**Or Hand Deliver to:**	**Or Contact**
National Energy Regulator of South Africa P. O Box 40343 Arcadia Pretoria 0007	526 Vermeulen Street Arcadia Pretoria 0007	Lucky Nhlanhla Ngidi Tel: 012 401 4716 Fax: 012 401 4700 Cell: 083 499 1999 lucky.ngidi@nersa.org.za or Simphiwe Makhathini Tel: 012 401 4776 or 0832569139 Simphiwe.makhathini@nersa.org.za

Fig 4: Address details.

RSA DISTRIBUTION GRID CODE AMENDMENTS FORM

Submitter's name	
Organization represented	ESKOM
Date of submission	29 July 2008
Section of the Code to be amended (Network, Metering etc.)	Network
Reference number (to be issued by Grid Code secretariat)	GCAM008/005 Rev 2 This version include: • Outcome of IET Meeting held on 29 Oct 2008 • Outcome of the GCAC Meeting held on 14th May 2009

GENERAL AMENDMENTS

SPECIFIC AMENDMENTS

Clause	*Current Statement*	*Proposed Changes*	*Reason for change*
5.1.5 Transmission busbar protection			

Fig 5: A typical example of an application for an amendment of the standard form.

- The reason why the code should be amended.
- Any other information that can be used to justify why the code amendment is necessary.

The procedure for amendment, exemption or derogation is sketched in Fig. 3.

Fig. 3 outlines the manner in which the applications for amendments, exemptions and derogations should be done by the industry as well as the approval process.

A formal cover letter indicating the clauses that maybe affected on the code is required to accompany the standard form that is used to apply for amendments, exemptions or derogations. This form can also be downloaded on the NERSA website or made available at the applicant's request.

Glossary of definitions

This document contains all terms, acronyms and list of standards used in the Dx code for the industry's reference

Distribution Network Code

This code describes the following:

- Procedure/process for new connections (incl. sample application form).
- Set out the responsibilities of all parties regarding use and development of the distribution networks.
- Included some embedded generation connection requirements.

Distributors' responsibilities prescribed on this code are:

- Prepare "customer connection information guide".
- Upon customer request, prepare offer to connect and ultimately connection agreement.
- Advise potential users of the expected reliability on its network.
- Conduct "distribution system impact assessment studies".
- Compile a 10-year load forecast at each Dx incoming point of supply.
- Publish 5-year network development plan reviewed at least every 3 years.
- Comply with reliability indices set annually by NERSA.

Network investment:

- Least life-cycle cost investment criteria in line with NRS 048 & NERSA reliability requirements.
- Premium connection costs shall be borne by the requesting customer.
- Statutory investments will be based on predetermined criteria. Government requests to be considered if passed by legislature.
- No cross-border subsidies shall apply for international customers.
- Refurbishment to be done by the distributor when equipment becomes unsafe and/ or unreliable to operate. Conditions: customer must also agree to the timing, and engineering solution to minimise costs of both customer and distributor.
- Provision and costs for excluded services shall be negotiated between the parties.
- NERSA reserves the right to regulate these costs if unreasonable.
- Embedded generation requirements included in sec 8.
- EGs >10 MVA must also comply with requirements of the grid code

Distribution System Operating Code

Defines roles of parties regarding operating of the DS and connected customer equipment.

It promotes having negotiated agreements between parties regarding network operating.

Scope:

- Safety of personnel and equipment.
- Operational responsibilities of embedded generators and other customers.
- Coordination of outages and commissioning.
- Dx has right to test customer equipment at point of connection.
- Contingency planning.
- Operational authority, procedures, liaison with other participants and communication requirements.
- Conditions for disconnecting customers (mainly for safety related reasons).
- May shed load to maintain network integrity, but customers must be informed (for planned maintenance, 5 days in advance).

Distribution Metering Code

Scope:

- Specify distributors requirements with respect to metering installations.
- Extensive reference to NRS 057, but Dx code takes preferenc.
- Tx/Dx boundary meters is the responsibility of transmission.
- Dx/customer meters is the responsibility of distributors.
- Metering data validation, collection, processing and verification shall be done as per NRS 057.
- Clarify metering data integrity and storage requirements.
- Automated meter reading is recommended for large customers.
- *Confidentiality:* Metering data to be regarded as confidential but may not be unreasonably refused if customer requests it.
- Also include dispute resolution process.

Distribution Tariff Code

The code describes:

- Principles for the determination of tariffs.
- Segmentation of costs for tariff design purposes.
- Tariff design for international load customers.
- Recovery of subsidies and other levies using tariff structures.
- Connection charges principles (standard and premium).

Included allowable charges:

- Energy charges including recovery of losses.
- Network charges, including ancillary services.
- Customer services charges.

05 September 2008

Mr XXXX
Company
Tel: +27 21
Fax: +27 21

NERSA ADRESS

Dear Sir

IPS 0010/08
APPLICATION FOR AN EXEMPTION FROM COMPLYING WITH PROVISIONS OF THE SA GRID CODE: ALL KOEBERG UNITS
TYPE OF EXEMPTION REQUESTED
Permanent
REQUESTED DEADLINE TO COMPLY (IF TEMPORARY EXEMPTION ONLY)
Permanent
TYPE OF CODE
Network Code
CLAUSE
3.1.7 Restart after power station black-out
CLAUSE DESCRIPTION
3.1.7 Restart after power station black-out
SUB-CLAUSE, BULLET - DESCRIPTION/REQUIREMENT
XXXXX
REASON/EXPLANATION OF NON-COMPLIANCE
XXXXXX
REMEDIAL ACTION TO UNDERTAKE (IN ORDER TO COMPLY)

Fig. 6: Typical example on the application of exemption or derogation.

- Connection charges.
- Tariff have to be as cost-reflective as possible.
- Non-tariff costs (excluded services costs) have to be shown separately and may be regulated.
- Appendix 1 – guideline to designing tariffs.

Distribution Info Exchange Code

- Objective: reciprocal obligations of parties with respect to provision of information.
- General principle: mutual agreement between parties.
- Information divided into 3 types: Planning info (e.g. info for connection and contingency planning;) operational info (e.g. real-time dispatch, maintenance and commissioning); and post-dispatch (e.g. incident investigations).
- Each party to appoint information owner to facilitate info exchange
- Data storage, security and archiving requirements: All information should be auditable by NERSA. Storage: 3 months for voice recorders, except where there was an incident. Storage: 5 years all other information except voice information
- Confidentiality requirement: information exchanged is non-confidential unless indicated by the owner

Phase 1 implementation process – what has happenend?

NERSA workshopped the code to the distributors with max demand >100 MVA

Extension to current license obligations initially distributors with max demand > 100 MVA – to occur in November 2009

Phased in approach over 12 months (trial) period:

- Month 1 – 6 distributors were given an opportunity to do self compliance assessment.
- Month 7 – 12 distributors required to inform NERSA of compliance status – minimal feedback. Apply for exemptions and amendments (via Code Secretariat through NERSA) – minimal feedback. Including interpretation requirements – minimal feedback
- Month 12 full implementation, licenses amended to include the code and parties expected to be fully compliant. If no exemption, non-compliant (penalty clause in the Act) – ongoing. NERSA to conduct adhoc compliance audits – ongoing.

Phase 2 implementation plan – what is going to happen next?

NERSA to start workshopping the code to the distributors with max demand 50 MVA>100 MVA – to commence in November 2009.

Extension to current license obligations secondly to distributors with max demand 50 MVA>100 MVA.

Phased in approach over 12 months (trial) period:

- Month 1 – 6 distributors will be given an opportunity to do self compliance assessment.
- Month 7 – 12 distributors required to Inform NERSA of compliance status. Apply for exemptions and amendments (via Code Secretariat through NERSA)
- Month 12 full implementation, licenses amended to include the code and parties expected to be fully compliant. If no exemption, non-compliant (penalty clause in the Act). NERSA to conduct adhoc compliance audits.

International best practice for compliance assurance on the codes and standards

Compliance framework

Most of the regulators have fully developed compliance frameworks in place. These are used mostly to conduct compliance monitoring and enforcement to the industry. This is normally done by conducting audits which would have questionnaires for both the actual business as well as site audits. The frameworks are normally open for public and industry's access. The first step to industry self compliance assurance is to align itself with these frameworks and be pro active in terms of trying to align these frameworks with the environment in which their utilities are run. Because of the research that goes into the development of these compliance frameworks, this exercise can assist the licensees to also align themselves with the best business practices to ensure that they are aware of the status quo of their utilities in terms of compliance.

The observation is that there is minimal pro activeness in the industry in terms of self monitoring to comply with the rules and regulations before the regulator's adhoc compliance audits. In most cases when regulators are conducting these audits, they do not get the full picture of the condition or status quo of the utility. This maybe because of time constraints in terms site audits, when they are done they do not cover the whole utility infrastructure. This results in reports that do not appropriately or completely reflect the true utility picture with respect to its operations. This signifies the importance of self assessment by utilities and proper information sharing with the regulator.

The licensees need to ensure that they conduct self assessment using the regulatory frameworks at their disposal. This can help the licensees in knowing exactly what is happening in their businesses in terms of the finances, quality of supply and service as well their infrastructure asset condition and management.

The industry needs to remember that complying with industry codes and standards, is for the good of their business and not the regulator and lastly for them to be able to run their utilities in a professional and efficient manner.

Work group and work streams formation

To ensure efficient and effective self assessments it is highly recommended that the licensees form internal expert work groups which can be broken down into different work streams with clear terms of reference on the self assessment. Following the formation of the work group, it is recommended that the following be done:

- Delegate tasks to each work stream depending on their expertise i.e. a certain code that they will be analysing to understand and then produce a work plan on how the contents of the code will be monitored and implemented in the business and the infrastructure
- Each work stream has to fully understand the requirements in the code and produce a self monitoring framework using the code as a reference
- After the self monitoring framework is done, execute the plan in the framework by:
  - Conducting self audits.
  - Produce reports with the findings.
  - Compile the action plan report to address identified non compliances.
  - Compile the execution plan of addressing the non compliances.
  - Where possible draft the possible amendments and exemptions that might be needed as per Governance Code requirements.

After all this has been done, it is recommended that an internal committee or body that will monitor the action plan based on the findings of the work streams reports is formed.

Conclusion

It is very clear that, for the energy regulator to regulate efficiently and in a manner that will be beneficial to all parties in the end, the regulator will need adequate cooperation of the industry. The manner in which the industry is structured currently poses challenges for the regulator to perform its mandate efficiently, there are more than 200 licensees that need to be regulated by just one regulatory body. This also brings a point of a need to accelerate the process of the formation of the regional electricity distributors. The research and future industry structure plans shows that regulating 6 distribution entities, generation and transmission will prove to be more efficient.

Challenges of providing energy infrastructure in a big city

Planning usually takes a long time to compile formidable plans for the city and utilities involved. The rapid development within the big cities has presented great challenges to this crucial phase in the growth strategy of the cities. Some authorities cannot respond fast enough to the demands of the cities and the volume of work that comes with all the city's needs.

by X Lembede and S Xulu, City Power Johannesburg

Both the speed and scale of urban development in big cities, particularly Johannesburg, have been taking place at an unprecedented pace and scale. The rapid urban spatial encroachment into urban boundaries has been driven by enormous economic growth for business development and by a strong individual desire for a better quality of life (measured by housing consumption, infrastructure improvement, increased transportation accessibility, and the building and preserving of urban green space). The remarkable urban spatial developments in big cities do not occur without great costs and unwanted consequences, reflected in environmental deterioration, open space destruction, increased transportation expenses, overloaded infrastructure.

This paper focuses on the fundamental issues that during the rapid transition period will emerge as urban spatial development patterns that have substantial long term efficiency or cost implications and affect sustainable growth trajectories and reduce a city's competitiveness.

Rapid urban spatial expansion and dramatic changes in institutions governing resource mobility in the country throughout the past decade may provide a rare opportunity to investigate the interaction between urban spatial developments and infrastructure development.

Systematic and quantitative analyses of urban spatial structure and their association with infrastructure provision require extensive data at both the micro- and macro-levels for measurement as well as in time series for possible causality examination. This kind of data, however, rarely exists.

Challenges within the planning environment

Below are the common challenges that most electrical supply authorities are faced with to provide electrical supply.

Challenges with environmental authorities

The implementation of the environmental laws in the country mean that each and every activity that is seen to be changing the original nature of environment from one form to the other must be assessed by the environmental officers. The extent of the impact must be determined and the necessary guidance given on how to implement that particular activity without major impact on the environment.

The Department of Environmental Affairs has identified a number of activities that need assessments. Because of the nature of energy supply, electrical installations fall within the listed activities. They have categorised the activities into three categories i.e. basic assessment, scoping and full EIA. Depending on the complexity of the surrounding environment and community, these processes can take a long time to complete. In the case of Johannesburg some EIA approvals have taken more than two years. This not only affects the duration but also the cost of the entire project as material escalations seem to multiply every year. The land costs are also escalating at a very high rate and are a general discomfort to the public as most of the developments are usually on hold during the process.

Challenges on finding the best service corridors

With the high rate of development in the big cities, open spaces are diminishing. These developments demand a lot of power and with every available piece of land comes at a price. Developers are very reluctant to release any piece of land for other uses. The situation makes it almost impossible to find adequate service corridors in these cities.

With the high demand of power in high density areas, supply authorities are forced to provide a number of substations few kilometres apart and this calls for an increased number of servitudes. To accommodate these supply points, the supply authorities are now looking at high voltage cables to wheel power through these areas.

These cables bring their own challenges i.e.

- *Sizes of pavements:* these pavements are not big enough to accommodate all the services within the developments. To accommodate these cables, authorities are still forced to acquire servitudes within the developments.
- *Cost of cable vs. the overhead line:* the price gap between the two technologies is increasing. The cable is now more than four times the cost of overhead lines and this put a big pressure on limited capital funding.

Inadequate resources i.e. funding and personnel

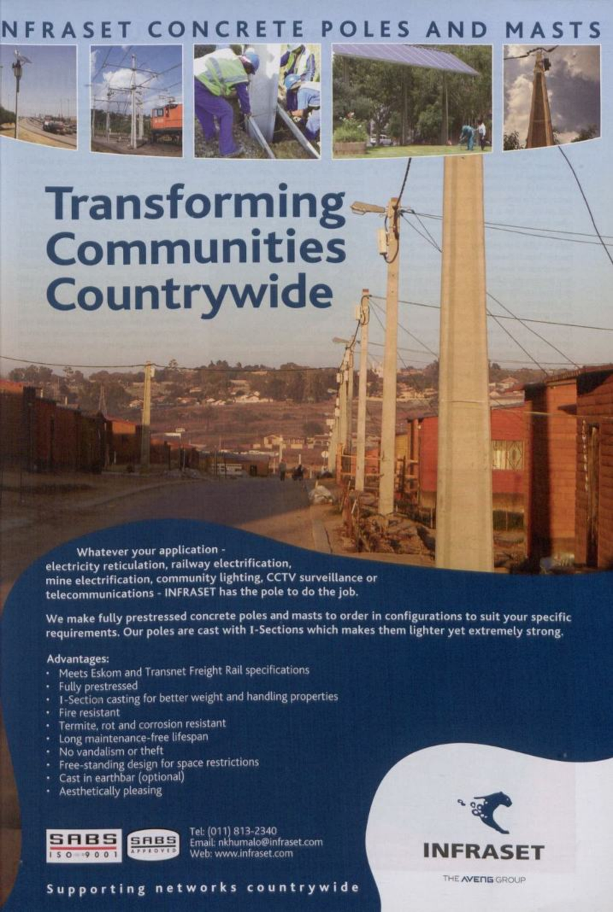
- *Shortage of engineers:* It has been proven that for the past few years, the higher education institutions are not producing enough graduate engineers to meet the requirements of industry. This shortage forces everybody to fight for these limited resources. The spiraling effect on the shortage leads to high production costs and the heightened salaries lead to low productivity at small businesses as they can't afford highly trained personnel. They're forced to make do with the inexperienced personnel who have to stumble along without any proper guidance or proper mentoring.
- *Shortage of skills:* The country is now experiencing a dire shortage of skills and it is very important for an engineer to be a jack of all trades. Companies have no choice but to appoint an engineer from a completely different field with the hope that application of his experience might be of crucial importance to some applications within the company. These hybrid engineers sometimes bring much needed skills to the company and assist in improving policies and procedures. The companies need to provide guidance and enabling environments to fuse their experience with their current environment.
- *Shortage of funds:* Due to the nature of current networks, the growth in power demand has triggered the investment need in all spheres i.e. expansion, strengthening, refurbishment and maintenance. For these cities to sustain growth, expansion projects have overtaken all other categories and the network integrity has therefore become more vulnerable

Matching new technology with the old technology

Most of the big cities were built in the 18 and 19th centuries and they have expanded over time due to urbanisation and immigration to economic nodes of the country. The old infrastructure was installed with the best technology at the time but with evolving innovation in the industry, there have been many changes on the latest technology.

Due to budget constraints and system configuration, utilities are sometimes forced to merge different technologies or retrofit new equipment with newer technologies. This presents many challenges as it requires much modification and interface systems which require more maintenance increase the risk of failure. Utilities are sometimes forced to change the entire system because of the compatibility challenges.

The old technology poses risk to personnel and new equipment where designers have spent years of work trying to improve the total safety of the system and personnel e.g. extension of



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Balancing network integrity with the fast growing city.

Due to budget constraints and high demand on power requirements, authorities are facing a challenge to provide the required level of service while maintaining the network integrity. Balancing the technical and political compliance has proven to be a bit of a challenge. One often finds that urban areas are fully developed and overcrowded and for government to be able to fulfill their housing responsibility, they have to look at the outskirts of the cities to find open space for new housing. Due to the nature and timeframes of these projects, some of the technical requirements have to be relaxed with the intention of rectifying the situation as the areas grow to full capacity.

Network improvement lags the rate of development in big cities and this results in increased restoration times in case of outages.

Synchronisation of activities among the role players

For a utility to produce sound developmental plans, it's important that all the role players provide the most accurate input within the defined time frames. Some of the most important role players are:

- *City town planners:* These are the most critical people in the loop as they have to give direction on the city's strategic direction with regard to land developments. It's important for infrastructure providers to align themselves with their plans. This will pave a direction on how to align resources such as funds and personnel.
- *Eskom:* As a national service provider, most municipalities rely heavily on the supply from Eskom. For Eskom to be able to forecast correctly, all municipalities have to provide fairly accurate plans with reasonable time frames. Both parties have to agree and stick to the plans.
- *Developers:* It is very important for the developers to discuss their plans with the utilities as soon as they decide on the type of development they are planning. As much as the town planners will give direction on the zoning, it's only the developers who can determine the exact type of developments and their time frames.
- *Environmental authorities:* The approval of EIA does contribute to the duration and cost of the project. The time frames are crucial to this process as utilities cannot start any activities without the necessary approvals. Recommendations can sometimes mean major changes or a complete change of the designs.

It is important that all these stakeholders forge good working relationships and adhere to agreed time frames.

Conclusion

Urban spatial development patterns for smart growth have drawn a lot of attention because they directly influence planning policies that advocate mixed uses, compacted and dense developments, transit oriented development, and corridor development.

Efficiency of urban spatial structure should be measured and gauged from the prospective of urban agglomeration, transportation implication, allocation of resources (land and capital), infrastructure accessibility and environmental and social impacts.

It is anticipated that Gauteng will experience rapid urbanisation far into the 21st century, which will merge the two developing frontiers – rural and urban areas – more closely together and will result in a need for integrated infrastructure between the neighbouring cities. The cities have demonstrated great abilities in promoting growth over the past decades and it is hoped that the government will take appropriate actions and measures to promote efficient spatial patterns for sustainable urban growth.

References

[1] C Ding: Policy and Planning Challenges to Promote Efficient Urban Spatial Development during the Emerging Rapid Transformation in China. Land Use Policy 2009.

[2] F Nkutha: City Power Environmental Impact Assessment (EIA) Procedure, CP_SHEREIAPR 07/01

Skills development and staff retention

The Electricity and Energy Directorate of the Nelson Mandela Bay Municipality has embraced a culture of learning by introducing key educating principles that are effective in developing, recruiting and retaining staff. It is as a result of this environment and the opportunities afforded that I am able to comment positively on the rich returns in human capital investment.

by Adrian Vermaak, Nelson Mandela Bay Municipality

The Chinese proverb, "Grow a tree for ten years; grow men for a hundred" is true in that nurturing and educating human talent is the key to prosperity.

This paper has therefore been written with the aim of promoting skills retention strategies and the development of engineering personnel as one of the key components for the industry to remain effective in its core functions, such as maintaining quality of supplies and service delivery.

The questions that employers should be asking about skills development are:

What effect does it have on performance? What priority should it have? Is it an expense or an investment? How can it be effectively implemented in practice?

This paper endeavours to contribute, make suggestions and answer these questions by exploring the following:

- The Far East's philosophy on skills development.
- Statistics clarifying the impact of skill shortages and staff turnover on a country or organisation.
- Practical mechanisms that are effective in developing engineering personnel.

The Far East's philosophy on skills development

The following facts are extracted from a report by Dieter Kusel, the former CEO of East Cape Training Centre, an institution accredited internationally for its quality of training offered. It compares the training approach in Hong Kong, Singapore and Taiwan with that in South Africa:

- In the Far East, the government, industry, commerce, and private people themselves, are totally committed to training as a life long exercise in continued upgrading and development.
- Training is viewed by all as an investment in the only abundant natural resource – their people!
- The right to be trained is embodied in their constitution and is seen as an expression of people's strength. The more they are trained the more they consider their development of strength, ability and expertise.

Fig. 1: A learning environment.

- The training is not only practical in nature, but is a full and total education system, involving personal and vocational guidance, counselling, moral and social education as well as community involvement.
- To ensure that only the highest standards are taught and maintained, regular national and international competitions are held where co-operation and exchange programmes for trainees and instructors alike are encouraged at international level as a standard procedure.
- Training centres operate virtually around the clock, utilising double shift methods, after hours and week-end training, thus catering for both the unemployed and employed. Only the latest state of the art equipment and facilities are utilised. This results in around 20% of the population being in permanent full-time training, excluding local in-service and normal education systems.

The official training policy of the Far East could be summarised as follows: the right to be trained, and trained free, to the highest limit of each individual's ability, is a standard mandate given to every public and private organisation. This is coupled to the total desire of each individual to absorb all the training possible, without abusing the privilege, in order to increase their personal strength, standing and ability and has made training a totally cost-effective exercise in human capital, repaying its investment many times.

This has transformed the Far East into an exceptional area of phenomenal growth, low inflation with some of the highest productivity internationally. It is considered one of the best places in the world in which to invest and do business. An enviable record!

A learning culture that the Far East has embraced can be defined as follows:

"The essence of organisational learning is the organization's ability to use the amazing mental capacity of all its members to create the kind of processes that will improve its own." (Nancy Dixon 1994)

"A Learning Company is an organisation that facilitates the learning of all its members and continually transforms itself." (M. Pedler, J. Burgoyne and Tom Boydell, 1991)

"Organizations where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning to learn together." (Peter Senge, 1990)

These findings and definitions provoke the need to inculcate a culture of learning to succeed in skills development and as a result provide sufficient engineering skills to the industry.

Statistics highlighting the impact of skill shortages and staff turnover on a country or organisation

The following has been summarised in this respect:

Skills lost to South Africa

It has been commonly recognised and accepted that value is added to organisations primarily through people and information and not, as was thought in the past, through the four Ms: money, man, machinery and materials. The statistics below, published by Statistics South Africa, indicate a net loss of technical skills to South Africa during the indicated period.

The immigration and emigration statistics below indicate the net loss of economically active Professionals, Engineers, Technicians, Architects and related occupations to South Africa.

(The figures within the brackets indicate immigration minus emigration data.)

- 2001: -6638 (i.e. 953 – 7591)
- 2002: -6280 (i.e. 1054 – 7334)
- 2003: -9529 (i.e. 1011 – 10 540)

Submission of immigration data is obligatory and the figures are therefore considered reliable. Emigration data however, is less reliable as some emigrants do not complete paperwork or are not specific as to their intentions. The above statistics are therefore conservative and the net losses are probably greater. The documented total emigrants was 25 465 for the years 2001 to 2003.

The financial implications for the country reaches into the billions.

Staff turnover and its financial impact

Research in the UK indicates that staff turnover by 2012 would have cost businesses at least £6,2-billion and these unacceptable levels of turnover impact significantly on employer finances. This negative impact can primarily be attributed to skill shortages and as a result the demotivation of existing staff.

Why do people leave their employer?

Research suggests that in response to the question of why people leave, employers answer "Money", whereas employees rate other factors more highly such as: career development; unresolved problems; working hours, and staff shortages.

Although career development is a key contributor to staff retention, the employer should remain positive in providing competitive packages and possibly scarce skills allowances to staff members.

In summary:

- There have been unacceptable levels of skills leaving South Africa particularly in the engineering industry.
- Employers should focus their efforts on establishing systems that would discourage high levels of staff turnover, maximise potential profits and promote effectiveness in core functions.
- If employees are nurtured and made to feel that their career development is important to the employer, then they will tend to remain loyal to their employer.

From these findings it is clear that skills development contributes significantly to the success of an organisation and country.

An increase in effectiveness and an upgraded economy can be achieved by overcoming the abovementioned obstacles if employers create a non-threatening culture of learning that is packaged by an organisational structure resourced to effectively apply skills development practices, like mentoring and lecturing. Ultimately a collective effort from industry stakeholders can reduce the skill losses to South Africa and make this industry attractive.

Mechanisms that develop staff

A healthy organogram or structure that incorporates skills development by providing:

Sufficient trainer capacity: As a general statement, most members of staff, in fulfilling their job descriptions, would not have enough time to train to the extent that a training officer or assigned mentor could. In keeping with the ethos of a learning company, however, all staff can educate by example and demonstration in their day-to-day functions. A fully equipped training centre with trainers, mentors and equipment can supplement the above, especially for artisan training.

For technicians and engineers, however, assigned mentors would be advised to fulfil or facilitate such a role. Ideally the mentors should have an understanding of the environment and be suitably trusted advisors. A good choice would be recently retired or experienced ex staff. I am aware that the Engineering Council of South Africa, ECSA, has a list of approved mentors who could be approached as well. The principle is to offer all staff an opportunity to grow and develop in offering a structure that has sufficient training capacity to meet these needs.

Training policies and skills development objectives: In keeping with a holistic approach, and to ensure that no-one is overlooked, each section should have a training policy and a set of skills development objectives. The policy can include guidelines like increasing effectiveness of staff, updates on new technology, etc. The objectives should outline the basic functions that staff are required to effectively fulfil within a given section. In addition, the list can include skills like management principles, which provide extra opportunities for staff in broadening their careers. If the above exists, it is convenient to circulate inexperienced personnel through the different sections, within a set timeframe, to gain an overall technical knowledge as to the institution's core functions.

Training as per the requirements of the Engineering Council of South Africa: It is imperative that the development of engineers and technicians is in accordance with the criteria of ECSA in keeping with the industry standards. The training and development of personnel should therefore tie in with the requirements of ECSA. The advantage of this approach is that personnel are led into an easy registering process with ECSA. It was very helpful when one of the ECSA employees and members visited us with a presentation on what is being offered by ECSA and the processes involved in registering.

A large resource pool of trainees: It is always worthwhile to have graduates incorporated into the system in order to reduce workloads and to introduce fresh ideas taught in the tertiary institutions. A strong recruiting process needs to be in place in order to maintain the number of trainees required.

We utilise the following vehicles offered by the Human Resources Directorate:

- Experiential trainees – those requiring practical experience in completing their qualifications.
- Volunteers – those seeking experience within the engineering field.
- Unemployed graduates – those who have completed their qualifications and are unemployed.
- Bursary students – a sponsored education with a contracted work-off period.
- Agency employed staff.

In addition, the Department of Minerals and Energy sponsors trainees at its expense. It is necessary to develop a healthy relationship with the tertiary institutions in order to recruit the graduates that are best suited to make use of the above opportunities.

The employer can manage staff turnover by having a nucleus of trainees as potential candidates for positions as and when they become available. Trainees that are not absorbed by the employer are marketable within the industry because of the experience gained. The employer thus fulfils a social role for the country.

Administration: Proper administration is necessary for the accurate keeping of a record of each trainee's progress. For example having a completed attendance register from every training session fed into a training database is essential. This also facilitates claiming for financial rebates for staff skills development.

The following pointers are being applied within the Projects Sub-Directorate, a team of mainly engineers and technicians within the Electricity and Energy Directorate:

Lectures and practical training on engineering fundamentals

If you do the basics well, you are set to achieve consistently!

Every Friday and Monday time is set aside for lectures and practical training with the aim of equipping staff with the fundamentals of electrical engineering, life skills and general topics such as telephone skills. The practical sessions are constructive in making clear the topics taught on the Fridays. The lecturer's notes are stored electronically and made available to all staff. In addition, the trainees work alongside more experienced staff and as a result gain further understanding of what is being taught. Confidence is also instilled in the trainees by delegating projects for them to manage, providing them with a sense of fulfilment. Fulfilment is also experienced by the trainer, as there is now evidence of competent skills being developed.

Lectures and practical training on general engineering practices

Training is also conducted every Wednesday with the aim of building onto the fundamentals, thus increasing the effectiveness of staff in their present positions. These sessions are open to all staff but are primarily geared to the more experienced staff. The format varies from time to time and there may be sessions of a brainstorming nature encouraging

teamwork in overcoming the day-to-day obstacles. A variety of topics are taught and interaction is encouraged. These topics can range from technical to general in nature. The technical lectures include topics such as protection, reticulation designs, transformer A and B values, planning principles, etc. The general lectures include topics such as management practices, financial planning, GIS mapping, renewable energy, etc. In addition, staff are given opportunities to present topics themselves and outside speakers are invited to impart their skills on topics that are industry related such as switchgear manufacturing, etc.

Ongoing professional training

In keeping with ECSA's requirements to provide staff with continuous professional development points, relevant courses are arranged with accredited training providers. An adequate budget is approved and a schedule of courses is created that would benefit the staff by expanding their knowledge and expertise.

Assessments

In order to determine if there is progress in the development of staff, assessments are crucial as a measuring tool. The assessment should include the evaluation of technical requirements, performance and potential in order to determine the overall performance of the staff member. See the Fig. 6 in this regard which relates to a planning environment.

Human resource management

Much can be said on this topic and it can never be underestimated as a key component in keeping staff satisfied and motivated. Issues like salaries being paid on time and contracts being renewed timeously are crucial in keeping staff motivated. If managers and mentors stay committed to principles like these and act quickly when needs arise, loyalty is cultivated between employee and employer, reducing staff turnover.

Research and special projects

A great way to keep staff stimulated and innovative is to expose them to new skills, such as involving them in renewable energy projects and research.

Team building

Team building on a regular basis, at least once a month, develops camaraderie and allows people to have fun. It's a great way to build friendships, strengthen teams and create a better atmosphere to work in.

Mentoring and mentoring contracts

The addition of designated mentors in the working environment, as a component for people development, has revolutionised the way training is done. It facilitates a more one-on-one and detailed approach in the development of staff, creating a professional environment in which to work. Managers can now partner with mentors in establishing staff competency and, as a result, managers have a reduced training load. With the efforts of the manager and mentor, the company skill levels can increase at a faster rate. It is therefore important to incorporate mentors within the system or structure.

If mentors form part of the structure, the options shown in Fig. 4 can be applied: Option 3 is preferred in maximising the training process by gaining the assistance of a mentor.

Mentoring, as far as possible, should aim to produce the complete staff member by facilitating training that imparts the necessary technical expertise required for a given job description and opportunities for growth in the following attributes determined by research as the key areas that businesses seek:

- Try to do their work well
- Set priorities
- Work well under pressure
- Can solve problems
- Can make decisions
- Work well with others
- Can communicate with others
- Know how to learn

87,5% of the people who are able to retain jobs do so because of these qualities. Only 12% are retained because of their skills.

Mentoring is a key component to skills development:

"The successful application of the mentoring process implies a host of benefits for both the organisation and the core participants, i.e. mentor and protégé. In accelerating the growth process of the protégé, the mentor himself experiences a substantial growth process, while the organisation adds new levels of expertise and productivity to its human resources balance sheet. The benefits of the process are substantial but they will not be optimised unless the organisation incorporates mentoring as a mainstream issue within corporate strategy." (Nasser, M. 1987)


Fig. 2: A training class.


Fig. 3: Physical exercise session.

Mentoring can be defined as:

"A mentor is a kind of a guide who, having been far enough to know something of what's down the path, comes back to walk with you and thus leads without leaving you to follow." (Boyd H.A. 1989)

It is the process of guiding and facilitating a less experienced person to achieve personal and professional growth. Mentors train, coach and provide support by sharing their experiences and knowledge with the protégé.

The benefits of mentoring are:

- Increased productivity and improved work ethics.

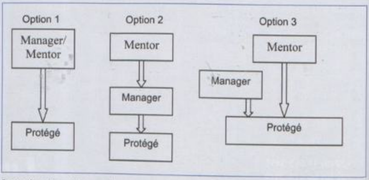

Fig. 4: Alternative mentoring options.

ANNEXURE A
MENTOR AND PROTÉGÉ AGREEMENT

MENTOR: **PROTÉGÉ:**

PURPOSE 1: TO DETERMINE THE PROTÉGÉ'S VISION.

PURPOSE 2: TO ESTABLISH THE LEVEL OF COMPETENCE.

PURPOSE 3: CLARIFY THE GROWTH AND EQUIPPING NECESSARY TO FULFIL THE PERSONAL VISION.

PURPOSE 4: TO MEASURE PROGRESS TOWARDS FULFILLING THE PERSONAL VISION.

VISION TO BE ACHIEVED:
Discuss and list desires or dreams. Create a Vision.
....
....

DETERMINE THE LEVEL OF COMPETENCE RELATING TO THE VISION:
Define the obstacles, shortcomings and lack of skills that must be overcome to fulfil the vision.
Confirm or modify the vision if necessary.
....

Fig 5: Mentor and protégé agreement.

DEVELOPMENT PLAN:
Discuss and list what must be put in place to overcome the obstacles, shortcomings and lack of skills.
....
....

LIST THE GOALS, WITH TIMEFRAMES, TO BE ACHIEVED IN EACH OF THE PHASES OF THE DEVELOPMENT PLAN:
Discuss and list the entries for a schedule that embraces the key steps needed to implement the Development Plan and enable the protégé to fulfil the vision.

ESTABLISH HOW THE PROTÉGÉ'S PROGRESS TOWARD THE GOALS WILL BE MEASURED:
....
....

GENERAL:
....

SCHEDULE OF MEETING DATES:
Decide on a regular meeting time and dates that will nurse the abovementioned process to completion.

MEETING TIME:

MEETING DATES:

1. .... 2. ....

3. .... 4. ....

Fig 6: Development plan.

THE ACTION PLAN WITH REFERENCE TO ANEXURE A:

MENTOR AND PROTÉGÉ AGREEMENT

MEETING DATE:

MENTOR: **PROTÉGÉ:**
REVIEW THE LIST OF GOALS AND TIMEFRAMES STATED IN ANNEXURE A:
....
....

MEASURE THE PROTÉGÉ'S PROGRESS TOWARD THE VISION SINCE THE LAST MEETING:
....
....

LIST THE PROGRESS EXPECTED BY THE NEXT MEETING
....
....

GENERAL
....
....

DATE OF NEXT MEETING:

Fig 7: Action plan.

- Transferred skills and the development of future leaders.
- Accurate selection of talent and placement.
- Opportunities for plateaued managers to grow and be challenged.
- Reduced staff turnover.

The role of the mentor:

- Advocate or opportunity provide.
- Interpreter – helps understand the broader purpose of the organisation.
- Learning consultant – audits and advises learning goals.
- Coach – transfers skills or competences with the aim of improving performance: on the job training, defining aim, problem solving, target setting, planning some experiences and monitoring; counsellor – talk through issues and allow for problem-solving.
- Guide.
- Ally – friend.
- Catalyst – inspires.

The mentor cannot impose a relationship with the protégé but can offer a process of development, which can be documented as shown in Fig. 5 .

Conclusion

What effect does skills development have on performance? A positive effect if properly implemented.

What priority should it have? A high priority as it has significant bearing on productivity.

Is it an expense or an investment? An investment, as the returns are great, because of reduced staff turnover.

How practically can it be effectively implemented? As described in the report.

The task may seem great but it is interesting to know that South Africa makes up 6% of the population of Africa and is the most significant contributor to the economy of Africa. Dynamite comes in small packages! Building with excellence and resilience ensures success!

One of our trainees decided to leave the directorate in response to employment offered by a similar and bigger employer for a better salary. This trainee, after a very short period, resigned and returned because he felt his career had greater potential and that his talents would prosper more being in an environment of learning. Surely these types of testimonies are what the industry needs!

References

[1] The Far East and their Approach to Training by Dieter Kusel.

[2] The NMMU Business School on the Philosophies of Mentoring.

[3] The Department of Statistics South Africa.

Telemanagement of public streetlighting infrastructures

Streetlighting fulfils many roles within our environment, although mostly facilitating a safety and security function. This is compromised through vandalism, cable theft, failures in lamps, ballasts, circuit breakers, and electrical supply infrastructures.

by Jason Smith, Beka

Today's public lighting designers and managers are required to provide far more reliable infrastructures, adopt ever increasing energy saving principles and to provide effective on-demand and proactive maintenance of these systems. Further to this situation, South African legislation enforces the requirement for well maintained systems, through strict operational requirements to avoid wasteful energy use, and to incorporate dimming during out-of-peak times.

Legislation

The South African Electricity Regulation Act (4/2006): Electricity Regulations for Compulsory Norms and Standards for Reticulation Services enforces very specific requirements for the adoption of energy efficiency practices in public lighting, as per the following excerpt:

In respect of lighting:

- Street and highway lighting must be energy efficient and licensee must ensure that it is switched off during the day.
- Streetlights must be fitted with systems that allow for remote reduction of power especially during capacity constraints.

Furthermore it states that *"the Energy Act (2008) will be used to implement regulations on the management, measurement and reporting of energy efficiency."* With the prevalent copper theft and luminaire vandalism adding to the already challenging task, one is no longer able to rely upon purely reactive processes to keep these critical systems running. Owlet nightshift, a telemanagement system designed specifically for the effective and efficient management of public lighting networks, addresses these issues at various levels.

Telemanagement

Telemanagement, as a technological enabler for system or infrastructure management, is not a new concept and has been successful in assisting organisations manage various systems across many industries. The challenges preventing legacy proprietary systems from providing a meaningful solution and contribution for the public lighting realm has been due to numerous factors, mostly surrounding communication – the primary backbone for an effective system.

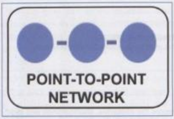

Fig. 1: Point-to-point network.

Traditional communication methods, typically based upon PLC (power line communication) or proprietary wireless systems, have found many stumbling blocks in achieving meaningful and effective large scale implementation. Both these communication systems rely on point-to-point communication which is rendered ineffective once a pole or luminaire is removed from the communication chain, through accident or malicious activity, effectively breaking the communication path.

Open standards enabled solution

New wireless mesh network technologies, based upon the open standard IEEE 802.15.4, incorporate both self-learning and self-healing which provides for a stable and reliable communication backbone. Adopting open standards, within such a system, is critical in order to prevent vendor lock-in. The principle technological requirement in facilitating this challenging management task is to adopt an open, scalable and modular system.

Developed from the ground up, Owlet nightshift has been built upon a reliable platform, incorporating open and industrial standards, to prevent proprietary system lock-in, which occurs with older legacy systems.

Systems structure

Owlet nightshift is composed of a three tier architecture, incorporating the individual end-point device controller, area controller, and centralised server. The end-point device control is facilitated through either a luminaire controller, for single output control, or column controller, for double output control. The luminaire controller, typically installed within the luminaire, facilitates the controlling and monitoring of the individual luminaire. A column controller, installed within the streetlight pole, can control two luminaires or alternatively a luminaire and power change-over unit (PCU) for dimming control of high pressure sodium light sources. Each column controller also supplies a dimmable output, for either an LED-based luminaire or advertising sign.

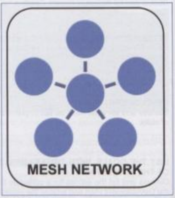

Fig. 2: Mesh network.

These devices communicate via the self-discovering, self-healing wireless mesh network in order to transmit the data between themselves and a central segment controller. each segment controller co-ordinates the interaction of manual commands and pre-programmed switching schedules with up to 150 column and/or luminaire controllers and also interacts directly with the centralised Owlet server for data logging and error reporting.

The centralised Owlet nightshift server incorporates a web management interface (WMI) and communication (email and/or SMS) module. Daily error reports are emailed for maintenance teams to address the previous days failures, whilst the WMI allows public lighting managers to interrogate the current operating status and also effect manual control.

Owlet nightshift groups the entire system into a logical hierarchy, namely city, suburb, street and control-device levels. This ensures that you have holistic view over each and every level within the system. Emergency or public events can be responded to in order to override any pre-programmed dimming

Fig. 3: Owlet web management interface.

or switching state during the particular event. Every device manually overridden is indicated within the system through a change in the displayed icon on the Google Map component, making identification of each device's state extremely simple. This status icon also indicates any failure states.

Benefits

Each individual light point or end-point device can be monitored for actual energy consumption, lamp status as well as failures, and can be switched on and off or dimmed at any time. Scheduled control of the system, based upon a split weekday and weekend calendar, at fifteen minute intervals, is configured for each group or individual end-point. This allows for granular control and ensures that the maximum energy saving can be achieved during low-use times, whilst maintaining the required level of lighting during peak use times. Operating state, energy consumption and failures are reported and stored in a central database with exact timestamp and geographic location. This information will assist public lighting managers to ensure that service levels are maintained.

Maintenance time and cost is reduced, as staff are able to check the status of the installation, identify faults and respond to these. Time spent checking installations, section by section, is now negated. Maintenance cost reduction schemes, such as group lamp replacement, now also become feasible in public lighting. With Owlet nightshift, management reports show luminaires with lamp burning times exceeding certain timescales. Any luminaire which has had a recent lamp replacement is therefore automatically excluded. The strength of this is that maintenance time is not expended on replacing good lamps, the primary drawback of traditional group lamp replacement schemes.

Local challenges

Controlling and switching the end-point device results in a required change to the installation paradigm, as the sections are now permanently live. This ensures that cables installed in the public lighting network will be less prone to theft due to the added risk. Furthermore, with the constant threat of cable theft, having an insight into the failures occurring in the field, at the time of occurrence, would help to alert staff to respond accordingly to this.

Future proof

Any system implemented today needs to allow for the future technologies as they emerge. LED will soon supersede traditional HID light sources, bringing with it the ability to dim the output on demand. Owlet nightshift allows for the scheduling of dimming levels in 0,5% increments, ensuring that the streetlight of tomorrow can be controlled through today's systems.

Owlet gives public lighting managers the right tools to assure the correct lighting level on the street while improving the overall reliability of outdoor lighting, effecting energy efficiency and reducing operating costs.

Non-technical losses — how do other countries tackle the problem?

Technical losses in a distribution network are well understood and their reduction is finite and essentially an engineering issue. Non-technical losses, on the other hand, although also well understood have evolved into an art form and their reduction requires innovation and persistence. Utilities around the world are actively addressing the issues. In South Africa prepayment meters were adopted as the "solution" in the poorer communities but it has been said that theft and non-payment of electricity are equivalent to the output of one Eskom "Six Pack" power station.

by Ron Millard, PB Power South Africa, and Mike Emmerton, PB Power Hong Kong

The term "Viva the Meter" would appear a common "term of reference" for urban based "meter consultants". In these days of a critical generation shortage and low spinning reserve the financial impact of the high level of non technical losses is very significant. A recent PB project required research into the extent of the problem in both developed and undeveloped countries and this paper shares these findings and provides a brief insight into how other countries tackle the issue. Approaches range from strong policing and regulatory based incentives or penalties to "outsourcing" the solution by transfer of operating rights offering the potential for large financial profit incentives for utility investors. The developed countries are often used as a benchmark as having best practice for the managing the issue of non technical losses but certain poorer and less developed countries have adopted different approaches with considerable success.

Total loss comprises three components

Technical loss: The component of distribution network losses that is inherent in the physical delivery of electric energy. It includes conductor loss, transformer core loss, and potential/current coils in metering equipment. Technical loss is calculated as the sum of the hourly load loss and no-load (or fixed) loss in all distribution equipment, devices and conductors for a specified billing period. It is calculated through three-phase load flow simulations of the distribution system using the appropriate network and load models. Such load flow simulations capture all technical losses from the incoming and outgoing delivery points of the unbalanced three-phase distribution network (i.e. from sub-transmission lines to the service drops of the distribution network customers).

Administrative loss: Includes the component of distribution network losses that accounts for the electric energy used by the distribution utility in the proper operation of the distribution network. Substations, offices, warehouses and workshops, and other essential electrical loads are usually considered as part of the administrative loss.

Non-technical loss: Includes the component of distribution network losses that is not related to the physical characteristics and functions of the electrical network, and is caused primarily by human error, whether intentional or not. Non-technical losses include the electric energy lost due to pilferage, tampering of meters, and erroneous meter reading and/or billing. Losses in metering equipment, including the electrical burdens of instrument transformers, are usually considered as part of the technical loss.

Non-technical loss is the residual loss that remains after subtracting the administrative loss and technical loss from the total distribution network losses[1].

The estimation of non-technical losses requires an accurate computation of technical losses and administrative losses. In practice administrative losses are determined by measurement, and thus the accuracy of the estimate for non-technical losses is largely dependent on the accuracy of the estimation of technical losses. In this paper we explore the experiences of distribution utilities in several countries and conclude by extracting from these experiences the more popular strategies that have been shown to work.

Countries of interest

The level of non-technical losses varies generally according to the economic conditions of the country. In countries where GDP per capita is very low it is common to find higher levels of non-technical losses (pilferage). This is perhaps because the cost of electricity is high relative to household income. There are exceptions to this, however, and in countries such as Indonesia and Thailand, GDP per capita is low but the reported non-technical loss level is also remarkably low. The reason here is most likely due to the fact that poor customers receive subsidised electricity that is affordable in the form of a social tariff. In Venezuela, a move to a social tariff in 2001, resulted in the level of losses falling significantly as electricity became affordable for poor communities. In some countries electricity supply has become non-regularised due to war or failure by government to maintain adequate controls on the supply of electricity and pilferage has become endemic with high levels of tolerance within the community. These varying circumstances mean that it is difficult to identify a specific benchmark for non-technical losses correlated with GDP per capita. On the other hand, the relationship between non-technical losses and the severity of loss mitigation practices is valuable in justifying the approach taken by any utility in their loss mitigation strategy.

PB has collected information regarding practices in countries experiencing high levels of non-technical losses where utilities have tried a wide range of techniques, some of which may be suitable for application in South Africa where they are not already being applied. The countries of interest (see Table 1) are ranked in order of purchasing price parity (PPP per capita).

It will be seen from the case studies that the non-technical loss mitigation practices in the Philippines, Indonesia, Jamaica and Thailand are of particular interest.

Case studies

Meralco, Philippines

Meralco is the largest electricity distributor operating in the Philippines and serves around 4-million customers A large part of Meralco's customer base is either very poor or experiences continued difficulties in paying for their day-to-day living needs. Electricity is an essential commodity to maintain a reasonable standard of living, especially in the urban and semi-urban areas served by Meralco, and this need along with the high cost of electricity leads to high levels of electricity pilferage amongst the poor non-manageable communities that live in these areas. The impact on Meralco has been significant:

[1]Regulators expect that any electric energy loss in the distribution network that is recovered through anti-pilferage activities would normally be subtracted from the non-technical loss.

Country	Estimated Losses in 2007	PPP per capita 2007
India	NTL – 20% to 40%	2700
Philippines	NTL – 3,5% Total losses 10%	3300
Indonesia	NTL – Unknown Total losses 12%	3400
Jordan	NTL – 3 to 5% Total losses – 15%	4700
Jamaica	NTL –13,2% Total losses – 23,2%	4800
China	NTL – 10%	5300
Thailand	NTL – 0,32% Total losses – 5,69%	8000
Brazil	0,5% to 25%	9370
Turkey	NTL – 6% to 64%	9400
Lebanon	Unknown	10 400
South Africa	NTL – 10%	10 600
Venezuela	NTL – 12,74%	12 800
Russia	Unknown but 10%+	14 600
UK, Australia, United States	NTL between 0,2% to 1%	> 30 000

Table 1: Relationship of distribution losses to economic prosperity.

- Growth in consumption is understated due to pilferage.
- Reliability of supply has been impacted because low-paying areas do not contribute sufficient revenue to justify capital improvements (SAIDI is around 17 hours).
- Meralco's public image is poor due to customer's sensitivity to price rises and the perception that the company is only interested in profits even at the expense of the poor.
- Servicemen often have to operate in a hostile and life-threatening environment, especially when having to disconnect non-paying customers.
- Network infrastructure is damaged or rendered unsafe due to illegal connections.

The extent of the electricity theft problem has had such an impact that the company has been forced to become very innovative in its attempts to reduce non-technical losses. The innovation on the part of Meralco has only been matched by the innovative approaches employed by the pilferers of electricity. High voltage barriers have proven to be no deterrent to determined thieves. Meralco even has evidence of organised crime syndicates

	Number	Consumption (MWh)
Residential	3 616 963	8 140 000
Commercial	341 272	7 960 000
Industrial	11 543	6 560 000
Streetlights	4202	140 000
Total	3 980 980	22 800 000

Table 2: Meralco market segmentation (2007).

providing customers' with custom-designed radio controlled switching devices, that connect and disconnect illegal wire taps, on a monthly subscription basis! Meralco has tried and tested many approaches to non-technical loss reduction and has learned from experience what works and what does not work. For this reason Meralco's experience in fighting electricity pilfering should be of interest to other utilities faced with escalating non-technical losses.

The Energy Regulatory Commission of the Philippines allows distribution companies to recover electricity losses up to a cap of 9,5 % through rate setting. A separate revenue component is included in electricity accounts to allow for this recovery. This revenue is intended to compensate for both technical and non-technical losses. The Energy Regulatory Commission is styled on a US-model.

Meralco's system loss caps were introduced in 2003 at 15% and reduced to 9,5% in the following year. The cap has remained at 9,5% since 2004 until the present day. The results achieved in 2007 suggest that the cap has been effective in making sure that Meralco has been incentivised to achieve sustained reductions in electricity pilferage.

In 1986, Meralco experienced an all-time high total loss level of 21%. By 2004, Meralco had reduced losses to a level of 11,1%, of which technical losses were estimated at 7,44% and non-technical losses at 3,66%. Nevertheless Meralco had to write off about 1,5% of all electricity purchased. At average generation and transmission charges in 2004, and Meralco's average energy purchase costs, this amounted to a loss of around PhP 1,8-billion per year or $30-million USD per year. As Meralco had to pay this amount to the generators and the transmission company, it represented a direct reduction in profitability. In 2003 for example, Meralco's net profit margin was 4,1%. If the system losses had been recoverable, this figure would have been 8,8%.

System loss in 2006 was reported at 10,10% and 9,65% in 2007, the first time single digit loss figures had been achieved. This result was largely brought about by increasing the emphasis on improving the timing and quality of the work of apprehending crews. Most of the apprehensions conducted were triggered by the information provided by concerned citizens anonymously through Meralco's website, telephone, and sometimes directly to an email address dedicated to anti-pilferage reports.

Loss reduction measures

Meralco categorises its tactics according to deterrence, detection, apprehension, monitoring and recovery.

Deterrence programs have centred on surprise off-cycle reading of large customer meters as a check against on-cycle reads, and saturation drives for high loss circuits wherein inspections are carried out at random and on regular basis.

Meralco has been able to reduce the level of non-technical losses by focussing on large customers and on illegal connection communities (close-knit villages).

For the large customer segment Meralco regularly employs the following approaches:

- Amnesty
- Off-cycle readings and analysis
- Random inspection
- Use of check meters
- Elevated meters (sometimes with high voltage barriers)
- Metal casings for meters
- 24-hour security guards

For illegal connection communities' Meralco has tackled non-technical losses with support from local officials through a memorandum of agreement. The MoA recognises that local area officials have influence over the attitudes of local people and covers a range of activities designed to regularise electricity consumption:

- A Certificate of Electrical Inspection (CEI) program was facilitated by the city government.
- Local area officials helped in the handling of delinquent accounts and reporting of illegal connections.
- Local government and Meralco collaborated in the design and financing of load-side wiring to ensure that customers did not bypass the meter at the point of connection.
- Local area officials helped Meralco conduct information campaigns designed to educate customers on how to apply for legal electric service, and the impact of pilferage on the community and electricity rates.
- Meralco partnered with government institutions and NGOs to create community-based long-term solutions (e.g. lifeline assistance and short term credit arrangements).
- The local city government facilitates police assistance in apprehension.

Fig. 1: A program for curbing electricity pilferage.

Year	Total T&D Losses	T Losses	D Losses	Reason for change
1999	12,22%			
2000	11,65%			
2001	13,52%			
2002	16,54%			Sharp increase due to tariff rise
2003	16,88%			
2004	11,29%	2,33%	8,96%	A reduction of such magnitude suggests a measurement error
2005	11,54%			
2006	11,45%			

Table 3: PLN T&D loss statistics.

Anonymous reporting hotline

Meralco has established a program for curbing electricity pilferage known as Kuryente Watch. Kuryente means electric current.

A cornerstone of the Kuryente Watch effort includes a public service educational campaign to make customers aware of the dangers of power pilferage to lives and property. The program is a campaign that encourages customers to legalise their electric connection, and a drive to rally support from citizens and local government units in fighting pilferage.

Kuryente Watch uses television and radio advertising, and signage to promote customer awareness. The campaign uses branding to support customer recall.

Meralco has established a text messaging facility for customers and an email facility (that can also be accessed on their home page) for customers to report suspected pilferage. The email facility is easy to remember – stoptheft@meralco.com.ph

Support from the law

The legal position of the utility is governed by the Republic Act No. 7832. This Act is known as the "Anti-electricity and Electric Transmission Lines/Materials Pilferage Act of 1994."

The law:

- Penalises the pilferage of electricity and theft of electric power transmission materials.
- Specifies prima facie evidence and the manner/basis of computation of differential bill, surcharge bill, other penalties.
- Rationalises system losses by phasing out pilferage losses through introduction of caps.

The penalties are imprisonment from 6 years and 1 day up to 20 years, and/or payment of a fine from PhP10 000 (US$200) up to P20 000 (US$400). The offender must also pay for the corresponding amount of the full cost of the electricity stolen.

In practice Meralco cannot prosecute electricity thieves unless they are caught in the act of placing or removing illegal wire taps. The law provides a protection to the poor. Consequently Meralco has resorted to night patrols and utilises night vision cameras to take photographs of customers removing illegal taps when the alarm is raised that a Meralco vehicle has entered the village area.

Organisation

Meralco has appointed a senior executive to head their Revenue Protection Department. This person reports to Meralco's Asset Manager and is accountable for non-technical loss reduction strategies. Management have placed a weighting of 16% on their performance measure for non-technical loss reduction. In their performance scorecard, this measure has almost twice the weighting of any other performance target, whether financial-, customer-, process- or people-related.

The Revenue Protection Department is focussed on the detection of tampering of meters and metering installations at large users premises whether by employees/persons/electricians. Their target is 24 cases per annum.

The Operations Sectors (10 sectors) are focussed on prevention of illegal wire taps and domestic meter tampering. Overall Meralco has reported to the consultant that 25% of their labour effort is focussed on loss reduction.

Management have placed a weighting of 16% on the Operations Sectors performance measure for non-technical loss reduction. In their performance scorecard, this measure has almost twice the weighting of any other performance target, whether financial-, customer-, process- or people-related.

PLN, Indonesia

State Electricity Company, PT PLN, has suffered from moderate levels of T&D system losses. The level of theft is not as high as might be expected from Indonesia's 2007 PPP per capita figure of 3400. This is because there is an affordable social tariff that meets the needs of the poor, and PLN does not connect rural customers until there is sufficient economic strength to ensure that customers can meet the social tariff obligations. The greatest problem faced by PLN is theft in the large user segment (see Table 3).

PLN has focussed on electricity pilferage associated with large consumers with supplies greater than 200 kVA. PLN relies on raiding tactics carried out with the support of the metropolitan police.

In 2003, PLN launched an operation in the capital city's industrial areas over a period of two months. The company brought charges against 235 customers, mostly industrial companies, in Jakarta and Tangerang for stealing electricity and inflicting financial losses of up to Rp11,5-billion (US$1,35-million). A further 287 companies were raided. In this case the operation was a joint effort between PLN and the city police and had the full support of the government (as owner of PLN).

The thefts were found to be mostly accomplished by slowing down the rotation of the meter or through the placement of a metal strip in the meter to prevent the recording of power usage. The consistency of the methods suggested to PLN that these methods were promoted to large customers by an individual or team with specific knowledge of meter tampering methods. Suspicions fell upon PLN staff, particularly meter readers, who learned the specifics of such methods when trained to detect meter tampering. PLN is particularly wary of the potential for meter readers to promote illegal practices and conducts independent random audits to ensure that meter readers operate within company policy guidelines.

PLN is also promoting anonymous reporting hotlines to fight power theft, and offers rewards for anyone who reports theft. The reward is in the form of cash equal to 3% of the total arrears collected from the party charged with theft.

PLN shifted the responsibility for street lighting payment to local government due to a serious problem with illegal street lighting connections.

Support from the law

Electricity pilferers face criminal charges under Law No. 20/2002 on electricity, as well as civil law charges.

Article 34 sets out the rights and obligations of customers. Electric power consumers are obligated to pay the prevailing subscription fees or electric power rate in accordance to the stipulation or agreement.

Article 34 supports PLN in prosecuting offenders, however the courts have been generally reluctant to jail offenders and power theft has been dealt with by fines.

Jamaica Public Service Company (JPS)

JPS's total system losses in 2007 were 23,2%. Of this figure, JPS estimates that technical losses are around 10%. This level of non-technical losses is considered by the World Bank to be comparable to that of a number of countries within the development strata in which Jamaica is ranked.

The contributory factors to losses of this nature are many and complex. Jamaica's less than robust social and economic environment over the past two decades have fostered conditions conducive and encouraging to electricity theft. Simultaneously, weak state law enforcement and several deficiencies in JPS's business operations have created opportunities for such losses that have been increasingly exploited.

Contributory factors include:

Social and economic

- Ten-year economic depression
- High rate of unemployment
- Generally high crime rate
- Weak law enforcement
- Relatively low penalty/fine for electricity theft
- Garrison communities phenomenon

Business deficiencies

- Past unavailability of meters resulting in direct connections
- Collusion by field operatives (company and contractor)
- Weak internal controls over adjustments to accounts
- Deficient record keeping
- Weak audit procedures
- Improper accounts set-up

Network access

- Large stretches of un-insulated secondary network offering easy access
- Unsealed meters
- Exposed, energised terminals when meters are withdrawn from service

In Jamaica, audits have shown that the non-technical component of system losses is generally due to factors fully within the utility's control. These factors are as follows:

- Polarity reversal of a current transformer (CT) in a three phase system during installation will result in only 30% of energy consumed being recorded on the customers' meter.
- Improper set up of accounts contribute to significant losses, e.g. a multiplier entered as 60 instead of 600, will result in an account being billed for only one-tenth the actual demand\consumption.
- Potential transformers (PTs), current transformers (CTs), and meters which become defective while in service are also major non-technical loss contributors.

An analysis of the company's non-technical loss profile yields the following results (see Table 4).

Dis-aggregation into the categories in Table 4 was based on prior analysis of the throw-up phenomenon and statistical data arising from various audits.

The company pursued a carrot and stick strategy in its effort to control and reduce commercial losses. These initiatives were organised in three primary areas:

- Removal of illegal connections (throw ups)
- Tightening of internal controls (including audits of large accounts)
- Conversion of illegal users to legitimate consumers

In 1999, JPSC established an integrated Loss Reduction Division (comprising up to 72 persons) in an effort to reduce system losses from the then prevailing level. In spite of the division's diligent efforts, the anticipated reduction in losses was not realised. A further re-organisation of the loss reduction effort was implemented at the beginning of 2002 following privatisation of the company. The primary objective of the re-organisation was to place greater emphasis on the removal of throw ups, the greater part of the overall problem, and, at the same time, again make core business units more accountable for activities closely aligned with their respective activities.

Removal of throw-ups

Illegal throw-ups (wires thrown up and hooked onto the company's open, low voltage, secondary conductors) remain the most visible, obvious and public manifestation of non-technical losses. They were also the most prevalent form of electricity theft. In terms of individual energy use this mode of electricity theft ranks a distant second to other more

Throw-Ups	5,2%
Other theft	0,8%
Defective equipment	3,0%
Incorrect installations	0,3%
Improper account set up	0,2%
Total	**9,5%**

Table 4: JPS non-technical loss causes.

sophisticated versions of illicit abstraction, such as meter bypasses by commercial enterprises and large residential customers in its impact on energy losses. Nevertheless, as can be seen from the analysis, cumulatively throw-ups account for the lion's share of non-technical losses and the company has historically placed great emphasis on this mode of electricity theft in its system loss reduction initiatives.

In excess of 30 000 illegal connections were removed from the system allowing for a theoretical, monthly reduction of 4 500 000 kWh of monthly electricity production.

This figure was derived from past efforts which identified and quantified the extent of non-technical losses within inner city "garrison"communities. Master meters were installed at the entrance of several of these communities that were devoid of any legitimate consumer. The number of "throw-ups" within the communities being used to steal electricity was counted yielding an average consumption of just more than 100 kWh per month per "throw- up".

Tightening of internal controls

One of the clear weaknesses identified in an early management audit consequent on the change of ownership of JPS was its poor internal controls. This presented abundant potential for revenue leakage. Such leakage would be most readily obvious, verifiable and of greatest revenue impact in the large customer rate categories. Audit of these accounts was therefore considered an effective strategy for loss reduction.

The effort resulted in more than 90 000 accounts investigated and close to 30 000 defects corrected yielding more than 2 000 000 kWh of incremental, monthly billing.

Gentle persuasion

The third axis of the company's strategy was a campaign to convert illegal consumers into customers. This it attempted to do through a community outreach programme working in conjunction with local political leaders. Inner-city communities, and in particular


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Copper thieving is a huge problem worldwide.
Thieves cut and remove exposed electric cables and "find" ready buyers in the black market. These greedy buyers in turn obtain their own sources of ruthless traders who melt down and resell the copper. This creates a chain of potentially dangerous results, such as - loss of revenue due to stolen cable, costly repairs, power outages which causes danger to personnel and rail transport which fail to operate.
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those identified as "garrison" communities were offered assistance in regularising their electricity supply in exchange for a minimum number of residents signing on. In an effort to reduce losses, recover some revenue from these consumers, and transition to the normal applicable residential rates a flat rate tariff was introduced in several communities. The flat rate was set at an effective level approximately one-half that of the normal residential rate.

While this effort succeeded in legitimising about 1600 consumers, it was not particularly successful as only a handful of these consumers consistently honoured their commitments.

Given the extremely volatile nature of many of these communities, the normal enforcement mechanism (disconnection of delinquent accounts) could not be routinely employed, thus weakening the "stick" element of the strategy. The 2002 organisation refinements were aimed at ensuring past deficiencies were more aggressively addressed.

Audits

Audit of large (R50, R40 and select R20) accounts were assigned to the Internal Audit Department. Their mandate was to ensure all R50 and R40 accounts were audited within three months of being set up and annually thereafter. The purpose was to identify and correct record keeping deficiencies (incorrect billing multipliers), meter defects, etc.

Audit of R20 accounts was to be accomplished every five years. Audits were meant to not only ensure meters accurately recorded energy consumed but also that correct potential and current transformer data were used for billing.

Progressive audits of R20 installations and audits of select apartment complexes, comparing cumulative, billed energy consumption to consumption recorded by a temporary master meter aided in detecting concealed by-passes yielding further system loss reductions.

These audits identified a number of issues that had not been previously noted. In several instances, defects issued for correction had not been acted upon due to a deficiency in the communication protocol.

Meters

The meter ordering and supply process was improved avoiding the need to temporarily connect customers without a meter.

Improvement in the meter control process, particularly at customer service centres, was implemented to minimise the risk of meters being withdrawn from stock and installed without proper authorisation. Particular attention was given to the timely return of meters to the Meter Department after withdrawal from service.

A large number of installed meters were unsealed. Most disconnections by the company were performed by contractors but they were not previously entrusted with disconnection seals. The Customer Service Department undertook to issue seals to contractors and ensure such issues were strictly accounted for.

Projects were undertaken by the Customer Service Department to ensure all in service meters were legitimised. In the first project, withdrawal of each meter, inspection of meter socket internals for shunts and meter testing prior to reinstallation and resealing was undertaken. The process was aborted without being concluded due to the extreme length of time taken. In the second project meters were simply re-sealed. The sealing of meters without inspection risked the possibility of some by-passes being "legitimised" behind a company seal but JPS decided that leaving meters unsealed facilitated meter removal and re-installation without detection with far greater potential for theft losses. The Customer Service Department rigorously reviewed field inspections and *corrections to advancing meters reflecting significant (>100 kWh) monthly consumption etc.*

Persistence and prosecution

While just less than half of the non-technical loss component of system losses was due to the conditions mentioned above, the remainder was due to approximately 150 000 highly visible throw-ups providing service to structures primarily within informal, inner city communities.

Because of a perception of lack of consequences associated with this practice, the phenomenon infiltrated many formal middle-income communities. A much higher profile was given to the removal of the throw-ups. Several of the raids received coverage by both the electronic and print media. Arrest and imprisonment of persons responsible, were pursued to remove the perception of lack of consequences. Additionally, in past times, areas were likely to escape being raided more than once a year. Individuals therefore restored throw-ups shortly after a raid with little chance of being disturbed for another year. The focus was changed to not only arrest and prosecute individuals for theft, but to also conduct repeated raids into areas to remove the feeling of comfort. The logic for this approach was based on an expectation that the stigma associated with the risk of arrest, fines, imprisonment, etc, would cause individuals involved in more sophisticated means of pilfering of electrical energy to desist.

Several individuals, including commercial customers, were arrested, convicted and fined under this new thrust.

In some areas the "throw-up" phenomenon appeared largely due to less than satisfactory socio-economic conditions. In others the problem appeared to be primarily due to prevailing attitudes of lawlessness.

In addition to continued vigilance and enforcement of the measures outlined earlier, one of the primary strategies pursued by the company was to forge a broader coalition of forces for a renewed thrust at reducing commercial losses. At the centre of this renewed effort was an acknowledgement that many of the factors driving the growth of non-technical losses were outside the ability of the company to control or influence. JPS therefore initiated a multi-sector, multi-prong approach canvassing support from the regulator, civic society, the political directorate, Commerce Chamber and the media.

Specific initiatives included:

- Enhanced collaboration between the company's senior management and a number of senior government officials, viz minister of national security, attorney general, and opposition leader to secure support of the political leadership for the company's effort to reduce, if not eliminate, this aspect of lawlessness which is presently prevalent in the country.
- The securing of a parliamentary commitment to introduce tougher penalties for electricity theft in new electricity laws being drafted.
- Closer ties were forged with law enforcement agencies to ensure adequate security protection was available to afford safe passage into and out of garrison communities to address theft problems. This measure alone was estimated to reduce total system losses by up to 2,0% (from 18,6% to 16,5%).

JPS continued to be affected by increases in world oil prices, which resulted in an overall 20% increase in the cost of fuel purchased by JPS during 2006, with very little expectation of a reduction in the near future. The increases in fuel costs had a negative impact on energy sales and directly contributed to an increase in the company's electrical losses, as more customers turned to electricity theft.

The gains in 2005 were effectively wiped out with the total system losses moving from 21,2% on average in 2005 to 22,9% in 2006. JPS once again intensified its efforts to reduce the theft of electricity. JPS carried out 138 arrests, audited 13 000 accounts; removed over 7000 throw-ups; and recovered approximately 9 GWh or J$100,5-million in retroactive and forward billing. The company also implemented an amnesty program which offered illegal users a 30-day grace period within which they could regularise their accounts with the company. This program resulted in the addition of approximately 5000 accounts to the system.

The company implemented a losses stand-down initiative. The program included sealing and barrel locking meters, repairing open circuits, replacing defective wires and auditing meters which showed zero readings and other irregular activity.

As part of efforts to get the public involved in the fight against electricity theft, JPS also introduced a new all-media campaign that successfully highlighted the legal consequences of stealing electricity while increasing the public's awareness of the safety implications of this illegal practice.

The investigations and analyses were undertaken during the year, as well as the introduction of a customer/feeder mapping project, which set the stage for a more intense loss reduction programme in 2007.

In 2007, JPS started to see some tangible results. Despite the continuing upward trend in world oil prices, which inevitably meant that customers paid more for electricity, JPS saw that the growth of electricity theft, had slowed, thereby reversing the trend of the previous five years. Overall, losses for 2007 went up marginally by 0,07% from 22,9% in 2006 to 23,2% in 2007. This result compared favorably to an average increase of 1% annually during the previous five years.

During the year, the company achieved notable successes with the discovery of several outstanding cases of theft among large business customers. This was the direct result of a concerted effort to focus more resources on the detection of theft and other anomalies among large customers, even as the company continued to focus on theft among residential users.

In 2007, JPS made 34 arrests, audited 15 000 accounts, removed over 25 000 throw-ups and recovered approximately 49 GWh or J$494-million in retro-active and forward billing.

In the last quarter of 2007, the company introduced an advanced metering infrastructure (AMI) program for priority commercial customers. This program significantly improved the company's ability to monitor customer consumption on the backbone grid on a real time basis, thereby significantly improving JPS's ability to detect non-technical losses. The first phase of the programme started in April 2008, while the second phase is planned for completion by April 2010.

Despite the considerable efforts made by JPS over many years, the company maintains that electricity theft is a matter that requires national attention from all stakeholders – the government, the police, social welfare groups, community leaders, influential members of the society, and religious organisations. The company position is that the stealing of electricity is a criminal act that cannot be tolerated and which has significant impacts on all honest stakeholders.

Russia and Eastern Europe

The problem of non-technical losses is known to be significant in Russia and Eastern Europe. The problem is reported to be most acute amongst industrial customers in Russia and at the domestic level in Eastern Europe; however the problem exists at all levels in both countries.

It is reported that the utility companies in these areas resort to "communal" metering whereby customers are allocated a share of the total bill according to individual customer metering. Should an individual pilfer electricity it will result in the remaining members of the "community" paying more than their fair share of the "communal" electricity bill. The utility publishes the payment allocated to each household so that the community can determine whether the allocation is equitable. Communal metering results in pressure on individuals to shoulder their responsibility as neighbours are less likely to be deceived by pilfering than utility staff. The utility company is indifferent if theft occurs beyond the point of the communal metering and the responsibility falls with community leaders or community support groups.

Electricity de Caracas, Venezuela

La Electricidad de Caracas (EDC) is an integrated utility, electricity and light provider in the Caracas metropolitan area, Vargas and Miranda and part of Aragua and Yaracuy states of Venezuela, with a population of about 6-million.

The company was acquired by AES in 2000, but was subsequently nationalised by the Government of Venezuela.

It is estimated that over half the population in the metropolitan area of Caracas lives in barrios (shantytowns). Most of these barrios are located on hills above the city. Few of their residents have a legal title to their property, which meant in the past that they could not get connected to the electricity grid. EDC had installed electrical lines in the barrios at the order of the municipal authorities, but as many people could not formally access the electricity, they started connecting illegally to the street lamps.

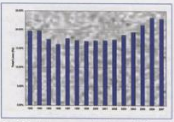

Fig. 2: Total losses reported by Jamaica PSC.

This soon resulted in a sharp increase in EDC's financial costs, exacerbated by the fast population growth of the barrios.

In 2000, the year AES acquired EDC (hereafter AES-EDC), non-technical losses attributed to electricity theft were estimated at 12% of energy produced, rising as high as 18% in 2004.

This level of losses was considered high even by developing country standards. In 2005, electricity losses represented some US$35-million in lost revenue. At the same time the number of accidents due to unsecured illegal electric connections increased steadily. It therefore became crucial for AES-EDC to find a remedy to this situation.

In 2003, AES-EDC launched the Barrio Eléctrico (Electric Shantytown) to turn illegal consumers of electricity into customers. This management initiative was conceived as an intervention favouring interaction among the community, the government and the company, with community empowerment at the core. Through the initiative, the company aimed to:

- Reduce non-technical losses attributed to electricity theft thereby restoring the financial situation of the company.
- Convert illegally connected consumers into paying customers.
- Increasing reliability and security of electrical connections.
- Improve quality of life of the concession area neighbourhoods.

Addressing the question of turning illegal consumers of electricity into customers required AES-EDC to undertake a learning process that involved organisational changes and abandoning old attitudes towards low-income consumers. The company's conservative management style and engineering focus had made it shun away from customers lacking property titles and it did not leave room for innovation in product service. Energy was supplied to areas of the city whose urban development had been approved by the municipal authorities, and was only extended to unplanned communities when those authorities commissioned the installation of the power lines. For a customer to arrange for the installation of a meter on his home to obtain electricity, he had to go to the company's offices, present a property or lease title, request the service and make a deposit.

The organisational change within the company started from the bottom up: the electricians and field crews confronted the situation in the barrios on a daily basis, where they were known as "cable cutters" because all they did was untangle illegal connections. The company's management realised that employees in lower levels had family or knew people in the barrios and understood life in those places much better, so it organised management meetings at all hierarchical levels to bring together executive managers and low- and mid-level employees. This spurred the change in organisational culture that was the prerequisite to start thinking about customer relationships in poor areas.

Operationally, the company radically changed its approach to power installation, billing and collection procedures, and it recruited a team of 20 social workers to build up a relationship with the communities in the barrios. The company soon learned that low-income consumers actually wanted a better supply of electricity and reliable street lighting to reduce crime. After initial hostility to the concept of paying for electricity, communities soon realised the benefits of stable power supply that would be gained from it.

After interventions in some barrios and as a result of initial interactions between community people and company relationship staff, the company developed an integrated solution consisting of the following initiatives:

- Installation and consolidation of electricity roundtables (Mesas Electricas)
- Improvement of the public lighting system
- Installation and maintenance of pre-paid meters
- Installation and maintenance of collective meters
- Creation and consolidation of electrical cooperatives (Coopeléctricas)
- Establishment of authorised community commercial agents
- Training of community leaders: leadership courses

A pilot project was launched in 2003 in Barrio La Morán, a low-income community populated in the 1980s in the hillsides of Caracas with some 1200 dwellings housing approximately 20 000 people. Previously, support to La Morán had come from church-organisations. But the barrio had no sewage system or running water. Nor did it have roads wide enough for vehicles. Access to the terraces where dwellings were located was by foot. The barrio was known for its community leadership, and the company managed to overcome its bad reputation as "cable cutters" through the initial organisation of "electricity roundtables". The role of the social workers the company hired was the key to building up a relationship with the communities. After the goal of the pilot project was explained, 300 of the 1200 dwellings were selected for a six-month follow-up, and they were assigned a rate of less than US$1,50 for the first 200 kWh used. In 2004, AES-EDC decided to introduce a pre-paid power card similar to the type used to pay for mobile phone services. First, it had to persuade community members that it was worth paying for electricity rather than stealing it. Then it had to remove the illegal wires that linked each dwelling or workshop to a lamp post and replace it with meters in each of the 300 households. And the company needed to obtain authorisation for the pre-payment system and tariff approval from the regulatory authorities, which was never obtained.

After its initial success based on the relationship between both parties in La Morán, the company went on to remove the tangled network of illegal cables in other barrios. On its first visit to a barrio at the outskirts of the city, the company team was received by residents with pistols in hand. Thanks to the intervention of community leaders and the expertise of social workers in interacting with the inhabitants, the goal of the visit was explained.

The team learned that the more distant huts were receiving less power and had to ration electricity, limiting the number of television sets that could be operated during the broadcast times of the most popular soap operas. With the removal of the illegal cable tangles, the service became more reliable and the repair costs of appliances damaged by power surges decreased. Customers with meters now had the opportunity to operate electrical equipment that required a stable electricity supply.

For the poorest consumers who could not afford an individual connection, the company installed collective meters, for which groups of people were made responsible collectively.

Thanks to community leaders, the company was able to identify residents who would assume responsibility for each collective meter. The company empowered such residents to coordinate the payment of bills and disconnect those who did not pay. The company also allowed certain payment delays for the poorest customers with irregular incomes before proceeding to disconnect lines. Also, to incorporate new customers in some barrios, the company installed individual meters with limited electricity.

Through its Barrio Eléctrico initiative AES-EDC managed to build up a positive reputation in communities once hostile to its personnel. It reduced the numbers of barrio residents considering free electric power as their right.

In commercial terms, electrical losses due to electricity theft decreased from around 18% in 2004 to around 15% in 2006, which represented a saving of around $6-million. Further gains were recorded during 2007 with the non-technical loss level falling to a national record of 12,74%.

Furthermore, communities that had previously helped themselves to free electricity became paying customers, potentially broadening the company's market in the future. In 2006, formal electric service user coverage was increased by 110 000 to 460 000. Electricity roundtables (176) were established, 300 pre-paid meters were installed benefiting 1200 people, 233 collective meters were installed benefiting more than 11 000 people, two electrical cooperatives were established with some 8400 clients incorporated, and 22 authorised communities commercial agents collected about US$15 000 per month, and 257 community leaders were trained in 16 communities and 12 institutions.

The initiative had further social benefits, including the removal of dangerous conditions from a lack of street lighting in many communities. Accidents related to the misuse of electrical installations decreased. Crucially, barrio residents who formerly had no access to the banking system were now eligible, since a utility bill with name and address was accepted to open a bank account. Huts that had been covered with cable tangles were cleaned and freshly painted. And the improvement of relations with the company also left communities more empowered.

AES-EDC found that communities had perceived it as a distant company, creating an attitude that electricity pilfering by poor communities did not have the attention of the company. AES-EDC realised that they needed to create a more visible presence by bringing the community and the company together. The company identified the needs of poor consumers and created service offerings of greater flexibility. The poorest dwellings were provided with collective meters, and trusted residents became payment coordinators. Barrio residents were not required to present a property title, an identification document was sufficient to qualify for connection to the power grid.

After its first initiative in Caracas, AES implemented this model in Brazil. AES consider that the first and most important step is to understand the particular necessities of local communities as well as the reasons why illegal connections are made and why some areas are not served. AES considers that the use of social workers and of the company's field crews of electricians is crucial for the company to become a close and active partner of these communities.

Other Latin American countries

The Argentine and Chilean governments included technical loss-reduction targets in the concession agreements for newly privatised distribution companies. In contrast, the Brazilian government did not establish loss-reduction targets for newly privatised distribution companies. The distribution companies were allowed to pass through the full quantity of power purchased. In early 2003, for the second, multi-year tariff period of two distribution companies, the Brazilian Regulator established loss-reduction targets rather than just accepting the full quantity of power purchases.

India

The non-technical losses of Indian State Electricity Boards are estimated to be as high as 40% – 50%. Historically, families in India's poorest neighbourhoods could only receive electricity if the household proved legal residency and guaranteed that it could cover the cost of distribution. But very few poor households could prove ownership and even fewer could raise the upfront costs of connecting to a grid. About 40% of homes in poor neighbourhoods have illegal power connections, but the supply is unreliable and costs twice as much as a legal connection. The estimate of 40% energy losses is based on the count of illegal connections in such neighbourhoods.

Law

In July 2000 the state government amended the Indian Electricity Act of 1910 to make electricity theft a cognisable offence and impose stringent penalties. A separate law, unprecedented in India, provided for mandatory imprisonment and penalties for offenders, allowed constitution of special courts and tribunals for speedy trial, and recognised collusion by utility staff as a criminal offence.

Advance preparations ensured that the government was able to constitute special courts and appellate tribunals as soon as the new law came into force. The utility service areas were divided into 24 "circles" coinciding with the state's 24 administrative districts. A special court and police station were established in each circle to ensure rapid detection and prosecution of electricity theft. And the state police and anticorruption units of other government departments were directed to support utility employees in inspections to control theft.

In addition, consultations were held with labour unions about the proposed legal provisions for making collusion by utility staff a criminal offence. Assurance that old cases would be excluded under the new law helped secure the unions' consent to punitive action against staff caught colluding in theft. Disciplinary action was taken against 218 employees and criminal cases launched against 87 employees involved in stealing electricity and misappropriating funds and materials. In the first three years after the law's enactment the authorities pursued more than 150 000 cases, compared with 9200 in the previous 10 years, and arrested more than 2000 defaulting customers. The government's political resolve to combat theft was tested when some politically powerful people (including a member of the legislature) were charged with electricity theft. The cases went forward, and the proof that even the most powerful were subject to the new law, and that utility officials would be protected from interference, generated broad support amongst the public as well as utility employees.

The Electricity Act 2003 gave full freedom to vigilance engineers in detecting power theft, confiscating machineries, papers, document related to production etc. and permitted utilities to frame their own rules. However the effectiveness of this law has been reduced as the states have not created matching legislation to empower the State Electricity Boards.

Theft control program

The government also initiated institutional changes in the utilities. Their anticorruption department was strengthened by promoting its head from an advisory to an executive position on the board, and the organisational structure was modified to strengthen the department's coordination with other departments. In addition, the anticorruption department's procedures were made simple and transparent. Inspecting officers provide an inspection report with an identification number to customers on the spot and carry numbered receipts so they can accept payments of fines.

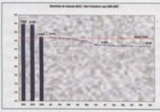

Fig. 3: Electricity de Caracas reported non-technical losses.

Police stations provide public notification of all theft cases. A tracking system followed the progress from inspection to payment of fine or prosecution. More than 2000 inspection teams were deployed throughout the state to launch the theft control drive.

The government launched a communication program through media ads, posters, and videos, and a public outreach program through visits by special teams and regular public meetings with utility managers. The outreach campaign deployed about 600 teams to conduct town hall meetings in all settlements with more than 200 residents. The teams informed people about the proposed new law and the penalties for electricity theft and gave everyone the opportunity to obtain an authorised connection on the spot after paying a connection fee. They also explained the utilities' deteriorating financial situation and the effect of electricity theft on their costs and tariffs.

In the initial phase the theft control program focused on high-value customers. Dedicated feeders were constructed to supply large industrial customers, which were also provided high quality, tamper-proof electronic meters, and protective boxes were installed on transformers.

Meter reading instruments were provided to inspection teams to download monthly data, allowing analysis to identify customers whose monthly consumption varied by more than 2%. Irregularities in metering and billing were found for about 15% of the 23 000 industrial connections – and 10% of the 3000 commercial connections – inspected in 2001. In many cases it was determined that the electricity theft was not for direct monetary gain. In certain industries, the excise duty, sales tax, etc. was determined based on the actual consumption of energy. In order to evade these expenses, some companies pilfered energy.

In the case of residential customers, inspections focused on 11-kilovolt feeders with high line losses and on 114 towns accounting for 53% percent of consumption and 60% of revenue.

Delhi Vidyut Board

On July 1, 2002, the Delhi government sold a 51% equity interest in each of three new distribution companies that had been created out of DVB, the state-owned enterprise that had served the metropolitan area. At the time of privatisation, DVB was a sick enterprise. It had technical and commercial losses of more than 50% and receivables of more US$400-million. Consumers were unhappy with the DVB's quality of service and the endemic corruption. For several years the Delhi government had been forced to prop up DVB with annual subsidies of US$200 to 300-million through loans that no one expected would be repaid.

The negotiated sale to BSES and Tata Power, two private Indian companies, was the first major distribution privatisation after several failed efforts elsewhere in India.

When it appeared that the government's efforts to privatise would fall victim to regulatory uncertainty, the Delhi government decided to issue a "policy directive" to the Regulator. The directive required the Regulator to accept realistic initial values for technical and commercial losses, and to adjust tariffs based on the loss improvement trajectory proposed by the bidders and accepted by the government.

Andra Pradesh Electricity Board

In 1999, the Chief Minister of the Indian state of Andhra Pradesh, decided that it would be impossible to privatise the state's power enterprises unless power theft was reduced. With the active encouragement of the Chief Minister, a strict anti-theft law (the first of its kind in India) was passed by the state legislature and went into effect on 1 July 2000. The new law provided for:

- A minimum mandatory punishment of 3 to 60 months imprisonment for the theft of electricity
- Mandatory financial penalties ranging from a minimum of US$120 to a maximum of US$1200
- Residents convicted of stealing electricity would be prohibited from receiving electricity for two years
- The establishment of special courts and tribunals to quickly try cases under the new law

Before the law went into effect, AP citizens were given the opportunity to pay back bills and to "regularise" their status (i.e. to become legal customers if they were illegally connected or their request for legal service had not been processed). In a state of about 75-million people, about 1,9 million applications were received for "regularisation". Once the grace period ended, the law was vigorously enforced. From July 2000 to April 2002, more than 2800 people were arrested for stealing electricity (including 87 utility staff and two members of the Legislative Assembly). Over an 18-month period, billings for electricity increased by 34% and revenues increase by 44% (while average tariffs increased by 15%). Nevertheless, the state-owned power enterprise still experienced major deficits because even with the increase in collections, a large number of agricultural and domestic consumers continue to be supplied electricity without metering and under tariffs that recovered only a small fraction of the cost to serve them.

In a random sample of Indian electricity consumers, about 30% reported paying bribes to employees of power enterprises. Usually, the bribes were paid to linesmen, meter readers and billing employees. This is probably an underestimate for two reasons. First, the survey was limited to individuals and therefore does not capture bribes paid by corporations. Second, it probably fails to capture consumer initiated corruption.

The total losses of the Andra Pradesh Electricity Board, losses were measured at 38% in 1999 and following the changes to the law were reduced to around 26% by 2003.

West Bengal Electricity Board

West Bengal, in common with much of India, has a large electricity theft problem.

The board has introduced a program to replace LV reticulation with a high voltage network comprising long feeders and smaller transformers serving two or three customers each. These transformers are metered at the pole and customers are informed that any illegal taps taken off their service line will be recorded as part of their metered consumption. West Bengal reports that this approach has been highly successful in reducing electricity theft[2]. They have also fitted permanent LV metering to 90% of their distribution transformers to allow assessment of the actual non-technical losses. These meters give 3 phase power readings on a half hourly basis which are collected by VHF transmission. The data provides information on overloads, line loading balance, and supports the identification of losses as the distribution substation demand can be readily compared to the metered demand.

Turkey

Non-technical losses are generally lowest in the developed and urbanised districts, several of which have been privatised as part of the government's ongoing program.

Non-technical losses in 20 Turkish regions were as shown in Table 5 in 2007[3]:

Initiatives to improve the situation commenced in 1996 but attempts to "privatise" the problem have stalled repeatedly for legal and political reasons. In addition, although the non technical losses are due to all of the "conventional" reasons, including untidy low voltage networks, unsupportive legal systems, meter tampering, poor billing systems etc. little progress has been achieved in reducing NTLs due to a lack of institutional strength and poor management of the state owned utilities.

The Republic of Turkey's Privatisation Administration ("PA") initiated the privatisation of Turkey's electricity distribution utility, Turkiye Elektrik Dagitim Anonim Sirketi ("TEDAS") in 2003. TEDAS is a Turkish State-owned joint-stock company engaged in the distribution and retail sale of electricity and provision of retail services to final customers. With approximately 29,5-million customers, 126-billion kWh of electricity sales and 98% market share in electricity distribution across Turkey in 2007, TEDAS and its distribution companies together form one of the largest organisations in the country.

Privatisation of distribution companies will be executed using a Transfer of Operating Rights ("TOR") backed by a Share Sale model ("TSS model"). According to this model, the investor will be the sole owner of the shares of the distribution company and will be the unique licensee for the distribution of electricity in the designated region without retaining the ownership of distribution network assets and other items that are essential for the operation of distribution assets. The ownership of these distribution assets will remain with TEDAS. The investor, through its shares in the distribution company, however, will be granted the right to operate the distribution assets by a Transfer of Operating Rights Agreement ("TOR Agreement") with TEDAS.

Under the envisaged market structure, privatised electricity distribution companies will operate as regional monopolies with distribution licenses granted by Energy Markets Regulatory Authority ("EMRA"). As part of ongoing liberalisation efforts in the energy sector, Turkey's distribution network was divided into 21 distribution regions based on geographical proximity, managerial structure, energy demand and other technical/financial factors. After the inclusion of TEDAS in the privatisation program, a separate distribution company was established by the PA in each one of the 20 distribution regions owned by TEDAS. The geographical coverage of the distribution regions are provided in the

[2] This approach means higher numbers of transformers with attendant technical losses. West Bengal has chosen to optimise non-technical losses even if their method results in higher technical losses. [3] Privatisation of Turkey's Electricity Distribution - Industry Republic of Turkey Prime Ministry Privatisation Administration.

Regions	NTL %	Customers 2007 (m)
DQCLE edol	64,7%	0,97
VANGÖLÜ edal	56,2%	0,39
ARAS edal.	29,4%	0,70
ÇORUH edal	12,0%	0,97
FIRAT edal	11,0%	0,65
ÇAMLIBEL edal	8,8%	0,72
TOROSLAR edal	9,8%	2,51
MERAM edal	7,9%	1,48
BASKENT edal	8,7%	2,95
AKDENQZ edal	9,3%	1,40
GEDQZ edal	8,6%	2,29
ULUDA' edal	7,3%	2,21
TRAKYA edal	7,9%	0,74
AYEDAL	9,4%	1,98
SAKARYA edal	6,2%	1,27
OSMANGAZQ edal	6,3%	1,24
BO'AZQÇQ edal	12,5%	3,72
MENDERES edal	7,0%	1,44
GÖKSU edal	8,0%	0,47
YELQLIRMAK edal	9,1%	1,44
Average	**14,8%**	**29,52**

Table 5: NTL in Turkey for 2007.

following map. Menderes EDAS has been excluded from the privatisation program in 2008. The only distribution region operated by a partially private company is Kayseri (Region #18), whose operating rights were transferred to KCETAS in 1990.

According to the general principles as stated in the Electricity Market Strategy Paper1, Turkish Electricity Market has gone through a process of vast restructuring in core activities ranging from generation to distribution. Accordingly, a new tariff structure has been developed inline with the new structural requirements in mind.

The main purpose of the market liberalisation is to achieve lower tariffs by increasing overall system efficiency. Accordingly, the tariffs are calculated as "cost-reflective" based on pre-determined operating and loss/theft improvement targets.

The first tariff implementation period (or transition period) has been set as the period from 2006 to 2010 to serve as the transitory period to fully cost based tariff structure after 2010. EMRA has already approved the end user tariffs and revenue requirements of each distribution company for the transition period. Revenue requirements cover the projected expenses for providing distribution and retail services and provide an allowance for the target level of technical and non-technical losses. The end-user tariffs for the period after 2010 will be determined by the distribution companies in accordance with the Electricity Market Tariffs Communiqué and the related regulations again in a cost-reflective fashion and will be subject to the Regulator's approval.

It remains to be seen whether this combination of privatisation incentives and tariff targets (with loss reductions phased over time will succeed in reducing NTLs. Indeed, the financial incentives will more than compensate the private investors for their efforts.

Provincial Electricity Authority (PEA), Thailand

PEA determines the total system losses by subtracting the energy generated and purchased (system input) with the energy sold and provided to some consumers without charge (system output). PEA energy input in 2001 was 53 034 GWh or 53-million MWh. The total losses reported in 2001 amounted to about 2,5-billion kWh, or approximately 5,69%.

PEA undertakes inspections of meter and discovered incidents of meter violation – a key indicator of non-technical losses – between October 2000 and June 2001, amounting to a total of 130 violations for high-voltage meters, and 2167 cases for low-voltage meters. The total number of violations was very small compared to PEA's installed population of 11 400 000 meters.

According to PEA estimates, the 127 high-voltage meter violations found between October 2000 and June 2001 resulted in the recovery of 4904 MWh lost.

PEA estimated the total losses recovered due to electricity theft at 8 000 000 kWh. This means that electricity theft found only accounted for about 0,32% of the total system losses or about 0,018% of the system's total energy input.

PEA has guidelines and policies for dealing with electricity theft, as shown in Table 8. Table 9 shows the inspection schedules for the group responsible for inspecting high-voltage (115 kV, 69 kV, 24 kV, and 12 kV) and low-voltage (loads with 380 V line-to-line) meters. The quantity of 220 V meters is too great to make a dedicated inspection effort, so the inspection workload for those meters goes to the unit-readers who are also trained to detect improprieties.

The total amount of estimated recovered loss due to electricity theft in the period between October 2000 and June 2001, about 8-million kWh, is very small compared to the total losses of the system. The total losses of the PEA system is characterised by subtracting the energy generated and purchased (system input) with the energy sold and provided to some consumers without charge (system output), and the total losses amounts to about 2,5-billion kWh, approximately 5,69% of the system input. This means that the electricity theft found only accounts for about 0,32% of the system losses, or about 0,018% of the system's energy input.

EDL, Lebanon

In the post-war period, Electricity of Lebanon (EDL) was facing the consequences of a war that extended over approximately 17 years. Technical and non-technical losses were abnormally high and considered to be well above acceptable international standards.

EDL was experiencing difficulties in revenue collection management and in detecting illegal wire tapping. The company decided to develop their GIS systems (ESRI platform) and to use it to track collections and losses. The system depends on an energy map that supports real time capture of energy-related data. Energy data is supplied from the meter reading database at each level of the distribution network, allowing for a reconciliation of energy-in and energy-out. The tool is reported to be effective in the management of collections, technical and non-technical losses as reports can be generated on monthly basis at any point in the distribution network.

Guyana power and light, Guyana

Guyana Power and Light (GPL) reports the level of total distribution losses at almost 40 percent of the energy generated, well above

High voltage consumers (8 months of data)		
Violation type	**Cases found**	**%**
Tampering with terminal seals	69	54,3%
Tampering with meter seals	30	23,6%
Breaking control wires	12	9,4%
Shorting control wires	5	3,9%
Breaking the voltage taps	5	3,9%
Direct connections to grid	3	2,4%
Switching control wires	3	2,4%
Tampering with the meter	2	1,6%
Total	**127**	

Table 6: PEA, Thailand HV customer violation statistics.

Low voltage consumers (8 months of data)		
Violation type	**Cases found**	**%**
Direct connections to grid	677	31,2%
Using alternative neutral lines	541	25,0%
Phase-to-phase connections	270	12,5%
Meter tampering/ breaking meter seals	270	12,5%
Other	409	18,9%
Total	**2167**	

Table 7: PEA, Thailand LV customer violations.

Billing services	Target timeframes
Billing for fines, revised rates, and meter depreciation for large consumers Billing for fines, revised rates, and meter depreciation for small consumers	Within 7 office days of receiving results from the Evidence Department, the fines are sent out. Revised rates and depreciation bills are sent out within 15 office days. The revised rates and fines are both sent out within 7 days of the reports of damaged meters. If the fines and bills in items 1 & 2 do not elicit any response from the consumer within 3 months, the case is summarised and sent on to the legal department of the respective district office.

Table 8: PEA policies for billing customers who perpetrate electricity theft.

Audit / inspection	Goal / schedule (inspection cycle and % inspected per annum)
PEA operations: • Reports for routine meter checks • Reports for meters with past violations and suspicious business groups • Major consumers with recent meter installation/changes • Results from checking large consumers with irregularities • Results from checking meters with zero unit reading • Results from fine and revised rates collections for large and small consumers	Reports of results in items 1 a) through 1 f) are to be submitted to the district offices for each month by the 7th of the following month.
Results reports for each district, combined with reports from item 1) above.	Every meter-checking activity results and results from fines/revised rates for each month is to be summarised and reported to the deputy head of each district. The deputy heads of districts then follow up and make necessary changes in operations and a report is submitted for each month to the Electricity Economy Department by the 15th of the following month.

Table 9: PEA audit/inspection.

the 13,5% cap set by regulatory authorities. The losses arise from a failure to enforce collection of bills, and to eradicate theft and corruption in under-billing of the service.

The objective of GPL is to reduce total losses to 15,4% by the year 2010, made up of 10,3% technical losses and 5,1% non-technical losses. GPL's strategy relies mainly on the threat of prosecution and removal of illegal connections as the level of non-technical losses is considered as extreme and there are elements of lawlessness within the community.

Others

In more developed countries, the cost of electricity as a % of household income is relatively low. This leads to lower levels of electricity pilfering.

United States

The International Utilities Revenue Protection Association reports non-technical losses to be as high as 4%. This figure appears to be rather high for a developed country and may reflect a political agenda on the part of the IURPA.

Australia and New Zealand

Non-technical losses in Australia and New Zealand are reportedly low.

In 2006, Energy Australia reported a non-technical loss figure of 0,19% based on a rigorous measurement programme that assessed losses throughout their network. Energy Australia conducted a major study into system losses which yielded a non-technical loss figure of 0,03% in 2005 and 0,19% in 2006, against total system losses of 5,01% and 5,23% respectively.

Energy Australia relies on a consistent flow of reports from staff and the public giving rise to investigation. Energy Australia uses approximately 150 compact recording instruments (theft monitors). These are installed in the street to check the meter readings at premises under investigation. In 2007, this process was expedited by taking special meter readings at such premises, allowing many checks to be completed in a matter of weeks rather than a full 3-monthly billing cycle.

In New Zealand, non-technical losses are considered to be between 0,3% and 1%.

Source of non-technical losses	%
Electricity theft	11,0%
Defective meters	11,3%
Billing system errors	6,5%
Total	**29,0%**

Table 10: GPL sources of non-technical losses.

United Kingdom

In the UK, utilities have reported non-technical losses to be in the region of 0,2% and 1%, i.e. comparable to the levels observed in Australia and New Zealand.

The United Kingdom Revenue Protection Association (UKRPA) responded to an Ofgem consultation (22 March 2003) with an estimate of 1 to 1,5%.

Summary of NTL loss reduction methods

The themes that emerge from a comparison of the practices employed in non-technical loss reduction around the world are as follows:-

Measurement and estimation

All utilities measures "top down" losses as the difference between purchased energy and energy sold. Energy Australia's study of losses provides an argument in favour of measuring losses on a 3-year rolling basis to remove seasonal variations. All estimates of non-technical losses are based on the accuracy of the calculation of technical losses (assuming that administrative losses are accurately known) subtracted from an estimate of total system losses. Some utilities measure energy sent out at intermediate points in the distribution network, e.g. at 33 kV and 11 kV substations and/or distribution feeders, and reconcile the energy against consumption recorded by electricity meters that are downstream from the meter location. The most common practice is to install metering at large substations on the high or medium voltage side.

Deterrence

Resource allocation: Large users account for a high proportion of the revenue lost through theft, and revenue protection resources are allocated on the basis of revenue lost.

Large user inspections: Inspections are made on random but frequent basis in order to create perception in the minds of large users that there is a high risk they will caught if they resort to electricity pilferage

Large user off-cycle meter reading: Off-cycle meter reading is undertaken on random basis to create a perception that temporary meter tampering (between normal cyclic meter readings) is a high risk activity.

Community programs: Pilferage tends to occur in close knit "communities" where illegal behaviour becomes established as a cultural norm. This problem cannot be tackled by law enforcement alone as such attempts tend to draw the community closer together. Furthermore there is a general government and community backlash against punishing poor communities. If the problem is dealt with by local officials and employees, who understand and have influence in the community, then a change in the attitudes of the community is more likely.

High loss circuits: High loss circuits are identified and targeted for inspections on a "saturation" basis.

Billing exceptions: Where billing exceptions suggest electricity pilferage is a possibility, the utility contacts the customer (by call centre outbound call is efficient) to ensure that the customer is aware that the utility is vigilant; this creates a perception within the community that there is a high risk of being caught if a customer engages in illegal pilferage.

Anonymous reporting: Utilities provide opportunities for customers to report pilferage anonymously, through a hotline, and through an email link on the company's home page. It is important to emphasise that the identity of a person making such a report will remain anonymous. A relatively large number of pilferage cases are reported by disgruntled employees or during domestic arguments.

Pre-payment metering: Has successfully reduced losses as in general these meters are more difficult to "tamper".

Communal metering: Communities are metered at a single remote location (where tampering is difficult) and all customers are billed based on a consumption determined by pro-rating using their individual meter reading. This acts to deter offenders through direct community pressure.

Fines and imprisonment: The law in some countries is not always prescriptive regarding the fine that a court can apply. In the case of criminal prosecution, when charges are pressed and the police are involved, fines and jail terms may be determined by the court. Jail terms are usually a last resort that applies when the party found guilty cannot pay the fine. When the amount of revenue loss is high, the utility pursues the customer in court and uses media connections to make sure that the details of the offences are reported in the press. In the USA, the law provides for strong penalties for electricity or gas theft. The grading and punishment is shown in Table 11.

Detection

It is common to find that dedicated employees are deployed in order to check large user metering and metering installations on a random but regular basis whenever electricity pilferage is having a significant impact on revenue. These staff are usually organised and trained under the aegis of a revenue protection department. It is important that this department reports at the highest level in the utility.

Meter reading staff may also be trained to detect the most obvious cases of meter tampering and illegal connections, but this is not observed as a best practice or even a widespread practice. In some countries such as the United States, Australia and New Zealand, the use of outsourcing has worked against this practice. American Electric Power (AEP) is one exception where meter readers are trained to detect meter tampering by the revenue protection department. In developing and developed countries there are concerns regarding corrupt behaviour on the part of meter readers. In most cases meter readers are rotated to ensure that they do not develop close relationships with customers. (Internal auditors are sometimes used to check on meter readers – one telltale sign is a meter reader who prefers not to take time off for fear that one of his "customers" will inadvertently tip off the stand-in meter reader to any arrangement that is in place).

Detection of illegal connections in particular, and household meter tampering, is also dealt with by operations employees. The rationale for this approach is that these employees usually have links to the local community and social welfare groups. Once again there is a risk that employees may be tempted to make arrangements with domestic customers but this is less likely when these employees move about in teams.

Some utilities measure and provide incentives against employee performance through the use of kWh recovery targets or by the count of cases detected.

Apprehension

Apprehension of customers who pilfer usually involves the support of the police who conduct joint raids on customer's premises with the utility.

Theft amount (US$)	Maximum fine (US$)	Max prison term
Greater than $2000	Felony of the 3rd Degree with maximum fine of $15 000	7 years
Greater than $200 but less than $2000	Misdemeanor of the 1st Degree with a maximum fine of $10 000	5 years
Greater than $50 but less than $200	Misdemeanor of the 2nd Degree with a maximum fine of $5000	2 years
Greater than $50	Misdemeanor of the 3rd Degree with a maximum fine of $2500	1 year

Table 11: Grading of electricity theft and punishment, United States.

The law enforces the rights of the utility with respect to access for the purpose of inspection of wiring and metering installations and the utility takes advantage of their powers to protect their commercial interests.

Monitoring

Monitoring is undertaken through summation reconciliation of grid metering, communal metering and metering at customers premises. Check or temporary metering is used to detect electricity pilferage.

Another important source of monitoring data comes from the billing and collection system. However it is not generally reported by utilities that low consumption or sudden reductions in consumption provide reliable indications of electricity pilferage. Utilities monitor meter advances and meter readers are used to report obvious signs of occupancy and / or electricity use in premises that have been disconnected.

Recovery

Recovery involves the customer paying for stolen electricity along with a fine commensurate with the amount of electricity stolen (as discussed under deterrence). It is also generally seen that a utility is able to recover the full costs of repairing meters, wiring, etc. The energy is estimated based on the customer's end use profile and the period of time over which it is believed that the energy has been stolen. The time period is usually determined from the historical billing pattern.

The current policy of the ERC is to allow JEPCO to recover the amount of the stolen energy + a 25% penalty + the cost of repairing meters, wiring etc. JEPCO estimates the amount of energy stolen in a consistent manner to that observed elsewhere.

Utility positioning

Utility positioning on non-technical losses is largely a function of the regulatory drivers and to some extent on ownership, i.e. government versus investor-owned.

Where caps are applied to non-technical losses, it is evident that utilities focus effort on managing losses within the cap. In other cases, particularly where utilities are government-owned, higher levels of non-technical losses are tolerated. In general however, there is a relationship observed between the level of losses and the manner in which the utility positions itself. The term positioning is meant to describe the attitude that the utility presents to external stakeholders.

For the most part utilities resort to legal means to recover lost revenue from commercial or industrial customers who engage in pilfering. The community is generally supportive of the utility prosecuting business owners willing to engage in electricity pilfering.

At the small consumer level however, utilities position according to the severity of the losses problem.

When non-technical losses exceed 15%, utilities send messages to the community that theft will not be tolerated and the full force of the law will be applied. The utility uses media coverage to highlight successful prosecutions, and offers rewards for information leading to prosecution.

The utility positions itself as an "electric" police force. When non-technical losses are between 8 to 15%, utilities send less stern messages to the community regarding theft and are more inclined towards developing joint solutions that meet the needs of disadvantaged groups. Prosecution remains an option, but emphasis is placed on cooperation between the utility and community.

The utility positions itself as socially responsible (assisting the disadvantaged while protecting the rights of honest customers) – a firm but fair positioning.

When non-technical losses are between 2 and 8%, utilities act to recover losses and apply fines but do not take electricity pilferers to court unless they offend repeatedly.

The utility positions itself as vigilant and ready to take action to recover its losses and penalise offenders directly (at least on the first or second occasion after which the utility may resort to legal action).

When non-technical losses are less than 2%, the utility remains vigilant and acts on information of theft reported by the public.

The utility positions itself as neutral (there is little in the way of communication regarding theft). Electricity pilfering remains below the line as a low key issue.

Acknowledgement

Our thanks and acknowledgment to Parsons Brinckerhoff for their permission to present this Paper.

National Code of Practice: emergency load reduction and system restoration practices

The country's infrastructure, of which the power system forms an essential part, is exposed to a variety of threats. Unlike countries more regularly exposed to the impact of such threats, South African society is relatively unprepared for the associated disruptions. The increasing dependency of society on electricity, and the potential for such threats materialising, requires that deliberate predetermined measures to be implemented to manage such emergencies and enhance the resilience of the country.

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NRS 048-9 Edition 1 - Load reduction practices, system restoration practices, and critical and essential load requirements under system emergencies - has been compiled by a working group including representatives of the South African Electricity Supply Industry, NERSA, government, and customer groupings (inter alia formal representation of the Energy Intensive User Group). The document specifically addresses system emergencies – defined as: "a situation arising on the system as a result of significant loss of generation, transmission, or distribution plant, and/or where all due precautions and interventions fail to prevent the integrated power system or a localised part of the system from approaching or entering a state of collapse" [2].

Scope of NRS 048-9

NRS 048-9 is a code of practice that provides a national protocol for the management of two categories of system emergencies: Load shedding and/or curtailment under national or regional system constraints, and load restoration after a national or regional blackout.

It also provides guidelines on the treatment of critical loads; addressing essential power requirements of customer installations; and measures to be taken within individual customer installations in the event of supply interruptions or load shedding/curtailment.

Key concepts and definitions

The code of practice provides a set of national definitions (common vocabulary) for concepts related to system emergencies.

Key definitions are:

- *Blackout:* unplanned loss of supply over a wide geographic area (e.g. national or regional area).
- *Load curtailment:* load reduction obtained from customers who are able to reduce demand on instruction (by system operator or its agent).
- *Immediate load curtailment:* load that is curtailed within (typically 10 min) of the instruction being issued.
- *Notified load curtailment:* load that is curtailed within hours (typically within 2 h) of the instruction being issued.
- *Load shedding:* load reduction obtained by disconnecting load at selected points on the transmission or distribution system.
- *Automatic load shedding:* load that is shed by automatic defence schemes in response to a sudden threat to the system (e.g. sudden trip of several generation units).
- *Manual load shedding:* load that is removed by a human operator.
- Load reduction: the reduction in system load that can be achieved by load curtailment and/or load shedding.
- *Essential load requirement:* minimum customer load requirement (e.g. MW, notification time, and duration) to avoid a direct and significant impact on the safety of people, the environment, and physical plant/equipment for nationally critical products, and which has been specifically notified as such by the customer to the licensee.
- *Critical loads:* loads that should as far as possible be protected from the impact of load shedding or loss of supply in order to either maintain the operational integrity of the power system, or to avoid a cascading impact on public infrastructure.

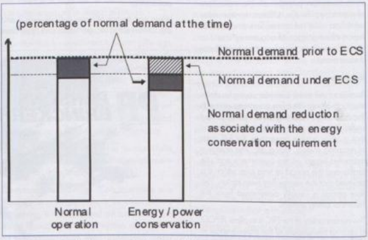

Fig. 1: Emergency load reduction required before and after energy conservations scheme implementation.

Load reduction principles

The (emergency) load reduction practices in the code of practice are based on seven principles:

- The integrity of the national automatic under-frequency load shedding system shall not be materially compromised by manual load-shedding or curtailment.
- All customer installations shall be considered for load reduction under a system emergency, based on broadly equitable participation by customers.
- Critical and essential load requirements shall be addressed in accordance with the code of practice.
- Time-based manual load shedding shall be applied.
- Load shedding schedules shall be developed, maintained, and be available to customers.
- Load shedding schedules and curtailment requirements shall be defined up to a

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predefined maximum load reduction. Where more load shedding is required, this is regarded as an extreme system condition explicitly excluded from the above principles 1 to 5, and which will be handled in accordance with the situation prevalent at the time.

- Load reduction achieved under an energy conservation programme shall not be considered as emergency load reduction, i.e. a customer complying with the full reduction requirements of such a programme shall still be required to reduce load under a system emergency in accordance with the requirements of this code of practice (Fig. 1). Exemption from early stages of load shedding may be considered for customers who achieve more than the required reduction.

National generation constraint

The specific reduction in load required to stabilise the system under a national generation constraint will be dictated by the conditions prevailing at the time. In order to facilitate the development of load shedding and curtailment schedules (that can be made available to the public) pre-determined stages of load reduction are specified. These stages are summarised in Table 1. Under a system emergency, the National System Operator will declare the applicable stage of load shedding.

Load reduction: stage 0

Stage 0 represents the first stage of load reduction under a system emergency. It is intended to be available at short notice and is hence unscheduled. The actual level of load reduction called on will be determined by the amount of load made available by customers under the immediate curtailment option. Customers eligible for this option shall meet the following requirements:

- At least 25% of normal load can be made available for immediate curtailment.
- This curtailment can be maintained for an agreed period after the instruction is given to curtail (e.g. for a period of 2 h).
- The curtailment can be effected within an agreed time frame (typically 10 min to an hour).
- This curtailment does not affect the integrity of the national under-frequency load shedding scheme (i.e. load that is on the under-frequency shedding scheme may not be eligible for curtailment under this stage).
- The required load curtailment can be measured and verified.
- The customer's essential load requirement is met during this curtailment.
- Protection of this customer from load shedding shall not result in the need to exclude significant other load from load shedding due to network limitations (i.e. recognising this customer may not be on the same circuit as other customers that are on the load shedding scheme). Where this customer represents over 80% of the load supplied by a specific feeder, curtailment may be considered. Alternatively, where the customer can offer the equivalent load for curtailment for the total feeder, curtailment may be considered.
- Actual load curtailment instructed during an event meets the requirements agreed on with the licensee.

Curtailment in the event of a system emergency is considered an "imposed" reduction rather than a contracted reduction as in the case of demand-market participation (which in many cases will have already been called upon before the emergency).

Customers who participate under the immediate load curtailment scheme (stage 0):

- Shall be excluded from stages 1 and 2 of load shedding and/or curtailment until 24 h after notice to reduce under stage 0 has been given, and shall not be called upon again within 24 h during stage 0.
- May return to normal demand after the agreed curtailment period (subject to the system emergency remaining under stages 0, 1, or 2).
- May not exceed normal demand during the emergency.
- Shall participate under the delayed curtailment or shedding schemes for stages 3, and 4 if required.
- May revert to notified curtailment within 24 h notice to utility.

Load reduction: stages 1, 2, 3

The national level of reduction required under stages 1 to 3 is defined at each stage as a percentage of the national load. This reduction is achieved by both load shedding (according to pre-defined schedules) and by reduction required from customers eligible for notified curtailment

All customers are by default included in load shedding schedules, with the exception of:

- Critical loads and loads with essential load requirements, where such exceptions are provided for in the code or practice
- Loads that meet the requirements for immediate or notified curtailment
- Some loads that participate in the merit order.

Load shedding (scheduled)

Licensees shall develop and maintain load shedding schedules. Maintenance of the schedules shall include ad-hoc revisions in response to changes in the operating environment, as well as a formal review every year.

In the case of stage 1 and 2 schedules, the total load required to be shed by a licensee shall be scheduled by assigning customer loads to specific time slots. Schedules shall be prepared from 06h00 to 22h00 daily. Where possible, these schedules shall be designed to minimise the impact on various types of customers in the selection of time slots. In the interest of "stable" schedules, published schedules might indicate that customers are impacted for 2 h every second day under stage 1 and for 2 h every day under stage 2 (i.e. stage 1 schedule is doubled in frequency).

Stage 3 schedules shall be prepared to meet the additional reduction requirement on a 24 hour basis. In the (unlikely) event that national load shedding is required between the hours of 22h00 and 06h00, such shedding shall be undertaken on an ad-hoc basis under instruction from National Control.

Although utilities would establish time-based schedules using specific time slots (e.g. 2 h), customers may engage with utilities to consider alternatives such as doubling the duration of being shed, whilst reducing the frequency of such shedding. Such discussions need to be finalised well before an emergency to ensure that the schedules are adapted for this request. It is noted that such requirements may not in all cases be possible to accommodate.

Licensees shall construct load shedding schedules based on the normal feeder annual peak demand associated with a particular feeder breaker.

Licensees shall further take into consideration potential diversity between feeder demand so as to ensure that the overall reduction meets the requirement in each time slot (i.e. shedding should attempt to follow the natural load profile of their system – providing the full allocation at peak).

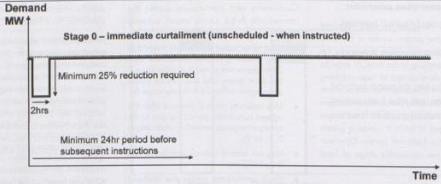
Where technology options such as curtailment by load limiting relays becomes available, the schedules shall be revised accordingly (i.e. shedding replaced by curtailment).

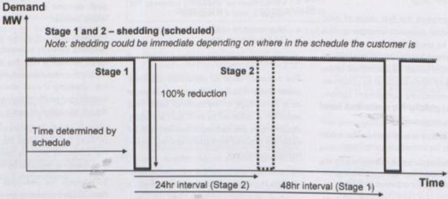
To address the potential implications of manual load shedding on the load required for automatic under-frequency load shedding, the following procedure shall be applied:

- Each control centre shall determine the load under its control.
- For the first 10% of system load required for automatic under-frequency load shedding, a percentage of this total requirement may be allocated to various time slots on the load shedding schedule.
- A proportionate increase in the available load for under-frequency load shedding scheme shall then be implemented to address the load that may not be available in any given time slot

In the case of special events (such as a national sporting events involving large numbers of people), certain loads should be

Stage	Type	Reduction required from end-use customers by load shedding	Reduction required from end-use customers eligible for curtailment
Stage 0	Unscheduled (agreed)	Load made available for curtailment by licensees / the public in response to an appeal to avoid subsequent stages of load reduction	25% demand reduction for 2 h offered by customers who select the immediate curtailment option (pre-agreed with the utility)
Stage 1	Scheduled	5% reduction in load profile of the national non-curtailment load (e.g. 1000 MW at system peak)	10% reduction in normal demand profile within 2 h of notification (excluding customers that have elected to participated under Stage 0)
Stage 2	Scheduled	10% reduction in load profile of the national non-curtailment load (e.g. 2000 MW at system peak)	
Stage 3	Scheduled	20% reduction in load profile of the national non-curtailment load (e.g. 4000 MW at system peak)	20% reduction in normal demand profile within 2 h of notification
Stage 4	Unscheduled (instructed)	>20% reduction in load profile of the national non-curtailment load (e.g. >4000 MW at system peak)	As instructed by the National System Operator at the time.





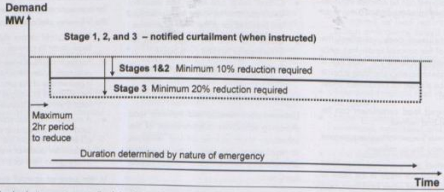


Table 1: National load reduction requirements (load shedding and curtailment) under a system emergency - declared by the national system operator in the event of a national generation capacity constraint.

temporarily protected from load shedding. It shall be the responsibility of the licensee to revise the schedules, whilst still ensuring that the required load to be shed is available.

Load curtailment (notified)

A licensee may identify specific customers that, in lieu of being shed, can provide a pre-defined amount of load to be curtailed within 2 h on instruction from the licensee. Customers who meet the following requirements will be eligible for notified load curtailment under stages 1, 2 and 3:

- The customer shall offer at least 10% of normal load for curtailment under stages 1 and 2, and 20% of normal load under stage 3.
- This curtailment shall be maintained for the duration of the emergency.
- The curtailment can be effected within an agreed time frame (typically under 2 h).
- The curtailment does not affect the integrity of the national under-frequency load shedding scheme. The customer shall indicate whether the load curtailed to obtain the required reduction is or is not also on the under-frequency scheme.
- The required load curtailment can be measured and verified.
- The customer's essential load requirement is met during this curtailment.
- Protection of this customer from load shedding shall not result in the need to exclude significant other load from load shedding due to network limitations (i.e. this customer may not be on the same circuit as other customers that are on the load shedding scheme). Where this customer represents over 80% of the load supplied by a specific feeder, curtailment may be considered (i.e. other loads protected). Alternatively, where the customer can offer the equivalent load for curtailment, curtailment may be considered.
- Actual load curtailment instructed during an event meets the requirements agreed on with the licensee.

Where such conditions are not met, a customer shall not be eligible to be removed from the load shedding schedules (and may be placed back on the schedule if the actual load curtailment is not achieved during an event).

Customers who participate under the delayed load curtailment scheme may not exceed normal demand for 12 h after the emergency. In the event that a customer does not achieve the load curtailment requirements during an emergency, the licensee shall have the right to shed the customer after reasonable notice has been given, and/or shall have the right to place the customer on the load shedding schedule going forward.

Customers may select to manage the required percentage reduction across several independent installations (e.g. a customer may choose to completely close down one plant while other plants remain in operation). This arrangement applies to a load reduction required under a national emergency. It may not apply in the event of a regional or local system capacity constraint.

Stage 4 (unscheduled)

The shedding and curtailment requirement under stage 4 is unscheduled and will be instructed by the national system operator at the time.

Operational information

Regional control centres shall provide the national system operator with information on the manner in which load reduction requirements have been implemented for the various stages. Municipal and metro control centres shall provide the regional control centres with information on the manner in which load reduction requirements have been implemented for the various stages.

The national system operator shall make daily system status information available to regional and municipal/metro control centres. This information should provide an indication of the expected need for emergency load reduction for the day.

At the time of publication of this code of practice, technical information on the weekly system status can be found at www.eskom.co.za – i.e. the national system adequacy report.

In the event of a high risk of national load shedding, the national system operator shall issue an alert communication. In the event that national load shedding is initiated, the national system operator shall instruct regional control centres on the level of load reduction required. Regional control centres shall instruct municipal and metro control centres on the level of load reduction required.

Licensees shall make load shedding schedules available to their customers. Such schedules may be published in print media, available on a website, and/or attached to electricity bills. An appropriate mechanism for communicating changes to schedules shall be implemented. Where possible, customers shall be notified when there is a high probability that load shedding may be required.

Licensees may choose to define a specific set of customers that will be notified by direct communication (e.g. SMS, telephone, email), whilst the bulk of customers may receive such communication via the media (primarily radio, television).

Specific provisions

International customers

Cross-border load reduction requirements shall be at least the same percentage as the load reduction required in South Africa – i.e. the exports from South Africa to these countries shall be reduced by the same amount under the curtailment option in relation to each stage of reduction (e.g. 10% under stages 1and 2).

Participation in the merit order

Where interruptible load has been contracted on a commercial basis as part of the merit order (i.e. in terms of a special pricing agreement or in terms of demand market participation) these may be excluded from the first stages of manual load reduction schedules. Under emergency conditions, agreement may be reached with these customers on further load curtailment.

Where it is technically feasible to isolate demand market participation customers who participate with a minimum of 25% of their total load, these shall only be included in stages 3 or 4. Emergency DMP customers who participate with a minimum of 40% of their total load shall only be included in stages 3 or 4.

Metro/municipal generation

Where a metro or municipality has embedded generation, and such generation is not already contracted as an ancillary service to the system operator, such generation may be used to offset the load reduction required under emergencies. Such generation may be offered as unscheduled reduction under

Stage 0, particularly where the possibility of further stages of load reduction can be avoided. Where this generation has been considered as part of the load reduction required during subsequent stages, offering such generation during stage 0 shall not increase the requirement from individual municipalities/metro's during subsequent stages of load reduction. Offering such generation will reduce the likelihood of load shedding being called upon (i.e. stage 1).

Geyser control (hot water storage)

If geyser control is used as a normal part of managing peak demand by a licensee, additional demand reduction will be required during a system emergency. These may however be useful if implemented during off-peak periods under emergency conditions. Geyser control should be used with care to ensure that load pick-up does not negate the demand reduction required. Geyser control may be offered as unscheduled reduction under stage 0, under the same conditions indicated for generation (see above in *Metro/municipal generation*).

Voltage reduction schemes

Voltage reduction schemes may be applied on carefully selected feeders to reduce demand during an emergency – where this is not likely to result in contraventions of the requirements of NRS 048-2 (minimum power quality standards) [3].

Smart metering/load limiting

Smart metering and load limiting schemes should be considered as a technology solution to limit the impact of emergency load reduction on customers. Application of these technologies on feeders supplying critical loads should in particular be considered. Smart metering and load limiting schemes may be used by licensees to off-set load shedding requirements (stages 1 to 3). These technologies may be offered as unscheduled reduction under stage 0, particularly where the possibility of further stages of load reduction can be avoided.

Customers exceeding ECS targets

Customers may be excluded from load reduction under stages 1 and 2 (not stages 3 and 4) under the following conditions:

- Where it can be demonstrated that an equivalent demand reduction (in MW) accompanies the energy saving.
- The customer meets the requirements for notified curtailment.
- The saving has not been traded in terms of ECS rules.
- The equivalent demand reduction (over and above the ECS requirement) is equivalent to the stage of shedding required from the system operator – i.e. the customer may be excluded from stage 1 and 2 shedding if the customer demonstrates a continuous demand reduction of 10% over-and above the ECS requirement.
- The customer shall demonstrate that the reduction achieved is not related to a reduced output of the plant, but due to actual process savings (or investment in local generation).
- The saving shall be in place for a year, and the exclusion shall be reviewed annually.
- Should the customer not meet the continuous reduction agreed to, the customer will be placed back on load shedding or curtailment schedules. The licensee shall notify the customer that this is the case.
- This exclusion may in some cases not apply in the case of a regional constraint.
- This exclusion shall only apply to existing sites.

Critical loads

Licensees are required to appropriately interact with customers in addressing critical load requirements. Licensees shall identify the feeders to which these loads are connected. Customers operating critical loads shall evaluate their level of preparedness in terms of the practices in this part of NRS 048. In the case of critical loads not identified in this part of NRS 048, licensees and customers shall co-operate in addressing the requirements of these loads by considering at least the following alternatives:

- Exclusion from load shedding schedules and curtailment requirements. This shall in principle be limited to cases where the load can be isolated so that other loads that should be shed are not also protected from the schedules (i.e. exclusion from load shedding is possible where the customer load is supplied directly, or where smart metering/load limiting technologies have been installed on all loads on the feeder).
- Where the installation meets the conditions for load curtailment, the critical loads can be accommodated under this option.
- If shedding is required, careful selection of the specific time of day that a critical load is shed (i.e. when it is not as severely impacted).
- Interventions within the installation (e.g. appropriate backup supplies). In the case of many critical loads, it is necessary to protect the installation in the event of a "normal" supply interruption, i.e. due to a local network outage.
- Implementing protocols for interaction between the customers operating critical loads and the electricity supply utility. (For example, provision of a direct line of communication to the regional or municipal/metro control centre in the event that the on-site backup supply fails).

The following loads are specifically considered as critical loads in terms of this part of NRS 048:

- *Public transport (e.g. rail)*: Metro/commuter rail shall be excluded from load shedding and curtailment. However, long-distance goods transport shall be required to participate in emergency load shedding or curtailment. Licensees shall interact to ensure that load shedding schedules have the minimum impact on a rail line crossing different supply areas.
- *Water*: Water supply systems to power stations (including co-generators) shall be excluded from load reduction. Potable water supply systems shall be included in the load reduction requirement. Licensees shall interact with the operators of such systems to optimise the scheduling of these systems on the load shedding schedule to ensure that adequate reservoir levels can be maintained.
- *Sewerage*: Generally, sewerage systems shall be included in load shedding schedules. Special attention shall be taken to identify linked pump stations and to coordinate load shedding to ensure that shedding will not result in adverse environmental consequences. Where this is not possible, these may be removed from load shedding schedules.
- *Refineries and fuel pipe lines*: Refineries, fuel pipe lines, and associated loading and off-loading depots shall be excluded from emergency load reduction requirements.
- *Coal mines supplying power stations*: Mines supplying power stations (including co-generation plant) shall be excluded from load shedding schedules.
- *Educational facilities*: Generally educational facilities shall be included in load shedding schedules, but may be declared as critical loads by national or provincial government at critical times of the academic year.
- *Critical loads associated with essential services*: Police, fire fighting, and other essential services shall be included in load shedding schedules. These customers shall provide their own back-up facilities. Processes shall be in place to provide fire fighting services with information when load shedding has commenced. In the event of a fire, these services shall liaise directly with the control room should water pumping be required.
- *Telecommunications infrastructure*: The facilities of telecommunication service providers shall be included in load shedding schedules. These customers shall provide their own back-up facilities.
- *Traffic lights*: High impact intersections (those that would lead to significant congestion on major highways, in central business districts, or important access points) should either be equipped with backup systems able to support the supply for at least 4 h or effective deployment of pointsmen should be planned. Contingency plans shall be implemented for medium-impact intersections to ensure that traffic flow is maintained (plans may include the coordinated deployment of pointsmen or traffic officials, based on the schedules).
- *Airports*: Airports shall be required to participate in emergency load shedding or curtailment. Where an airport is on the load shedding schedule, the scheduled time for shedding shall be between the hours of 09h00 and 17h00. The licensee control centre managing the emergency load reduction of the airport shall provide the airport with direct communication and co-operation to the control room in the case of an emergency (e.g. failure of backup generators). Protocols shall be in place for notifying these customers that load shedding has commenced – so as to allow them to start up the backup generators if required. Airports shall ensure that on-site backup supplies shall be available for critical processes.
- *Major sports stadiums*: These shall be required to participate in emergency load shedding or curtailment. Where a sports stadium is on the load shedding schedule, the scheduled time for shedding shall be between the hours of 06h00 and 17h00. Stadiums shall ensure that on-site backup supplies shall be available for critical processes. The licensee control centre managing the emergency load reduction of the stadium shall provide the stadium with direct access to the control room in

the case of an emergency (e.g. failure of backup generators). Where the licensee is notified of a major sporting event, protocols shall be agreed on for notifying these customers that load shedding has commenced – so as to allow them to start up the backup generators.

- *Hospitals and medical facilities:* State and private hospitals shall be treated equally. Hospitals with life support systems:
  - Shall be included in load shedding schedules.
  - These hospitals shall provide their own back up facilities and shall be required to declare their essential load requirements.
  - Protocols shall be in place for hospitals to contact the local operations centre directly in the event of an emergency example, if the back-up facility is out of service at the time of load shedding.
  - Protocols shall be in place for notifying these customers that load shedding has commenced – so as to allow them to start up the backup generators.

  Hospitals without life support systems shall:
  - Be included in load shedding schedules,
  - Hospitals shall be required to declare their essential load requirements and should, if practicable provide their own back up facilities,
  - Protocols shall be in place for hospitals to contact the local operations centre directly in the event of an emergency,
  - Protocols shall be in place for notifying these customers that load shedding has commenced – so as to allow them to start up the backup generators. Clinics and medical centres shall be included in load shedding schedules.

  Clinics and medical centres shall be required to declare their essential load requirements, but are not classified as critical loads.
- *Public health and safety:* All officers in charge of public buildings and facilities shall be required to assess the risks to the public associated with power interruptions and declare their essential load requirements. By exception such buildings or facilities may be considered as critical loads.
- *National critical product:* Where the destruction or damage to plant, equipment, or facilities would disrupt production of a nationally critical product, the minimum power required to prevent such damage may be considered as an essential load requirement.

Blackout restoration

The national system operator shall be responsible for developing, maintaining, and testing plans for restoring supply after a national blackout (including the availability of black-start facilities). The plans shall be reviewed annually and shall take essential load requirements into consideration. National Disaster Management shall oversee the development of multi-sectoral plans for a country response to a regional or national blackout.

Individual licensees are responsible for developing, maintaining, and testing plans for restoring supply after a regional or local blackout. These plans shall be reviewed annually and shall take essential load requirements into consideration.

Customers may be required to cooperate in exercises related to blackout preparedness.

Essential load requirements

An essential loads register is required by a licensee for the prioritisation of restoration of supply in the case of a blackout. It is critical for customers to provide the necessary information to ensure that they are prioritised for restoration after a blackout event. The essential load requirement is the minimum customer load requirement should stage 4 load reduction be implemented.

Licensees are required to collect essential load data and to appropriately address customer essential load requirements. Licensees shall notify customers at least every two years that such information is required. A licensee shall provide its upstream electricity supplier with the power supply requirement to meet its own essential load requirements and that of its customers. In the absence of a submission from a licensee, the maximum essential load allocated to a licensee shall be 10% of the notified maximum demand. A licensee shall evaluate its essential power requirements, and where these are greater than this amount, this will need to be justified based on individual essential load requirements from its customers and essential load requirements in its area of supply. The upstream licensee shall notify the licensee of the agreed essential load requirement. A licensee cannot guarantee that essential load requirement can be met under all supply emergencies.

Customers shall notify their licensee of their essential load requirements in accordance with the format in NRS 048-9. Such requirements shall be regularly (at least every two years) updated by the customer to reflect any changes to processes and/or requirements with regard to safety or the environment. Where a customer does not provide an essential load requirement, the licensee shall be entitled to assume that no such requirement exists. It is incumbent on a customer to ensure that appropriate measures are taken in the case of a failure in the supply of electricity to an essential load. The essential load requirement may be subject to verification by the licensee in terms of: a critical safety requirement, a critical environment impact requirement, and a critical national product requirement.

Where the submission does not meet these verification requirements, the licensee shall inform the customer. All customers shall be entitled to provide licensees with essential load data. Customers with essential load requirements shall ensure that appropriate back-up systems are in place, as restoration times cannot be guaranteed for the various possible system emergencies that could occur. All customers in the following categories shall be required to provide essential load details: deep level mines; hospitals and medical centres with life support requirements; sewerage systems; prisons; refineries; and national key points reliant on electricity for their core operations. Supply may be cut off to a customer if this customer exceeds the notified essential load data during the restoration process.

Technical considerations

Many municipalities and some metros require the manual switching of circuits. This may impact the ability to switch at feeder level. In such cases is may be prudent/necessary to switch at a point further back in the network. This may impact customers wishing to be considered for notified or immediate curtailment.

Care needs to be taken when returning load after it has been shed. Cold load pick up may be significantly higher than normal full load – placing the system under stresses beyond its design limits.

Conclusion

NRS 048-9 provides a national code of practice for load shedding and system restoration under emergency conditions. As such it answers the call made by many stakeholders for a "national protocol for load shedding".

This first edition is based on the limited options presently available for demand reduction. It makes allowance, where possible, for load curtailment rather than shedding. Whilst this edition addresses the phased introduction of new demand management technologies (such as load limiting relays and smart meters), future editions can be expected to further emphasise the use of these technologies before load shedding as a response to a system emergency. As a more targeted approach to curtailing loads on MV and LV feeders becomes possible, this may allow for reduced curtailment / shedding requirements on sectors that contribute more to the economy (see Appendix A).

It is essential to recognise that this code only addresses emergency load reduction. Until national generation capacity is increased, it remains imperative that other demand management solutions are implemented.

References

[1] M Chettiar, K Lakmeeharan, RG Koch, ("A Review of the January 2008 Electricity Crisis in South Africa: A Problem a Decade in the Making"), Cigré Southern Africa Regional Conference, Somerset West, South Africa, 18-20 August 2009.

[2] NRS 048-9 Ed. 1 (WG Draft 5), Electricity Supply – Quality of Supply – Load Reduction Practices, System Restoration Practices, and Critical & Essential Load Requirements under System Emergencies, 4 September 2009.

[3] NRS 048-2 Ed.3, Electricity Supply – Quality of Supply – Voltage Characteristics, Compatibility Levels, Limits and Assessment Methods, 2008.

Acknowledgements

The NRS-048 working group acknowledges the contributions made by various stakeholders throughout the drafting process – including the stakeholder consultation forum held at the SABS in July 2009.

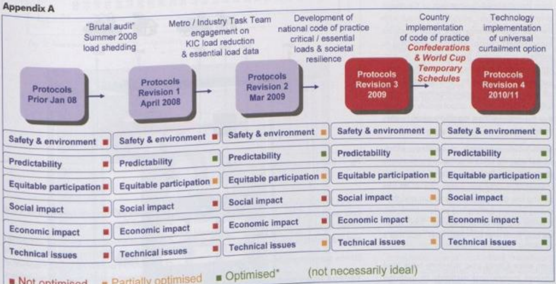
Appendix A - Summary of the development of load reduction processes

Appendix A illustrates the progressive improvements in national load shedding that have come into effect since the summer of 2007/8.

The optimisation of key criteria is illustrated (i.e. safety and environment; predictability of shedding; equitable participation; social impact; economic impact, and technical impact).

The last three criteria may only be optimised once "universal curtailment" is possible using smart metering and load limiting technologies.

Appendix A



Appendix A: Roadmap and progress in improving load reduction schemes under system emergencies.

Voltage power optimisation: energy efficient facilities for municipalities

Effectively managing and improving the power supply while saving energy - a brief overview of efficient, safe and reliable voltage management to deliver improved electricity power quality with good energy savings in a non disruptive manner.

by Alan Palmer, Power Optimisa

To date, making significant electricity energy savings within any facility has often meant making either significant shifts in process procedures, or making major investments across various technologies. The majority of "easy" savings in electricity have often come from introductions downstream of the mains distribution room: usually achieved with the use of low energy light bulbs, complex management control systems, upgrading to modern equipment that costs less to run, lighting control systems, motor controllers or just simple initiatives to remind staff to turn off the lights! Few people however consider fully and deal with, the actual quality of power that they receive from the grid and that enters their building.

Most facility managers of buildings, plant, workshops, etc seldom question the electricity power quality that they receive until some inexplicable problem arises. It's a bit like putting low grade petrol in your car and then seeing you are getting less performance. So, how do you get better electrical "fuel" when we only have one standard "fuel" type that's available.

Ever since Ohms Law, scientists have tried various means and methods to manage voltages from the supply and thus effect energy savings. However, until recently the methods to do this have been uncertain, relatively inefficient and/or unreliable, thus negating the whole objective. Fortunately, the Japanese have solved this problem, probably because they had to tackle the same pressures on fuel and energy prices, going back well over ten years ago, that we now face today. They focused a lot of attention on the incoming electricity supply voltage levels and quality. And in response they invented and perfected a unique technology specifically designed to save energy and improve electricity supply quality – efficiently and reliably.

The benefit of this approach is obvious in that an entire site would then be able to be made energy efficient in one hit. This not only simplifies the problem with minimal disruption, but also ensures the whole facility and its equipment is receiving optimal energy. This is additionally important in that the incoming site's power is then cleaned up and prepared for the application of any further incremental energy saving solutions as and when required (and reassuringly all in the knowledge these added technologies are been well protected and fed perfect optimal power).

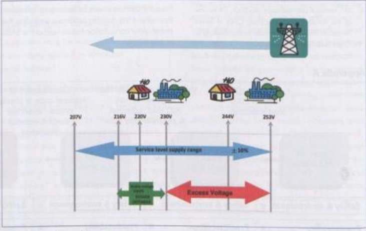


Fig. 1: Single phase voltage limits.

So why are voltages an issue?

Voltage limits and service levels

In South Africa, when we plug into the electricity mains, most of us don't give any thought about how the voltage level might affect the efficiency of our electrical equipment. We know that when the voltage is far too high, light bulbs glow more brightly, motors heat up and vibrate (and saturate), and all equipment will also break with alarming (and costly) regularity; whilst with very low voltages, TVs will flicker and motors struggle and possibly overheat (current surge, etc.). In between these two extremes, though, there is a voltage range within which the effects are more subtle and less noticeable, but can still be very significant in terms of energy efficiency and cost savings.

The statutory voltage band, within which the South Africa electricity providers deliver three phase electricity, has changed in recent years from 380 V to 400 V (220 V single phase to 230 V), plus or minus 5% (or +10% in the prescribed range within which all electrical equipment must operate effectively). Therefore all single phase electrical devices must be able to operate effectively between 207 V and 253 V. See Fig. 1.

It is not uncommon for electricity companies to set voltages slightly towards the high end of the statutory band for a large proportion of their customers from the point of final delivery. They do this for a few reasons:

- They need to ensure that the customer at the end of a particular distribution feed receives sufficiently high voltages (due to voltage drop over the distance distributed).
- Higher voltage transmission produces lower losses on the electricity companies' transmission systems, so it saves them money to keep the voltage high.
- Lower voltages mean less energy and thus less income.
- If the power utility adds more customers to an existing feed, they tend to increase voltages to ensure sufficient energy reaches all new and old customers.

As a consequence a large proportion of industrial consumers receive higher than required voltages for some if not all of the time.

Optimising voltages and power management

What does this mean for a municipality. Well, as major power users they are very likely receiving excess voltages for significant periods of time (often without knowing it)

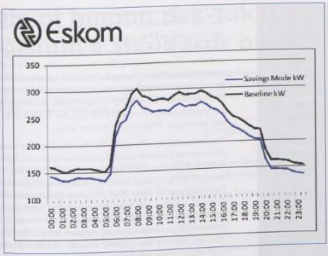


Fig. 2: Averaged demand profiles – weekdays.

Fig. 3: Voltage management technology equipment.

and this is thus wasting their own energy. What the Japanese have done (and now also many other major corporations and governments – and even energy producers – are now using it around the world) is to use new technology to reduce and stabilise their voltages to a safe level and save money and energy. There are over some 180 000 sites around the world now benefitting from this. As municipalities are also energy resellers they may be reluctant to promote the same technology to their customer base for obvious reasons, but remember two things: inevitably the customer will do their own energy efficiency actions, and secondly, if their customers used such technology themselves then the municipalities will benefit directly from lower customer kVA loads which the municipality can resell or use to defer infrastructure investments.

What does voltage optimisation do (also known as voltage power optimisation? The technology saves energy and load by various means, including automatically and very efficiently reducing voltages down to a preset level within tap down ranges. This means that the voltage levels are managed within predetermined safe ranges. It thus ensures all equipment works at its best rated efficiency levels, but without the waste associated with upward fluctuating voltage. In recent installations in South Africa customers are acheiving savings ranging from 8% to 12% on energy kWh alone, and even higher persentage cost savings when kVA load factors are calculated and added.

It is estimated that within the cities and environs probably 60% plus of the facilities will be in this over-voltage situation. The savings achieved will vary with load types and the extent of over – voltage levels.

The added benefits from the other functions of such technology are also persuasive. Typically, users will see large savings on extended equipment life, lower maintenance costs, improved harmonics and power factor, improved phase voltage balancing, reduced neutral currents, and a lot less production down time. Similarly, such technology also acts as a voltage transient or spike protector, and hence many major corporations and large data centres also use it not only for energy management, but also to protect sensitive equipment, computer facilities, robotics, and the like.

The graph in Fig. 2 shows an Eskom tested South African example of energy measurements before and after using this technology. The data was independently measured in five minute kW consumption readings. Voltages in this example were reduced by an average of 8%.

How does voltage optimising technology work?

It filters, optimises and manages voltage levels down to a pre-set level in an efficient reliable safe and automated manner. In this way, the *V* in $P=V^2/R$ is reduced and energy saved on your upstream supply meter.

Many people, however, think that just reducing the voltage level on the high voltage transformer side, would still save substantial amounts of energy. I am afraid this is wrong, and has often proved so by empirical studies in Europe. In these instances some small savings were indeed made by doing this, but the savings achieved were three to four times lower than if they had simply installed a voltage management technology downstream of their HV transformers. So why are the results so much better than if they had just reduced voltage on the MV transformer?

First, it is rare to find an MV transformer with more than 5% reduction capacity so the extra 3% to 5% that would be left to manage has not been taken advantage of. Secondly, the technology is so efficient that it has losses of just 0,3% or less through its entire operating range, because it is a completely different design to transformer technology. It is also solid state and so reliable that it has no maintenance requirements, and is actually designed to last between 35 years to 50 years. Thus virtually all the savings made are passed through to the customer and are not lost (via heat, vibration, noise; etc) as in the process of transforming in a traditional transformer design. Some other reasons to consider, are that if your energy provider did indeed tap down their transformer for you, they will themselves be wasting energy and stressing their own infrastructure - and they are consequently not incentivised to do so. Alternatively, you may even share your transformer with other users and your voltage drop could affect them adversely. In any event, not managing the voltages to a singular base level, but rather just tracking them down via MV transformer tapping is likely to lead to many other electrical dangers to the facility and is a risk few are willing to take. Some people even tap up and then apply the technology to assist with brown outs. Think about it. It makes sense.

Here are some basic differences within the technology I am discussing. A transformer's coils are wound from copper conductors, typically in the form of round wire and rectangular strip. The Japanese voltage management technology, however, utilises wide copper sheets of the highest possible purity. Sheet production is outsourced to major Japanese suppliers with large, hi tech accurate machines rolling sheets up to 800 mm wide, between 0,05 and 3 mm thick; this is then insulated and wrapped around a uniquely designed flaked silicon iron core. Separate star and delta windings are included which act to generate a strong internal magnetic field that assists in balancing the incoming three phase supply, while suppressing harmonics [1]. Other design features also stop any transients (spikes) from entering a building. As a by-product, this solid state technology also improves power factor in a building by around 3% to 10%. All of this function is then controlled automatically in a patented software method while adjusting voltages every 10 ms to the optimal level.

Most of the savings with voltage management are realised within induction motors and lighting equipment. When you efficiently manage the voltage to motors to within their normal operating range, the core and winding losses are significantlyreduced. They thus run more efficiently, with less stress, and last longer. By removing the fluctuating voltages, it's a bit like the analogy of driving along a motorway. If you kept accelerating and decelerating your car, you will use more fuel than if you kept a steady throttle for the same average speed. Lighting also benefits greatly by them being returned to their design voltage and brightness, so that both current and power is reduced and lamp life is increased substantially.

Economics

Good financial returns are the key to any successful adoption of any energy saving technology. Whilst some "green" customers may show limited support for wind and solar technologies (with paybacks often of 10 years or more) realistically many technology adopters are forced to look much more closely at the shorter term returns on investment. Here the news is good as a voltage management solutions for a typical facility will often return 30% and better on their investment (i.e a savings versus cost payback of 3 years or better). Professionals find this return very persuasive for a simple one hit, reliable, efficient and "green" solution lasting 30 years. Compared to most known technologies, that themselves average a five year lifespan or less, the economics are very compelling.

Importantly, voltage management is the best starting point to clean up your energy supply and save money; and it does not preclude the opportunity to implement many other energy efficient products on the market today (like motor controllers and lighting control systems). To the contrary, these other technologies are performance enhanced by stable voltages and their own life expectancy (and your investment in them) will likewise be improved.

References

[1] Angus Robertson, 'Electricity Management' — Energy Institute, Energy World, January 2006.

Role of human risk-taking behaviour and legislative standards on electrical incidents

South Africa has, due to its cultural, political and historical background, a far wider difference in individual risk perception, and as such, this would have a much greater impact on health and safety (H&S) management than other western countries The purpose of the study is to determine what influence the individual's perception of risk has on H&S practices in the South African electrical industry.

by Willem J du Toit, Saftek

In most electrical engineering environments, individuals usually perform, to a certain extent, specialist tasks on their own. With this in mind it would be advantageous to understand how electrical workers' perception of risk allows him or her to perform certain job functions in a healthy and safe manner. The selection process of persons to perform certain tasks should incorporate both the specific aspects of the job and the characteristics of that individual that make them best suited to undertake such tasks.

Risk perception and the individual's attitudes towards H&S is related to a tendency of responding in a given situation in a particular way, and by not taking this into consideration the current approach of forcible compliance with standards, creates a tendency of resistance. According to Stranks [14] the attitudes of individuals towards H&S comprise of a cognitive component and an affective component. The cognitive component is concerned with thoughts and knowledge related to perceiving, remembering, judging, reasoning, and the analysis of a scenario. The affective component on the other hand, is concerned with emotions or feelings of attraction or revulsion. Both of these components play a critical role in an individual's risk behaviour profile.

Slovic [11] postulates that reaction to risk can be attributed to sensitivity to technical, social and psychological qualities of hazards that are not well modelled in technical risk assessments. The importance of social values in risk perception and risk acceptance has thus become apparent. According to Lussier [5], people are a manager's most valuable resource and as such need to be maintained, by understanding the potential an individual has to contribute to accidents; management will better care for this most valuable resource of an organisation.

Given that risk perception is argued to be quantifiable, an increasing number of studies have focused on cultural and national differences in risk perception. A few studies have focused on countries such as Japan and China, but developing countries on the whole have been ignored [16]. The need for research relative to this critical component of H&S management is indicative of the increase in serious accidents in the electrical maintenance and construction industry of South Africa.

Review of the literature

H&S in the electrical maintenance industry

The South African electrical engineering and maintenance environment is faced with unique problems, which in totality reflect on the wider problems facing engineering in South Africa. Skill shortages due to a change in legislation and funding of apprentices, technicians and engineers and the ineffective implementation of training by selective Sector Educational and Training Authorities (SETAs) resulted in a shortage of trained engineering staff. Due to these factors and the ineffective management of applicable legislation and standards, the quality of services is deteriorating. A study conducted by Paivinen [8] to determine risk perceptions of electrical tradesmen, determined that electrocutions were not rated as a serious risk compared to that of working at heights. Paivinen [8] postulates that electrocution may be such a close work associated risk that its risk is underestimated in risk analysis by electricians.

Due to the physical environment of electrical maintenance work, the perception of danger is related to competence rather than the reliance on human sense.

In South Africa, electrical maintenance organisations and municipalities cannot expect to manage H&S in the same context as other developed countries due to the following internal factors. These are:

- A low skilled work force
- An expanding economy
- A unique cultural diversity
- A low level of investment in human capital
- A history of a large section of the population not exposed to technology
- A work force being exposed at a fast pace to complex technology

According to Hall et al [4], the profile of the engineering in South Africa has been enhanced and demand for related human capital and leadership talent has increased. The primary challenge lies in the development of basic skills, the procurement and development of strategic and professional leadership and the protection of experience in South Africa.

The electrical maintenance industry is unique in the danger it poses to service providers as well as users, in that the perception of what is dangerous is not easily judged and the result of exposure can be more extreme than in other industries Trimpop & Zimlong, [17].

Cultural values and H&S

According to Lonner and Malpass (1994) as quoted by Smallwood [12] cultural values affect the view about risk. They cite Hofstede's conditions that the value of avoiding uncertainty has a direct effect on risk perception.

Weber et al [9] indicate that norms and values in a given culture influence the behaviour of members of that culture. In addition to this, events and circumstances over many generations contribute to the creation of those values as a cultural adaptation. Cultural norms can have a direct influence on the individual's perception of risk and to what extent risk will be taken.

Perez et al [9] believe that the study of culture could facilitate understanding as to when and why people behave in a safe manner at work. Cultural values thus affect the way in which people think and behave when faced with a safety-related issue. This aspect in terms of various culture interactions, in the South African workplace, is not acknowledged in H&S strategies.

Motivational behaviour

According to Stranks [14] human factors affecting H&S related behaviour are defined as a wide range of issues which include: the perceptual, physical and mental capabilities of individuals, the influence of equipment and system design on such person's performance, and the organisational characteristics that influence such individuals' behaviour.

To determine what motivates an individual to either intentionally or unintentionally behave in a certain risk taking manner there is a need to understand human motivational analysis. McClelland [6] indicates that human motivation has to do with the why of behaviour, as contrasted with the how or what of behaviour. The role of unintentional actions in incidents, or as Sigmund Freud names it unconscious intent

Measure	ICMEE	ECA	MUN	SAIEE	Mean
Measure	ICMEE	ECA	MUN	SAIEE	Mean
Analysed (No.)	12	11	8	8	9,75
Sample stratum (No.)	145	450	30	64	689
Response rate (%)	8,3	2,4	2,4	13	10,7

Table 1: Response rates for the sample strata.

is a factor contributing to incidents not always taken into account.

According to McClelland [6] Freud's early work showed that peoples' motives for what they do in everyday life are often unconscious.

Ai Lin Teo et al [1] determined that positive reinforcements motivates workers to perform their jobs in a safe manner and is desirable above negative reinforcements in that although the same outcome may be achieved a negative climate would be created.

Regarding the issue of how to address the human (failure) element, a person intuitively looks toward inadequate, or lack of training and instruction. This aspect of appropriate training, education and instruction being a pre-requisite to achieving human H&S compliance appears frequently in the maintenance literature [3]. Human risk behaviour thus involves more than mere action or impulses.

Perception of risk

The individual's psychological make up affects their attitude towards H&S management in either acceptance or rejection of standards imposed on them. To understand why people accept certain risks and reject others there is a need to understand the psychological processes that lead to either rejection or acceptance [17].

Human behaviour and H&S relates to factors affecting psychology, sociology, and the anthropology of humans. Individual human factors that affect decision making in taking or rejecting risks relates to both the external socio environment as well as the individual's beliefs.

Trimpop and Zimlong [17] quote Slovic et al, who conclude from factor-analytical studies and interviews that risk is assessed differently by the dimensions of controllability, voluntarism, dreadfulness, and whether the type of risks are known.

Mitchell [7] indicates that although physical harm can be measured by experts using specific measurement tools. Psychosocial risk is less easily calculated. Although psychometric scales, in some cases, could be devised to measure such phenomena, the risk is so complex and potentially changeable, that it is difficult to measure accurately. An objective measure of risk is therefore difficult to obtain, but that is not to say that it does not exist. All that can be easily measured is the subjective or perceived risk.

According to Wilde as quoted by Trimpop and Zimlong [17] people adjust their risk taking behaviour towards their target level of perceived risk. This means that people will behave more cautiously and accept fewer risks when they feel threatened and conversely, they will behave more daringly and accept higher levels of risk when they feel safe and secure. Stallen and Vlek [13] indicate that the subjective perception of risk is the basis for risk acceptance regardless of the objective or quantified nature. Dey [2] found that the probability and severity of each risk factor are determined through active involvement of the experienced persons from the field in an interactive environment. The experience of risk therefore is not only an experience of the physical properties of the situation, but also a process of learning and understanding the potential of specific aspects of the risk environment.

Risk can be related to the probability of an incident occurring. According to Ridley and Channing [18] risk reflects both the likelihood that harm will occur and its severity, and hence these factors should be taken into account when undertaking either qualitative or quantitative risk assessment.

Risk is a complex concept. It is the natural consequence of uncertainty and is part of human activity. It means different things to different people, and is intimately linked to personal or collective psychology although analysts give it the trappings of objectivity [15]. Risk in totality to an organisation is the threat of loss to any of its assets. In terms of its most important asset, human resources, the threat of loss of individual employees injuring themselves or others is a serious risk that needs management intervention.

Research

Sample stratum and response rate

The sample stratum consisted of members of the Western Cape branch of the Institute of Certificated Mechanical and Electrical Engineers of South Africa (ICMEE), the South African Electrical Contractors Association (ECA), various employees of municipalities (MUN) electrical departments in the Southern Cape and the South African Institute of Electrical Engineers (SAIEE), Southern Cape branch only.

Table 1 presents the size of the sample strata, the number of completed questionnaires included in the analysis of the data, and the net response rates relative to each of the sample strata, including a mean.

Table 2 indicates the importance of five parameters in terms of a mean score ranging between 1,00 and 5,00, based upon percentage

	ICMEE		ECA		MUN		SAIEE		Mean	
Parameter	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
Cultural impact	4,22	1	4,13	1	2,50	5	3,00	4	3,46	1
Perception of hazards	3,39	2	3,50	2	3,30	2	3,25	1	3,39	2
Motivational incentives	2,83	3	3,19	3	2,83	4	3,00	4	2,96	3
Management Influence	2,61	4	2,25	5	2,93	3	3,13	2	2,73	4
Role of H&S legislation	2,44	5	2,58	4	3,70	1	2,00	5	2,68	5

Table 2: Degree of importance of various parameters to respondents' organizations.

Aspect	ICMEE		ECA		MUN		SAIEE		Mean	
	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank	Mean score	Rank
Training can alter risk taking behaviour of electrical maintenance workers	4,44	1	4,25	1	3,50	2	5,00	1	4,30	1
Electrical workers will perceive hazards differently	3,78	3	4,00	3	3,00	3=	4,00	3	3,70	2
Existence of different cultures perception of risk	4,22	2	4,3	2	2,50	4=	3,00	5=	3,46	3
The influence of safety standards on risk perception	3,00	6	3,00	6=	4,50	1	3,00	5=	3,38	4
Electrical accidents are related to management incompetence	3,11	5	2,25	10=	2,25	5=	3,50	4	2,78	5
Management competency is related to risk taking behaviour	3,56	4	3,00	6=	3,00	3=	1,50	12=	2,77	6
The framework of legislation, prevents risk taking behaviour	2,67	8=	2,75	8=	2,50	4=	2,50	9	2,61	7
Safe work procedures differ among electrical maintenance workers	3,00	6	3,50	4	2,25	5=	1,50	12=	2,56	8
Financial gain or other advances results in unsafe behaviour	2,67	8=	3,38	5	1,00	9	3,00	5=	2,51	9
Management training not the solution to risk taking behaviour	2,00	12=	1,75	14	1,50	7=	4,50	2	2,44	10
Better government policing will prevent risk taking behaviour	2,67	8=	2,75	8=	2,25	5=	1,00	14	2,17	11
Health and safety legislation can alter risk perception of unsafe acts	2,00	12=	2,25	10=	1,75	6	2,50	9	2,13	12
Unsafe behaviour is the norm for general electrical workers	2,33	11	2,25	10=	1,25	8	2,50	9	2,08	13
Management practises do not promote safe behaviour	1,78	14	2,00	13	1,50	7=	3,00	5=	2,07	14

Table 3: The impact of risk perception in the electrical maintenance industry.

responses to a scale of 1 (not important) to 5 (very important).

It is notable that the mean scores are all above the midpoint score of 3,00, which indicates that in general the respondents can be deemed to perceive the parameters as prevalent. The mean score for the impact of culture and perception of hazards is $> 3,40 \leq 4,20$, the respondents can be deemed to perceive them to be between important to more than important/more than important. Given that the mean scores for motivational incentives and the influence of management are $> 2,60 \leq 3,40$, the respondents can be deemed to perceive them to be between less than important to important. It is significant that risk perception and the impact of culture are ranked first and second. Furthermore, it is notable that the role of H&S legislation in altering risk taking behaviour is ranked last with a mean score of 2,68, which means that the current legislative approach is not seen as a motivation for better H&S management.

Table 3 indicates the impact of risk perception in the electrical maintenance industry in terms of a mean score ranging between 0,00 and 5,00 based upon percentage responses to a scale of 1 (minor) to 5 (major). Given that effectively a six-point scale ("no impact" linked to a five-point) was used, and that the difference between 0,00 and 5,00 is five, ranges with an extent of 0,83 (5/6) are used to discuss the degree of central tendency.

Firstly, it is notable that the mean scores for 12 of the 14 manifestations are above the midpoint score of 2,50, which indicates that in general the related manifestations can be deemed to be prevalent.

The manifestations falling within the upper range of mean scores $> 4,17 \leq 5,00$ – between a near impact to impact/impact, are discussed first. The importance attributed to training in altering risk taking behaviour of electrical maintenance workers is a significant indication of the need for knowledgeable workers.

The manifestations falling within the second range of mean scores $> 3,33 \leq 4,17$ – between an impact to near major impact/ near major impact: The manifestation, electrical workers will perceive hazards differently than in other industries, is significant in terms of the view of the electrical engineering environment in acknowledging their unique work environment.

The existence of different cultures' perception of risk is indicative of the importance that cultural influences can have on risk perception. The high ranking at level three, of the influence that H&S standards have on risk perception, reiterates the importance of knowledge in altering risk taking behaviour and the influence in individuals risk perception.

The third range of manifestations, those with mean scores $> 2,50 \leq 3,33$ – between a near minor impact to impact/impact, are discussed below. Management competency is related to risk taking behaviour, is significant as the importance and relation between management competencies is rank highly in the relation between management and accidents and indicative of the need to not only address workers but also management competency. The framework of legislation, which prevents risk taking behaviour, is ranked seventh. It is notably lower that the manifestation of the influence of safety standard with a mean score of 2,61, which is 12,83% lower.

The ranking of safe work procedures differs among electrical maintenance workers is notable, in comparison to the manifestation, ranked fourth, of the influence of safety standards where the latter is guidance to uniformity in work procedures.

Financially gain or other advances results in unsafe behaviour is ranked lower at position nine which indicates than manifestations such as training and cultural influences, ranked first and third, have a greater impact on risk perception. Although ranked tenth, the indication that management training will not be the solution to risk taking behaviour, is ranked below management competency is related to risk taking behaviour, ranked six, effectively 5,5% lower than the latter, it is nevertheless a manifestation, for the need for competent management that includes both experience and relevant knowledge.

The last range of manifestations, those with mean scores $> 1,67 \leq 2,50$ – between a minor impact to near minor impact / near minor impact, are discussed below. The mean score and eleventh ranking of review that better government policing will prevent risk taking behaviour is notable as this low ranking provides the view of the current perception on the effectiveness of government inspectorates.

The mean score of the twelfth ranked manifestation, namely that H&S legislation can alter risk perception of unsafe acts, is notable in that legislation is not viewed as the strongest drivers in altering risk perception. The view of the thirteenth manifestation that unsafe behaviour is the norm for general electrical workers, at a mean score of 2,33 can be described as the tendency and belief of the industry not to accept unsafe behaviour.

The last ranking of review that management practises do not promote H&S behaviour, are significant as the implication are that management do promote healthy and safe behaviour, but as per the manifestation ranked six that this does not imply that management has the relevant competency.

Conclusions and recommendations

The approach to H&S in South Africa should be expanded to take into account human behaviour factors related to the individual's psychological behaviour in relation to the capacity for analysing risk factors in a work environment. Further, should such psychological traits take into account South Africa's unique environment of different cultures and the effect change in economic expansions and technologies have on people. Weber and Hsee [18] found consistent and reliable cross-cultural differences in risk perception and indicated that the effects of different cultural backgrounds of workers on H&S management are not always incorporated into H&S management.

Edwards et al [3] postulate that non-compliance with H&S rules includes worker apathy and ignorance (which in turn can result from inadequate or absence of training and instruction); pressure to get the job done as quickly as possible; and lack of supervision. This aspect of human acts or omissions and their relationship to H&S failings generally in maintenance, is well documented.

The use of standards alone is no guarantee that an organisation's H&S management system will reduce incidents of loss. Standards used in South Africa in relation to H&S are usually developed or obtained from other sources such as the International Labour Organisation (ILO). The ILO has, as one of its key functions, the creation of international standards on labour and social matters where such standards are contained in conventions and recommendations.

Regarding the issue of how to address the human (failure) element, one intuitively looks toward inadequate, or lack of training and instruction. This aspect of appropriate training, education and instruction being a pre-requisite to achieving human H&S compliance appears frequently in maintenance literature (Edwards et al [3]. Developing workers' competency by increasing their knowledge through training and by identifying individuals with low risk taking behaviour for high risk tasks should form part of the H&S system processes.

The future management of H&S must include the development of that section or part of this field that will concentrate on the component that interact on the process that influence human behaviour in evaluating specific job task where this component can have significant influence on human risk behaviour.

Consequently, it can be concluded that the impact of human risk perception in the electrical service and maintenance industry is significant and forms part of that section in H&S management not always addressed.

References

[1] E Ai Lin Teo, F Yean Yng Ling, and D Sern You Ong, (2005) Fostering safe work behaviour in workers at construction sites. Engineering, Construction and Architectural Management, 12(4), 410-422.

[2] P K Dey, (2001) Decision support system for risk management: a case study. Management Decision, 39(8), 634-649.

[3] D J Edwards, and G D Holt (2008) Health and safety issues relating to construction excavators and their attachments.Engineering, Construction and Architectural Management, 15(4), 321-335.

[4] J Hall, and E Sandelands, . (2009) Addressing South Africa's engineering skills gaps. Education & Training, 51(3), 215-219.

[5] R N Lussier, (1997) Management. Cincinnati, Ohio: South-Western College Publishing.

[6] D C McClelland, (1985) Human Motivation. London: Harvard University, Scott, foresman and Company.

[7] V W Mitchell, (1999) Consumer perceived risk: conceptualisations and models. European. Journal of Marketing, 33 (1/2), 163-19.

[8] M Paivinen, (2006) Electrician's perception of work related risk in cold climate when working on high places. International Journal of Industrial Ergonomics, (36) 661 -670.

[9] L R Perez, and J A Gonzalez, (2007) Risk, safety and culture in Brazil and Argentina: the case of TransInc Corporation. International Journal of Manpower, 28(5), 403-417.

[10] J Ridley, and J Channing (1999) Risk Management, Volume 2, Oxford: Butterworth, Heinemann.

[11] P Slovic, (1997) Assessment of risk taking behaviour. Psychological Bulletin.61 (3) 220 – 233.

[12] J J Smallwood, (2000) A study of the relationship between occupational health and safety, labour productivity and quality in the South African construction industry. The University of Port Elizabeth.

[13] P Stallen, and C Vlek, (1981) Judging risk and benefits in the small and in the large, Organizational behaviour and human performance, New York Academic Press, 28. 235-271.

[14] J Stranks, (1994) Human factors and safety. London: Pitman Publishing.

[15] R H Stillman, (1997) Negligence and the marginal utility of engineering safety. International Journal of Social Economics, 24(7), 873-883.

[16] E Thomson, D Onkal, and G Guvenc, (2003) A cognitive portrayal of risk perception in Turkey. Risk management, 5(4) 25-35.

[17] R Trimpop, and B Zimolong International Labour Organisation: Risk Perception. [Online]. Available: ilo.org/encyclopedia [Accessed 23 September 2007.].

[18] E Weber, and C Hsee, (1998) Cross cultural differences in risk perception, but cross cultural similarities in attitudes towards perceived risk. Management Science, 44 (9) 1205-1217.

[19] E Weber, C Hsee, and A Sokolowska, (1998). What folklore tells us about risk and risk taking: Cross- cultural comparison of American, German and Chinese Proverbs. 75 (2) 170-186.

EDI HOLDINGS

Phindile Nzimande – leading the transformation of the electricity distribution industry

advertorial

Phindile Nzimande, the young, brilliant, insightful and energetic Chief Executive of EDI Holdings is always a marvel to listen to when talking matters energy, in particular on EDI restructuring and energy efficiency.

Having led the company since its inception more than five years ago – and also lately appointment by the Presidency as a national energy champion – the experience gained over this period undoubtedly puts these matters at her fingertips.

She has led the organisation through a challenging yet exciting journey to transform the electricity distribution industry from a fragmented, inefficient set up to one where there will eventually be parity in tariffs, equal treatment of customers as well as sufficient maintenance of networks.

The restructuring and consolidation of the electricity distribution industry will culminate in the creation of six wall-to-wall Regional Electricity Distributors (REDs) that will ensure accessible, affordable, reliable and sustainable electricity for all.

The EDI restructuring objectives, as encapsulated in the Energy White Paper of 1998 and the Blueprint on Electricity Distribution Industry Reform of 2001, are as follows:

- To provide low cost electricity to all customer segments
- To provide a reliable and high quality supply and service to all customers, in support of the Government's economic and social development goals
- To meet the country's electrification targets in the most cost-effective manner, and thus ensure that electrification is contributing to social and economic development
- To meet the legitimate employment, economic and social interest of all employees in the sector, and ensure their safety

Ms. Phindile Nzimande, CEO EDI Holdings

- To operate in a financially sound and efficient manner in order to provide a reliable and sustainable future for both consumers and employees

In terms of the Cabinet decision of 25 October 2006, the Regional Electricity Distributors (REDs) must be established as public entities regulated by the National Energy Regulator of South Africa (NERSA).

Over the period of its leadership of the restructuring process, EDI Holdings has achieved several important milestones, amongst which are the following:

- The signing of Accession to Cooperative Agreements by 147 out of 187 electricity distribution municipalities
- The progress with the completion of MSA Section 78 and ring fencing exercises by Eskom and several metropolitan municipalities
- The awarding of millions of rand to smaller municipalities to assist them with completion of the ring fencing exercise
- The ground breaking agreement reached with organised labour on the placement and migration of employees from the legacy employers to the newly-established REDs.

"The achievement of these and other milestones such as our role in ensuring that the necessary enabling legislation is put in place is a clear demonstration that the EDI restructuring process is moving full steam ahead. On our part, we will keep raising the bar to ensure that we deliver to South Africa a dispensation that will contribute towards the creation of a better life for all"' said Ms. Nzimande.

EDI Holdings also serves on the National Electricity Response Team (NERT) and its substructures, which have been set up to assist Government address the energy challenges currently faced by the country. Furthermore, Ms. Nzimande is part of a team of dedicated, committed and respected patriots who have been appointed as national energy champions to help Government lead the charge on the promotion of energy efficiency.

On this, Ms. Nzimande says: " The energy challenge faces all of us as South Africans, irrespective of race, colour or creed and we must all pull together to ensure that we save energy in our environments as well as encourage our peers, neighbours and relatives to do likewise. LET'S MAKE EVERY WATT COUNT!"

www.ediholdings.co.za

Practical perspective of the RED business model

This paper presents a practical perspective of the future Regional Electricity Distributors (REDs) and a brief overview of the EDI restructuring progress to date.

by Dr. Willie de Beer, EDI Holdings

The electricity distribution industry (EDI) in South Africa which serves approximately 9-million end customers, employs 31 000 people and has an asset base of R260-billion (2008 replacement value) is a more complex business than what is appreciated at times. The average age of the asset base is 45 years. While this industry is generating revenue, the sustainability of the industry is at significant risk and without a holistic and structured intervention the ability to render a reliable service to end-customers and to support the economic growth required is at risk. The six future REDs will be established through the merge of the electricity distribution assets of the 187 municipalities licensed to distribute electricity and the Eskom distribution assets. The pockets of good performance are becoming less and should the restructuring process be further delayed the ability to recover in the medium term will be compromised.

Within the South African context, the challenges facing the EDI are well documented although not always appropriately appreciated. The current industry is amongst others grappling with an acute skills shortage, disparate tariffs, underinvestment in people and assets. Roughly one-third of the nearly 187 municipal electricity distributors are currently experiencing serious financial problems while Eskom Distribution is equally experiencing challenges regarding appropriate levels of maintenance, refurbishment and strengthening of key infrastructure. These challenges have manifested in distributors not being able to consistently provide adequate, reliable, and acceptable quality of electricity related services. The consequences of the under investment in the electricity distribution assets and staff development are surfacing and are clearly demonstrated through an increase in outages and customers demonstrating against unsatisfactory service delivery.

This introduction highlights some of the challenges which must be addressed through the establishment of the REDs. It is therefore essential that the future business model must leverage the current pockets of good performance, address the gaps and be flexible to accommodate the geographical diversity of the respective RED areas.

Proposed RED business model

The electricity distribution industry is by its nature an asset intensive business. To ensure customer satisfaction and to grow the shareholder value, the RED business model must recognise the core functions of the business and effectively integrate the resources and business support enablers. The two core components of the future RED business model will consist of the retail and wires (engineering) divisions. These two divisions will be supported by a common support service function consisting of amongst others treasury, finance, human capital, corporate service, audit, compliance, legal, integrated enterprise-wide risk management and an integrated business process and systems platform. The business will be a value chain driven organisation with a strong focus on adding value and measuring performance. While each RED will have a central point from where the business operation is directed, the regional presence will be enhanced through geographical deployment of resources as close as practically possible to the end customer.

The common support envisaged for the future REDs and the system support interface is illustrated in Fig. 1.

Retail

The retail component of the business will include all the activities related to customer service, energy trading, forecasting, load research, contracting, tariffs, energy balancing, service levels, revenue management, risk management, acquisition of new customers and other related customer interfacing activities. In many of the current municipal electricity businesses in South Africa the retail or customer related activities are performed through the financial departments of the municipalities. However, research of best practices has indicated that the functions described above are best executed through a dedicated retail division.

The diagram in Fig. 2 provides an illustration of the value chains applicable to a classic retail function within a modern electricity distribution business.

Wires

The wires (or engineering) component of the business is by its nature an asset centric, geographic monopoly, responsible for the safe distribution of electricity to the satisfaction of the customers. It is therefore essential that the wires business must be tightly regulated and subjected to well defined investment, performance and reliability standards. The application and introduction of appropriate technology will be leveraged in the future wires business to ensure a well integrated business with good performing assets. Furthermore open and undiscriminated access must be provided to all customers, retailers, generators, co-generators and renewable energy suppliers. Since the wires business owns the networks and associated assets it

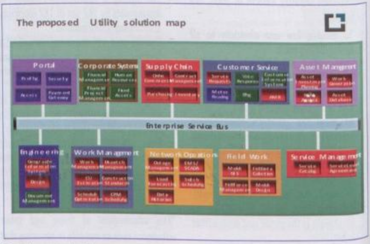


Fig. 1: The proposed utility map.

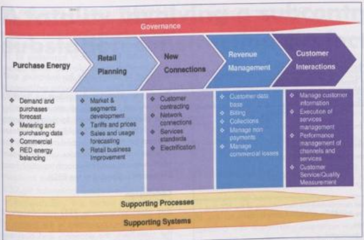


Fig. 2: The value chains applicable to a classic retail function within a modern electricity distribution business.

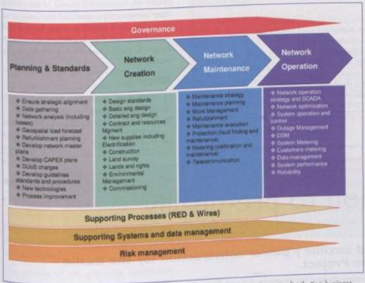


Fig. 3: The value chain applicable to a classic wires function within a modern electricity distribution business.

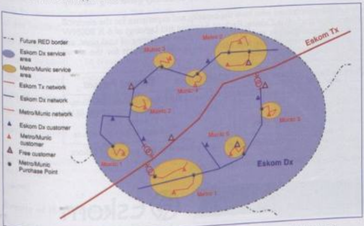


Fig. 4: Current network configuration which is a direct result of the current business model deployed.

is essential that a holistic asset management and investment plan is in place and efficiently executed. Availability and reliability of supply are but two of the critical performance areas from a wires/engineering perspective. All customers supplied off the distribution wires of the respective RED will contribute to the wires charges. The staff representing the wires component of the business are normally the most visible and are therefore by default the main business contact point for most of the customers and public at large. It is therefore essential that this default interface be factored in when stakeholder and communications strategies are developed and staff is recruited, trained and deployed.

The diagram in Fig. 3 provides an illustration of the value chain applicable to a classic wires function within a modern electricity distribution business.

Value proposition

From the above it is clear that the business model envisaged for the future REDs will be in line with appropriate best practices and be different to the current business model deployed by most participants operating in the current EDI in South Africa. The proposed business model will allow for focused customer attention, clear accountabilities, good governance, optimal resource utilisation and effective asset management. Furthermore the model will facilitate business process consolidation and optimisation, and cater for infrastructure and network reconfiguration which will lead to improved diversity and energy management. Ultimately the customers will benefit from improved reliability, savings through consolidation and a more predictable pricing signal.

The diagram in Fig. 4 provides an illustration of the current network configuration which is a direct result of the current business model deployed. The opportunities for consolidation and leveraging of point of supply diversity can be seen in Fig. 4.

There is no doubt that competent people play a significant role in providing leadership and ensure the effective managing and operating of any business. The future REDs are therefore not excluded from this requirement and the selection of the future leadership will ultimately determine the extent of successful delivery in terms of the value proposition.

Readiness progress to date

While discussions associated with the EDI restructuring has been ongoing for a good number of years, the RED establishment journey officially started in January 2004. The voluntary nature of the process and the absence of the required enabling legislation have significantly complicated this journey. Despite the challenges, good progress has been made since the establishment of EDI Holdings and Table 1 reflects some of the key milestones.

The journey ahead

The restructuring journey will remain complex and will call for commitment and strong leadership. It is encouraging to witness the level

Enabling legislation	Significant progress by DoE in terms of the RED Establishment Bill and the framework was tabled at Cabinet on 16 April 2008. Asset Transfer Framework promulgated and National Treasury issued the final regulations in August 2008. On 7 September 2007 the Municipal Fiscal Power and Function (MFPF) Act was promulgated which covers the surcharge principles which will be applicable to ensure a revenue flow to local Authorities for services rendered within their area of jurisdiction.
Staff transfer to the REDs	Establishment of the Transitional Labour Relations Structure (TLRS). Approval of the retention of the pension tax exemption which are applicable to specific municipal staff. Agreement at TLRS level on the following: • Regional Transitional Labour Relations Structure • Transfer of employees to the REDs • Placement and migration of employees within the REDs
RED establishment	On 25 October 2006 Cabinet reconfirmed the restructuring of the EDI and the establishment of six wall to wall REDs as an end state model: • Business model developed • Industry financial model developed • RED establishment framework developed • Detailed RED viability analyses completed • Proposed governance, compensation and asset valuation frameworks developed • DEAL issues identified • RED establishment governance structures rolled out • 147 of the 175 electricity distributing municipalities have signed the accession to the cooperative agreement • 11 municipalities are ringfenced • Eskom Distribution is 98% ringfenced • 56 municipalties in the process of being ringfenced • Business plan and strategy developed to address the distribution asset management turnaround.

Table. 1: Key milestones.

of support from various key stakeholders and a demonstration of this is that 147 of the 175 electricity distributing municipalities have signed the accession to the cooperative agreement. Furthermore the electricity businesses of 11 municipalities are ringfenced while Eskom Distribution is 98% ringfenced.

The journey ahead is dependent on the RED Establishment Act and all indications are that this piece of legislation could be promulgated during 2010. In the interim EDI Holdings will continue to focus on the RED establishment readiness activities and the negotiations with the current asset owners to ensure a smooth transition from the current businesses to the REDs.

Conclusion

It is essential that the RED establishment programme be accelerated in the interest of the customers, the economy and business stability. The restructuring can never take place at the cost of the current asset owners and therefore the transaction envisaged is designed to take into account the interest of the current asset owners, customers and the country at large. The environment is ready for the EDI restructuring and there is sufficient stakeholder support to move forward with the restructuring programme.

References

[1] EDI Holdings. 2008. *"Wires Blueprint"*.

[2] EDI Holdings. 2008. *"Retail Blueprint"*.

[3] EDI Holdings. 2008. *"Business Process and Systems Blueprint"*.

[4] Powertech IST, 2009. *"EDI Hosted Solutions"*.

A fatality involving a subcontractor on a substation construction project

The purpose of this brief is to inform and highlight the need for more stringent controls around risk assessment in operating procedures and training. The focus of this paper is risk assessment on certain construction regulations, which in this particular case study, a lack thereof resulted in a fatality. The first question that is raised is "what has this incident got to do with electrical safety". More attention should be given to risk assessment in other engineering fields in the construction of our electrical infrastructure.

by Dwayne Baker, uMhlathuze Municipality.

Neptune substation is a newly constructed 132 kV substation located within the port of Richards Bay. It is owned and operated by the uMhlathuze Municipality. The substation is key in maintaining a stable supply of electricity to the existing Richards Bay load and will provide the future power requirements of the port and the port expansion. The substation is equipped with the latest in high voltage switchgear technology and due to its location, is fed via high voltage XLPE cables from an overhead line take off point.

Neptune substation was constructed over a period of two financial years between the years 2007 and 2009. The substation contract was awarded to a prominent power projects company with a net contract value of R55-million. The construction project involved a fairly large and complex civil engineering component.

Accident resulting in a fatality

The names of the principle contractor, the subcontractor and the identities of the deceased and his supervisor are withheld due to sensitivities surrounding the nature of this incident.

The names of the principle contractor, the subcontractor and the identities of the deceased and his supervisor are withheld due to sensitivities surrounding the nature of this incident.

Site name:	Neptune substation
Date of incident:	14 November 2008
Time of incident:	08h40
Type of incident:	Lost time injury
Section: Concrete batch plant	
Name of injured:	Mr. Gumede (not his real name)
Name of supervisor: (not his real name)	Mr. Khoza

Events of the accident

On 14 November 2008, Mr. Gumede's work task for the day was to provide a mix of concrete for the planned work and to clean the concrete mixer once the mixing operation had been completed.

At the time of the incident, all labour assisting with the mixing operation were requested to return to site where the concrete was being poured with the exception of Mr. Gumede who was left alone to clean the concrete mixer.

Mr. Gumede climbed onto the frame of the concrete mixer. Mr. Gumede's supervisor, Mr Khoza who was standing a way off, heard a loud "cracking" sound. Mr. Khoza immediately noticed Mr. Gumede on the concrete mixer with his head wedged between the frame of the mixer and the hopper. Mr. Khoza together with two other employees immediately reacted and attended to the scene.

The concrete mixer was first switched off. While holding Mr. Gumede, the hopper was lowered. Mr. Gumede was then lowered to the ground. First aid was immediately administered and Netcare 911 was contacted. Netcare 911 attended to the scene within 10 minutes. Paramedics stabilised Mr. Gumede after which he was taken to a local hospital in Richards Bay.

Mr. Gumede was later transferred the same day to a hospital in Umhlanga, Durban. He was admitted into ICU and placed on a ventilator. Due to excessive and uncontrollable bleeding on the brain, Mr. Gumede passed away on the 19 November 2009. The Department of Labour were notified and an inspection and full investigation was conducted and concluded.

Outcome of the investigation

Mr. Gumede had switched on the concrete mixer in order to rotate the water in the mixing drum to clean it. It has been assumed that Mr. Gumede climbed onto the concrete mixer to inspect the progress of the cleaning operation.

It is assumed that while standing on the frame, his foot accidentally pressed down on the operating lever, which controls the movement of the hopper. Not realising what he had done, the hopper lifted with far too much acceleration and jammed his head against the frame of the concrete mixer, which resulted in an immediate head injury. The photograph (see Fig. 1) attempts to illustrate the scene of the accident.

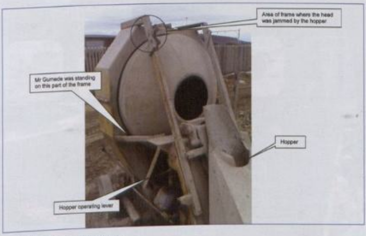


Fig. 1: Illustration of accident scene.

Mr. Gumede had been trained and deemed competent to operate and clean the concrete mixer. He had been operating the same concrete mixer for 4 months. He had attended all safety and toolbox talks.

Analysis

- Why was the employee left to clean the concrete mixer alone in the first place? Is it fair to say that a single individual should undertake the cleaning of such a piece of machinery?
- It has been found that there is no operating procedure for the cleaning of the concrete mixer. If such an operating procedure exists, should it clearly define the supervision of such a concrete mixer? Yes it should.
- If Mr. Gumede had been found to be competent to operate the concrete mixer, why did he climb up onto the frame in the first place? Unfortunately this question can never be answered. Sub clause 7 (5) of the construction regulations stipulates that the principal contractor is to ensure that the employee is informed of any hazard as stipulated in the risk assessment before any work commences.
- There is no record of any risk assessment done for the operating and cleaning of the concrete mixer. So can it be assumed that Mr. Gumede was informed through his formal training of the hazards pertaining to the safe operation of the concrete mixer or was he verbally informed on site? This question cannot be answered!
- It can be noted that the principal contractor provided the safety specification to the sub contractor. The specification is clear that a risk assessment is to be undertaken for all rotating machinery.
- Probably the most important find is that of the unguarded hopper-operating lever. Sub clause 18 (3) of the construction regulations is clear on the safe use of any batch plant. The regulation reads that all devices used to start or stop the batch plant are constructed in such a manner to prevent accidental starting.
- It can be noted that the contractor has now installed a steel guard plate to prevent such an incident from occurring again and thus fully complying with the construction regulations.
- Sub clause 18 (4) clearly states that all dangerous moving parts of a mixer are placed beyond reach of any person by means of doors, covers or similar means. It is a known fact that concrete mixers do not have any covers or similar means of preventing people from climbing onto them. If this is the case, then once again the safe operating procedure as noted in 4,2 above should be clear on the supervision of the mixer while being operated or cleaned.
- So is the question raised that we do not pay enough attention to the safety of our construction projects? No, not at all. In this particular case, no risk assessment had been carried out. Insufficient operating procedures and training are clearly noted. Were both the client and principle contractor aware of the risks associated with the civil engineering component of this project?

Conclusion

It can be concluded that a single individual should never undertake the cleaning operation of a concrete mixer of this size alone. The risks associated with the operation of the mixer and its associated rotating and moving parts is too high and should be supervised at all times. Safety specifications should ensure that procedures to manage risk assessment are adhered to at all times. Although our safety briefings focus on electrical safety regulations and operating procedures, attention must also be given to safety in the construction of electrical infrastructure, which includes other engineering disciplines.

Safety paper: an incident arising from an illegal electricity connection

Eskom and Municipalities distributing electricity are all experiencing electricity theft. An incident arising from an illegal electricity connection promoted me to submit a safety paper.

by Mark Donaldson, Endumeni Municipality.

On Tuesday, 12 May 2009 at 05h30 the standby electrician was called out to a house in Sithembile Township.

The electrician noticed two cattle were lying next to the house boundary fence. Small blue sparks were visible at each joint in the fence wire, indicating that the fence had been electrically energised. The electrician immediate isolated the main 200 A LV circuit breaker in the mini-substation supplying the surrounding houses.

During the investigation by the municipal electrical department, it was found that the neighbour was illegally switched on as the meter had previously been removed and the supply switched off by the municipality for tampering. This cable had developed a fault at the base of the metal kicker pipe housing it on the service pole. The illegal connection was done in such a way that the house service circuit breaker was unable to trip. Both property fences were also mechanically bonded to the metal kicker pipes on the supply pole, thus energising the property fences and electrocuting the cattle when they come into contact with the fence.

I shudder when I think of the outcome if it was later in the morning when the parents and children were on their way to work and school.

I hereby urge all municipalities to find and remove all illegal connections, not only to reduce the percentage losses but also to eradicate these "death traps".

Conclusion

From 2006 to date, Endumeni Municipality awarded a bid to a company to perform a meter audit to outsource tampered meters. This project has proved to be very viable although tampered meters are still reported on a daily basis.

Generally, free electricity is abused, so a project of this nature assists with the following:

- Reduces electricity losses.
- Reduces the risk of electrocution due to unsafe electrical connections.
- Reduces the load on the network.

I urge all municipalities that have not yet embarked on a project of this nature, to consider doing so as the recently approved increase by NERSA in electricity tariff will surely encourage the theft of electricity.

Lastly I would like to thank the AMEU for allowing the affiliates the opportunity to submit safety papers so that other municipalities can prevent similar incidents occurring in their area.

Safety... can it be regulated?

I have been involved in investigating a number of internal accidents over a number of years. It is usually quite easy to establish the technical causes for the accidents that took place as there are regulations in place that guide an investigation to make certain conclusions. I have always felt that there were underlying facts that had an influence on the accidents and I decided to investigate the underlying causes. In doing the research the question I asked myself was "Can safety be regulated?" By the conclusion some of you may agree with me and some may not but if in the end, I stimulated debate around safety, then I will have achieved my goal.

by Robert Ferrier, Buffalo City Municipality

South Africa is one of the most regulated countries in the world when it comes to safety. The Occupational Health and Safety Act is a comprehensive collection of laws and regulations, with over 23 regulations and sub-regulations that control "How, What, When Who and Where" safety is implemented.

Surely with such comprehensive laws in place, far less/or no accidents should occur.

We need to ask the question "Then why do accidents still occur?"

One of the usual reasons provided in recent years is: *"It should be remembered that our present work force is uneducated, ill trained and poorly skilled"*

In the 12 years that I have been with Buffalo City, I have been involved in a number of internal accident investigations. I have conducted further research into recent accidents that have occurred in our industry. I have looked beyond the normal technical reasons to reach my conclusion.

In the electrical industry accidents are a major concern because while electricity under normal conditions is usually an unseen force, under fault conditions it becomes a very visible and destructive force which usually leads to death or injury, catastrophic damage to equipment, and/or loss of income to both the utility and consumers.

To illustrate my conclusion I will discuss three of the accidents that I researched:

Accident 1: Unsafe switching procedure

This accident involved two operators that were performing switching; due to time and the need to return consumers to service normal switching procedures were not followed.

Normally the circuits being switched would have had all downstream loads disconnected. The two main feeders would then have been closed onto no load or a much reduced load. The downstream load would have been slowly returned to service to ensure that overloading did not take place.

On the day of the accident the decision was taken to close the two main breakers simultaneously onto the full load.

While under some circumstances such procedure could be considered, it should never have been considered on this circuit for the following reasons:

- Not humanly possible to close the breaker at the exact same time.
- The cables carrying the full load were of different sizes.
- The breakers were of different ratings.

The overriding fact was that neither one of the feeders could take the full load.

With the in-rush of current one of the breakers failed causing extensive damage to the equipment and the adjacent breakers. Sadly, major injuries also occurred to one of the operators.

The factors leading to this accident were:

- Time related taking a short cut to reduce outage time. While the intention was good the results speak for themselves.
- Not all the engineering factors were taken into account when switching the load.
- Ignoring general safety.

Personnel

The personnel involved in this accident were well qualified – engineer and senior electrician. They had over 20 years experience between them.

The relevant clause and regulations that should have prevented this accident are as follows:

The Act

- Clause 14 General Duties of Employees at Work.
- The Regulation 15 General Machinery regulations. Clauses 3.1, 4.1and 4.5.

Accident 2: Barricading and supervision

This accident occurred during what should have been normal/routine maintenance of a 66 kV switch yard. The area to be maintained was correctly isolated, earthed and barricaded.

All workers involved received the normal safety talk (tailgate) before work commenced.

One of the workers left the barricaded area without permission to relieve himself. On returning he climbed over the barricading into the live section of the yard and climbed a live structure and made contact. The supervising electrician was unaware of what was happening as he was occupied with other work.

The overriding factor in this case was that it was the end of the day and the people involved were concerned with completing all the work as quickly as possible so that they would be complete by normal time.

The factors leading to this accident were:

- The labourer involved did not follow the correct procedures when leaving and returning to the work area.
- The barricading was ignored.
- No proper supervision by the electrician in charge.
- Ignoring general safety.
- Time.

Personnel

The personnel involved in this accident had many years of experience. The labourer had 20 years field experience in this type of work. The electrician had over 10 years experience.

The Act

The relevant clause and regulations that should have prevented this accident are as follows:

- Clause 14 General Duties of Employees at Work
- The Regulation 15 General Machinery Regulations Clause 3.1.

Accident: Incorrect hot line tapping procedure

A contractor was commissioned to build a new line. He was provided with all the information to complete his task.

On completion he requested a final inspection which was granted. For the inspection he had removed all his staff and earths from the line.

During the inspection it was found that line dampers had not been installed. The contractor was instructed to install the dampers. To save time the normal procedure of testing and installing earths were ignored. The contractor proceeded to install the dampers, further down the line at the take off point the line had been made live using the hot line tapping method. The contractor had not been informed that the line had been made live as this was done without following normal procedures. The contractor was electrocuted.

The overriding factor in this case was that it was close to the end of the day and the people involved were concerned with completing all the work as quickly as possible so that they would be complete by normal time.

The factors leading to this accidents were:

- The contractor had not completed his work as instructed.
- The line was energised without following the correct procedures.
- On returning to the line the contractor did not follow the correct procedure.
- Ignoring general safety.
- Time.

Personnel

The electricians involved in this accident had many years experience between them. Over 15 years experience.

The Act

The relevant clause and regulations that should have prevented this accident are as follows:

- Clause 14 General Duties of Employees at Work.
- The Regulation 15 General Machinery Regulations. Clause 3.1.

Conclusion

The reason provided in the introduction (*"It should be remembered that our present work force is uneducated, ill trained and poorly skilled"*) is not a reason but an excuse.

In providing the conclusion to my research I tried to look beyond the normal technical reason. I looked at the underlying root cause to answer the question "Then why do accidents still occur?"

To answer this question, I asked what safety is and I believe the following:

- It's the time taken to do a job properly.
- It's the work ethic we apply to the work.
- I believe we need to return to old time value of sharing knowledge, skill, attitude and pride. This goes for both the employer and the employee. We should move away from the attitude of (*"I get paid for 8 hours and that's what you get,"*) to an attitude of *"I have pride in what I do and will take the time I need to do the job right"*.
- The employer should also have an attitude of showing gratitude to those that do show pride in their work and company.

In the final analysis, I believe the answer to the question "Can safety be regulated"? is "No".

The regulations are in place and most accidents take place in contravention of these regulations

Safety should be inherent to all workers. It should be re-enforced over and over as part of on going training. It should be understood by all that while safety is everyone's responsibility; ultimately personal responsibility remains that of the individual.

"Safety is everyone's responsibility."

Safety operations on medium voltage switchgear

It is important when operating on medium voltage equipment that we follow the safety rules and operating regulations in order to be safe. This paper covers general safe operations on medium voltage equipment and looks at the aspects of switching, isolating, testing and earthing, as well as various types of medium voltage testers and their usage.

by Barry Gass, Alstom Protection and Control

Hazards of operating on electrical equipment

There are five types of hazards associated with the operation of electrical equipment.

- Electrical shock
- Electrical burns
- Fire and explosion
- Heat build up
- Mechanical hazards

Electrical shock

There is no way to tell if an electrical conductor or terminal is alive just by looking at it, it should be tested using an appropriate approved tester. Thereafter it should be made safe in such a manner that it cannot be energised by someone else whilst it is being worked on.

Electrical burns

With medium voltage it is not necessary to touch a conductor or terminal in order to get burned. Air does not normally conduct electricity however, when a person gets too close to an electrical wire that is not properly insulated, the air can break down and form a conducting path between them to earth. Coils and capacitors store electrical energy and release it after power has been turned off and should, therefore, be discharged before work commences.

Fire and explosion

There is great danger of fire and explosion when working with medium voltage equipment, due to the large fault currents that can flow in the system. Oil circuit breakers (OCBs) and oil mini sub stations (MSS) and ring main panels (RMPs) pose a particular threat. Operator errors can also cause faults, livening up a cable, whist the other end is earthed for instance.

Heat build up

Heat can build up in wires. A lightweight extension lead gets hot when used for heavy duty service. Avoid using extension leads at all, if possible. If they must be used, ensure they can carry the current without overheating. Do not string them overhead, across aisles and under mats, where heat can build up and fully extend them.

Mechanical hazards

Electricity is often used to run machinery, rotating machinery and moving parts are always a source of danger, always ensure that guards are in place. Make sure the machine you are working on cannot be turned on without your knowledge.

Electricity

Because there is a serious threat of flashover, shock, arcing, etc. when working in a medium voltage environment, lower voltages tend to be treated with less respect. It must be remembered that a voltage as low as 50 V, with a current of ± 30 mA, can cause asphyxia and/or heart muscle fibrillation.

The biggest danger of electricity is that live and dead apparatus are indistinguishable from each other. Therefore, apparatus must never be assumed dead, always presume it is alive. This can only be ascertained by testing with the appropriate approved tester, or by the presence of a visual earth connection.

Electricity can jump gaps, which means that it is not even necessary to touch a medium voltage conductor in order to get hurt. Merely approaching too close can have fatal results, therefore, it is necessary to maintain close proximity distances.

Close proximity

Close proximity is the minimum distance any part of a person's body or work tool may encroach to any unearthed, bare LV conductor or any unearthed and unscreened MV/HV conductor.

In view of the dangers discussed earlier, it is obvious that work cannot normally be done on live or operational plant.

It is important to understand the meaning of the concept isolate, since isolation is the process where dangerous operational plant is rendered safe for persons to work on.

Even after isolation, a cable, or capacitor, or other similar device can retain a dangerous charge and therefore, they must be regarded as alive until discharged.

The term live is not only used in connection with electrical apparatus, but also to describe a vessel or pipeline under pressure, e.g. a live steam line.

ISITE

The acronym ISITE can be adopted to assist with the correct sequence of switching operations.

I - Identify the correct operating location

I - Identify the correct operating device

S - Switch

I – Isolate

T - Test

E – Earth

- Identify the correct substation/MSS etc.
- Identify the correct circuit breaker/isolator.
- Switch – open the circuit breaker/isolator.
- Isolate the circuit breaker by racking out/down.
- Test – using approved voltage detector.
- Earth – connect effectively to earth using correct method.

Switch

Circuit breakers can be opened in several different ways, remote operation is recommended.

Locally

- Electrically – using open/close switch.
- Mechanically – by pushing trip button.

Rated voltage	Clearance
Up to 11 kV	0,2 m
Exceeding11 kV, but not exceeding 33 kV	0,43 m
Exceeding 33 kV, but not exceeding 132 kV	1,45 m
Exceeding 132 kV, but not exceeding 275 kV	2,35 m

Table 1: Minimum clearance for safe working.

- Some circuit breakers have emergency trip buttons or foot pedals.

Remotely

- Remote operating panel
- Remote operating device
- SCADA (supervisory)

Circuit breakers should be opened remotely, where possible. If operation is to take place locally at the panel, then it is recommended that the appropriate personal protective equipment (PPE) is worn (flash suit).

Mini sub stations (MSS) and ring main panels (RMP) are opened manually using the appropriate operating handle. The "T" off to the transformer can be supplied with a circuit breaker or fuses and opened by pushing a button on the front of the unit. They can also be supplied with an electrical remote operating device, the same as a circuit breaker.

Isolate

Isolution mains physically disconnecting the apparatus from all possible sources of electrical potential by:

- Opening and/or removing of fuses.
- Opening of links.
- Withdrawal of truck type switchgear.
- Lock off and apply danger tags.

Security at points of isolation: All points of isolation should be locked off by the application of a personal lock to prevent inadvertent operation of the mains or apparatus.

Danger tags: The use of danger tags is an essential part of the isolation process. Danger tags should be applied at the switch or control gear which has been isolated, in order to enable persons to work on electrical apparatus or conductors safely, by notifying persons that work is being conducted on that piece of apparatus.

Authorised person: A person recommended by the electrical engineer or his nominee and appointed in writing by the designated person to carry out switching, isolating, testing and earthing on electrical mains and apparatus, in liaison with and under the instruction of a control officer and to issue work permits in respect of such mains and apparatus.

Isolation procedure

The authorised person shall carry out the necessary isolations, using personal locks, according to the rules and regulations. Thereafter, carry out safety tests using an appropriate approved tester to ensure that the mains and/or apparatus are dead and apply danger tags at all control points.

Control point: A position on the system where a main and/or apparatus can be switched, isolated, and earthed.

When isolating, the equipment must be isolated, from all possible sources of energy, not just electricity. Therefore, we must consider the following sources of hazardous energy and hazardous substances.

Hazardous energy: Electrical, pneumatic, hydraulic, stored (springs, batteries), potential (by virtue of position), heat (hot water, steam), radiation.

Hazardous substances: Gases, vapours, liquids, dusts with the potential to cause injury or illness, e.g. toxic, corrosive, flammable.

All plant and equipment must have written procedures for isolation; these procedures will set out a step by step account of how the system, plant or equipment is to be isolated and kept safe.

In the case of electrical isolation, a test for voltage must be carried out with an appropriate approved tester, to ensure that the mains and/or apparatus are dead.

Summary

The authorised person performs the isolation according to the rules and regulations. Control points must be locked off using personal locks. Danger tags must be applied to all points of isolation.

The locking of control points and application of danger tags is essential for a safe isolation, and isolation will not be deemed complete until those requirements are met.

Locking off of live shutters

All live shutters should be locked off with the personal lock. Cable shutters should be classed as live shutters, as the cable could be back fed, e.g. open point on a ring, therefore, both bus bar and cable shutters should be locked off.

Test

Before applying earthing equipment, the conductor must first be tested to prove it dead. Before using any approved medium voltage equipment it should be physically inspected for defects. When testing medium voltage the three point test should be adopted, test the tester on a known live source or a test box supplied by the manufacturer, test all three phases and retest the tester.

There are several types of voltage testers on the market and they all have specific uses:

Voltage detector (live tester): Used for testing the presence of voltage. A live tester is one that has to touch the conductor under test in order to determine if it is live or dead (it is recommended that one with audible and visual annunciation is used). These live testers are manufactured in two different types – S and L. S type for use on switchgear. L type for use on overhead lines.

Phase comparator/phasing sticks (live tester): Used to test that circuits are in phase with each other. A phase comparator should be used for phase comparison and not voltage detection.

Phasing in of ring feeds

It is essential to phase in medium voltage equipment prior to energising cable circuits, to ensure the correct phase rotation when cable systems are maintained and extended. Electrical phasing should be conducted when:

- New equipment is installed, which necessitates breaking into a ring feed, e.g. new substations.
- After the repair to any cable which forms part of a ring feed.
- Whenever a cable which forms part of a ring feed is terminated.
- An existing cable (to be returned to service) is being joined and/or terminated.

Voltage detector (proximity tester): Used on overhead lines. This tester does not have to come into contact with the conductor under test to determine if it is live or dead, it detects the magnetic field and therefore only works on bare and unscreened conductors.

There are no test facilities to test the cable is dead before earthing on an MSS/RMP, however, most modern units are supplied with LEDs, indicating if the cable is live or dead and these should be used as a guideline when operating. They also have the facility for doing electrical phasing on the front of the unit, using a multimeter. MSS/RMPs do have test points, however these are for testing the cable once it has been earthed and therefore access can only be gained to them once the cable has been earthed.

Earthed

Connected to the general mass of earth in such a manner as to ensure at all times an immediate safe discharge of electricity.

There are several different types of earthing methods: integral earthing, earthing carriage, earthing truck, and portable earths.

Integral earthing is designed into the circuit breaker and no external attachments have to be applied to the circuit in order to earth it.

There is no electrical tripping in the earth position on a circuit breaker that has integral earthing, so the manual trip button must be locked off.

Earthing carriages are usually used to earth bus bars and use the circuit breaker that has been racked out.

Earthing trucks are usually used to earth the circuit and rack into the circuit once the circuit breaker has been removed.

Portable earths are usually used on overhead lines, or as working earths when work is being carried out remotely from where the control point earths have been applied, e.g. at capacitor banks.

On MSS/RMPs there are test points on the two ring legs, they are used for testing the cable, e.g. megger tests. These test points are only accessible once the circuit has been earthed and the action of opening the test lever removes the earth off the circuit. It is, therefore, essential when earthing a MSS/RMP that the test point is locked off, as well as the earth point on the unit.

Earthing bus bars

When earthing a bus bar all possible sources of supply must be isolated.

Therefore:

- All remote ends should be switched, isolated, locked off and danger tags applied.
- All local circuit breakers should be switched, isolated, locked off and danger tags applied.
- Test with an approved voltage detector.
- Apply a minimum of one earth.

Portable earthing equipment

Application of portable earthing equipment:

- The mains and/or apparatus to be earthed should be tested with an approved voltage detector to ensure that it is dead.
- Check the condition of the portable earths.
- Securely connect the flexible lead to an earth bar or earth conductor FIRST.
- Using an earth or link stick touch each phase of the mains and/or apparatus to be earthed.
- Clamp onto each phase.
- When removing the portable earths the earth connection should be removed last.

Care must be taken to ensure good tight connections.

It is the authorised person's responsibility to ensure that all portable earths are removed before energising the circuit.

Interlocs

All circuit breakers and MSS/RMPs have mechanical interlocks, for example, you cannot rack a circuit breaker out if it is closed, you will not be able to place an earth on an RMP unless it has been opened first. However, they are not interlocked with each other and it is possible to earth a live cable. To this end, the correct oprating procedure must be followed and the authorised person should ask himself, before operating, what effect will the operation I perform have on the rest of the system – for every action there is a reaction! The following is a list of some of the things to consider before operating:

Switch (open)

- Will any supply be lost? If so, can I reroute the supply (shift open point on the ring, or shift load onto another circuit).
- If load has been shared with another circuit, ensure that that circuit can carry the combined load.
- If load has been shared with another circuit, ensure that that circuit has picked up load before opening the circuit breaker.
- Once the circuit breaker has been opened, check the other circuit has picked up the full load.
- Can the circuit breaker be opened remotely, if not what PPE is required?
- On a MSS/RMP the LEDs can be used to see if supply is lost to other circuits and to check if the circuit is dead.

Isolate

- Have all three phases on the circuit breaker opened?
- Before racking out/down a circuit breaker, it is good practice to check all three phases are no longer drawing load, this can be done by using the ammeter selector switch, if one is fitted.

Test

- Is the tester appropriate for use on the system? e.g. correct type and voltage rating.
- Is the tester in good condition?
- There are no test facilities (NTF) on a MSS/RMP prior to earthing.

Earth

- Is the other side of the circuit opened and isolated or earthed?

When reinstating the circuit

Remove earths

- There is no electrical tripping in the earth position on a circuit breaker, so the circuit breaker has to be tripped manually.

Close

- Has the earth been removed at the remote end?
- Has the remote end been made safe? e.g. has the area been checked after work that there no tools have been left in the working area. Have personnel been warned it is no longer safe to work in the area. Have portable working earths been removed etc.
- Has the remote end been secured? e.g. has it been isolated and locked off?

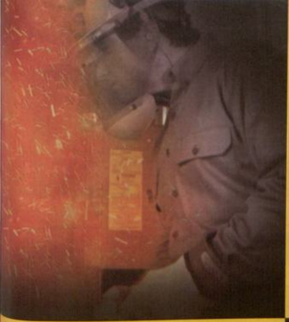
Work permits

Written authorisation for work to be carried out on electrical mains and/or apparatus.

Once the circuit has been made safe for work as above, the authorised person will issue a medium voltage work permit for work to be performed on the isolated mains and/or apparatus. It is important when issuing a work permit the following interaction with the person in charge is carried out:

- Give explicit instructions to the person in charge of the work regarding the work to be performed and the safe limits of the workplace and ensure that this is understood.
- Show the person in charge the control points and allow him/her to place their personal lock at the control point.
- Earth or prove the mains/apparatus dead at the worksite.

When receiving the work permit back at the workplace from the person in charge, the authorised person is responsible for obtaining confirmation that all persons are clear of the mains and/or apparatus and that all personal working earths applied during the work have been removed.



Stadium electricity supplies – an assessment of the specification and readiness

In a little over 250 days the world's largest and most anticipated sporting event will take place in South Africa. South Africa and the African continent will be showcased. Millions of viewers will tune in to matches, the broadcast of which will be critically dependent on the provision of uninterrupted high quality electrical power. The South African electrical supply industry (ESI) is critical in the preparation and execution of this historical event.

by T R Edmondson and Dr. C G Carter-Brown, Eskom

The main electrical loads associated with the 2010 tournament include:

- *Stadiums:* The 10 stadiums in 9 host cities at which the matches will be played.
- *Base camps:* Each of the 32 teams will have a "base camp", and are expected to arrive at base camp up to two months prior to the start of the tournament. Base camps could be located anywhere in South Africa.
- *Training venues:* Before each match (typically five days beforehand) teams will move from their base camps to the training venues within the host cities.
- *Fan parks:* FIFA fan parks will be located in host cities.
- *Public viewing venues:* Non-FIFA accredited viewing venues that will be set up by municipalities and private enterprise.
- *FIFA hotels:* Hotels at which FIFA will establish their local offices and command centre.
- *Media centres:* Journalists will be hosted at the international broadcast centre which will form the hub for broadcasting and reporting.
- *Supporters:* The accommodation, tourism and transport needs of visitors.

In relation to the South African peak demand, the magnitude of the additional electrical load is expected to be relatively small. Complexity and risk arise due to the uncertain nature of this load, including its location. Certain loads, such as stadium lighting and broadcasting, have onerous power quality requirements. A momentary interruption or voltage dip could disrupt broadcast to millions of viewers.

A problem in the supply chain (Eskom Generation, Eskom Transmission, Eskom Distribution, Municipal distribution or stadium distribution) will reflect poorly on the entire ESI, South Africa and Africa.

It is critical that all role players in the ESI work together to minimise risks and optimise approaches. Role players include:

- Host cities and municipalities
- Eskom
- Owners of the 2010 event stadiums
- 2010 Local Organising Committee (LOC)

Fig. 1: Stadium electrical supply 1.

- Association of Municipal Electrical Undertakings (AMEU)
- Department of Energy (DoE)
- National Energy Regulator of South Africa (NERSA)
- South African Local Government Association (SALGA)

The 2009 Confederations Cup was a successful tournament for the country and the electrical industry, but the real value was gained in the lessons learnt during and leading up to the event.

Stadium electrical supply

The stadia and surrounding areas are fundamentally broken down into three main focus areas, namely:

- Domestic/stadium power (stadium itself)
- Technical power (media and broadcasting)
- Overlay or precinct (area immediately surround the stadium including ticketing offices, hospitality, Accreditation etc)

Domestic/stadium power

The agreements signed by the host cities and FIFA in the delivery of "sufficient back-up power grids to deal with any power failure at the stadium and elsewhere in the host city which may arise during a match, and that appropriate power management systems are in place." *FIFA 2007 Specification – host city agreement*

Below is what is expected with regard to this statement:

- *Pitch Lighting:* "The primary goal of the event lighting system is to illuminate the event to digital video quality for the media without creating nuisance glare for the players/officials and adding spill light/glare to the spectators and surrounding environment. Permanent lighting, temporary lighting and a combination of both systems should be considered." *FIFA Football Stadiums – Technical recommendations and requirements, 4th Edition*
  - Host city is responsible for pitch lighting.
  - Lighting intensity of 2400 Lux (fixed camera lighting) with 1800 Lux at pitch level (field camera) is required at all times.
  - Available and functioning 100% during a match.
  - Zero switch time tolerance. i.e. switching between electrical supplies must have no impact on the pitch lighting.
  - Recommendation to have some sort of uninterruptable power supply (UPS) to ensure that any anomaly (Dips, surges etc) on the network (grid or generator) has no influence on the pitch lighting. Having a UPS would also ensure that the potential impact on pitch lighting during switching between electrical supplies will be mitigated.

Fig. 2: Pitch lighting.

Fig. 3: Nelson Mandela Stadium.

- Generators or alternate power supply capable of sustaining the pitch lighting for a minimum of three hours.
- Maintenance and refuelling are the responsibility of the host city.
- Configuration of the power supply is at the discretion of the host city but must have a minimum n-1 redundancy.

- *Stadium building power:* Stadium building power is the required supply within the stadium to power appliances, facilities and lighting within the stadium i.e. general stand lighting, administration offices and suites.
  - Backup power requirement in the event of a power failure is limited to that of the Occupational Health and Safety Act (OHSACT)
  - This power excludes any broadcast or media provisioning.
  - Configuration of the MV power supply is at the discretion of the host city and is recommended to have minimum n-1 redundancy.

Technical power

This is power for the broadcasting and television requirements

- No host city involvement. This is the responsibility of the LOC.
- No grid supply. Islanded from the grid power supply. Supply is provided via diesel generators supplied by the LOC.
- Covers all broadcasting mediums.
- Total of three 500 kVA generators each capable of taking the full load. Two generators run in parallel with the third being a backup. A fourth generator will be required for the venue hosting the final game.
- Zero supply switching tolerance.

Overlay/precinct power

Area immediately surrounding the stadium including ticketing offices, hospitality, accreditation etc

- Host city responsible to supply a medium voltage (11 kV) point/s of supply. For 2010 there may be as many as four required per stadium and the number and location of these bulk supply points will be stadium dependent.
- The requested capacity for the confederations cup was around 2 MVA. 2010 is expected to require greater capacity.
- The LOC will install and operate the temporary distribution network linking the MV bulk supply point with the individual loads.
- The LOC will install and operate backup diesel generation for the overlay supply.
- Approximate 1 min switch time tolerance between grid supply and the backup generation.

Preparation

The 2010 FWC is the event of events, a once in a life time experience, and the number of role players and stakeholders involved in the preparation and execution bears witness to this.

Action plans and programs have been put in place to help in the preparation for 2010 FWC and minimise risk. The information found in the points below is relevant and applicable to the stadia preparation and other 2010 critical loads.

Generation and transmission

The mitigation of risks for these components is primarily an Eskom responsibility and includes:

- Ensuring adequate primary energy supply prior to the event.
- The management of plans for the taking of generation and transmission plant out of servicefor planned maintenance or refuelling (Koeberg) in order that the risk to the tournament is minimised.
- The identification and assessment of Infrastructure providing supply to municipal distributor areas, which could directly or indirectly influence the supply to any of the stadiums, for condition and maintenance or refurbishment plans.
- Detailed emergency planning and simulation of these plans prior to the event.
- Plans for obtaining and storing of strategic spares, as well as logistic constraints such as communications and transport are in place.
- Inspection of networks will take place earlier than normal practice for those networks identified as critical for reliability and quality of supply.

Distribution

The establishment of regional task teams (RTT) in all the host cities has enabled the preparation to be tracked and understood. The suggested actions that are being carried out (many have been completed) by the relevant host cities include:

- Identify and assess the condition of theelectrical infrastructure that could directly or indirectly influence the supply to the stadium(s), training venues and key loads in their area of responsibility.
- Replacement, refurbishment or maintenance of these networks to be scheduled to be completed well before the commencement of the tournament.
- Evaluate the requirement and availability of strategic spares for their network.
- Assess loads connected to load shedding relays and revise existing plans to ensure that there is no impact on identified tournament critical loads should the need for load shedding arise.
- Arrange networks so that no abnormal conditions are maintained during the period of the tournament.
- Prepare contingency plans for supplies to the critical loads and ensure all control and operations personnel are thoroughly familiar with switching requirements.
- Plan leave and standby rosters well in advance to ensure the availability of an adequate level of competent staff.
- Optimise security measures for the protection of critical infrastructure.

Stadia

Each of the host cities have achieved the requirements for stadium supplies differently considering legacy requirements and historical infrastructure and layout, namely;

- *Ellis Park (Johannesburg)*
  Primary power – generators
  - 2 x 700 kVA
  - 2 x 800 kVA
  - 1 x 500 KVA

  Backup power – grid (n-1)
  - Prospect
  - Delta

  Uninterruptable power supply (UPS).
- *Free State Stadium (Bloemfontein)*
  Primary power – generators
  - 2 x 1250 kVA

Backup power – grid (n-1)

Configured to run parallel.

- *Royal Bafokeng Sports Palace (Rustenburg)*

  Primary power – generators

  - 2 x 2200 kVA

  Backup power – grid (n-1)

  Uninterruptable power supply (UPS).

- *Loftus Versveld (Pretoria)*

  Primary power – generators

  - 8 x 300 kVA

  Backup power – grid (n-1)

  Uninterruptable power supply (UPS) per light mast.

- *Green Point (Cape Town)*

  Primary power – grid supply (n-1)

  Backup power two sources of power. 2 x 2 MVA fixed generator supply supplemented by 4 x 500 kVA generators.

  Uninterruptable power supply (UPS)

- *Moses Mabhida Stadium (Durban)*

  Primary power – generators

  - 3 x 800 kVA

  Backup power – grid

  - 2 x 11kV sources from separate locations.

  There is currently no allowance made for any UPS supplies at the Moses Mabhida Stadium, albeit that the consultants have made physical arrangements to incorporate as such.

- *Soccer City (Johannesburg)*

  Primary power – generators

  Backup power – grid (n-1)

  Uninterruptable power supply (UPS).

- *Mbombela Stadium (Nelspruit)*

  Primary power – generators

  Backup power – grid (n-1)

  Uninterruptable power supply (UPS).

- *Peter Mokaba Stadium (Polokwane)*

  Primary power – generators

  Backup power – grid (n-1)

  Uninterruptable power supply (UPS).

- *Nelson Mandela Stadium (Port Elizabeth)*

  Primary supply – grid supply (Mount Rd substation @ 66/22 kV)

  Backup power – gas turbine

  There are rotary UPSs which are installed in each of the 4 stadium substations which will be dedicated for pitch lighting and emergency supplies.

Note: The above configurations are not final and may change leading up to the final preparation for the 2010 FIFA World Cup event.

Human resources

The human factor in the preparation for 2010 FWC cannot and must not be underestimated. Below are a few points to note during these preparations:

- 2010 FWC coincides with a period synonymous with wage negotiations and labour action.
- Staff still taking care of "business as usual" whilst also supporting the event with priority response.
- Manpower to support and be involved in event specific structures (venue operation centres, joint operational centres etc.)
- Staff on site match day -1 at key supply points.

General preparation

These are other significant items that should be noted during the preparation for 2010 FWC:

- Heightened electrical fault response and restoration is required to be in place ± 2 weeks prior to the first game.
- Fuel supplies and spares to be sent to site at least 48 hours before match and if used replaced within 24 hours.
- FIFA exclusive use period is 15 business days before first game at stadium and five business days after last game at stadium. – electricity readiness needs to mirror this.

Conclusion

A large amount of effort has gone and is going into the preparation of the 2010 FIFA World Cup with a large portion of these preparations dependant on the electrical supply and availability thereof.

With only a few months to go, final preparations for this event are at the forefront of host city and Eskom priorities.

"In every aspect of life, progress is constantly being made." Joseph S. Blatter - FIFA President

References

[1] FIFA World Cup 2010 State of Readiness, Media Briefing by Deputy Minister of Finance, 15 May 2007.

[2] "ESI Preparedness for the 2010 FIFA Soccer World Cup", CG Carter-Brown and PE Fowles, (*AMEU Convention*), October 2007.

[3] Recommendations for the 2010 soccer world cup stadium supplies, Draft 6a, 2010 ESI forum, August 2007.

[4] 2010 ESI project summary rev3, (*2010 ESI forum*), August 2007.

[5] World Cup 2010 base camps - revision 2, (*2010 ESI forum*), March 2007.

[6] Project: FCC and FWC power delivery presentation – ArupMajorProjects Consulting 2009

[7] FIFA football stadiums – (*Technical recommendations and requirements*) 4th Edition 2007

Acknowledgements

The authors would like to acknowledge the contributions made by all the Host City 2010 electrical task teams, Eskom task teams and the members of the 2010 ESI forum.

Lessons for the 2010 FIFA World Cup South Africa from the 2009 FIFA Confederations Cup

With the exception of the first democratic election in South Africa (SA) in 1994, the 2010 FIFA World Cup South Africa (2010 FWC) is arguably the most important event in the evolving history of this nation.

by Sicelo Xulu and Xolani Lembede, City Power; Sanjay Bhana, Eskom; Adam Pobe, Centlec; and Gert Booysen, Tshwane Electricity

The 2010 FIFA World Cup South Africa is scheduled to take place from 11 June 2010 to 11 July 2010. The only test run in preparation for the 2010 FWC was the 2009 FIFA Confederations Cup South Africa (2009 FCC) which took place from 14 to 28 June 2009.

As an essential service that underpins economic growth in SA, the Electricity Supply Industry (ESI) has a significant contribution to make in the form of a reliable supply of electricity for the 2010 FWC.

In terms of the South African ESI, as shown in the electricity supply chain in Fig. 1, it must be noted that the majority of the country's power stations and bulk electricity infrastructure backbone is within the control of the national utility Eskom, while the majority of the key installations for the 2010 FWC lie within the host cities and are supplied by the municipal electricity infrastructure.

The ESI took a decision to establish a 2010 ESI forum consisting of all the role-players in the supply chain (see Fig. 1) as well as the 2010 Organising Committee, Department of Minerals and Energy (now called Dept. of Energy) and the National Energy Regulator of SA (NERSA) to ensure that all activities for the 2009 FCC and 2010 FWC are co-ordinated and learnings are shared across the industry to ensure a successful event in SA.

It must be noted that the games are played at night and to ensure the masses can view each and every game makes broadcasting one of the most important components of the event.

This paper focuses on the lessons learnt nationally and across four host cities over the 2009 FCC that need to be incorporated into the Electricity Supply Industry (ESI) preparations for the 2010 FWC as a whole.

Background

The 2009 FCC occurred in the following host cities: Johannesburg, Bloemfontein/Mangaung, Tshwane, and Rustenburg.

A total of 16 matches were played over the 14 days.

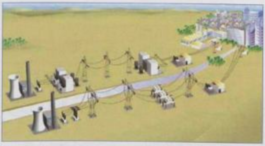


Fig. 1: Electricity supply chain.

This event was important for the 2010 FWC for the following reasons:

- It was the test run in preparation for the 2010 FWC
- Creating an understanding of the event's electricity requirements
- Defining the stadium power requirements and supply side configurations
- Training and developing staff for the 2010 FWC
- Reviewing our level of communication and security alignment across the ESI

National lessons

As the national electricity provider for SA, Eskom objectives over the 2009 FCC were as follows:

- Test Eskom readiness: technical readiness; communication; security; and collaborative efforts with identified stakeholders (2010 Organising Committee (OC), host cities and electricity municipal depts.).
- Enhance understanding of the events and related electricity considerations.
- Train and develop staff.

The Eskom 2009 FCC preparations went live on Friday 12 June 2009 and the following is a summary of the Eskom 2009 FCC experiences:

Risk identification and treatment

The top risks associated with the 2009 FCC were as follows:

- Loss of electricity supply to a stadium or key installation during an event
- Reputation risks for Eskom and SA
- Strikes and related risks.

Five Eskom situational awareness centres (SAC), one national and four focused on each of the host cities, were implemented for the event as one of the key treatments for the above risks. The purpose of a SAC was to know, analyse, share the status of, and progress on, electricity matters for the event (the situation). These SAC were used to ensure the ability of the organisation to make tactical and strategic decisions in order to influence the way the organisation would want to respond to a particular event or situation and by all accounts served this purpose very well over the period.

The treatment plans put in place for the above risks were tested for adequacy and effectiveness over the 2009 FCC. While the treatment plans put in place for the above proved to be adequate and effective over match days, on non-match days various gaps and inadequacies were identified in terms of the treatment plans implemented. Furthermore, the amount of labour related issues and number of strikes in SA as a whole in the run up to the 2009 FCC, highlighted the need for a more pro-active treatment plan to be implemented for the 2010 FWC.

Reliability of supply

Eskom preparations for the 2009 FCC went live on 12 June 09 and were in place post the 2009 FCC until 3 July 09.

Over this period there were no national reliability of supply issues that affected the 2009 FCC. There were however incidents resulting in loss of supplies to two sites on non-match days and one reduction in contingency level (n-3 to n-2) to a site.

The 2009 FCC assisted in understanding the event electricity requirements, operational considerations (resources, security, etc.) and communication considerations

Resources

In the final two weeks to the 2009 FCC, OC electrical representatives indicated that they required staff to be available 24 hours a day at key sites four days prior to the event and four days post the event,

Given the fact that Eskom transmission sub-stations have remote switching and the key sub-stations are manned during working hours, a decision was taken that these sites would only be manned from an hour before a match to an hour after the match.

Dedicated resources (SAC, field, operations, security and communication) were put in place for the event. While this was a great initiative to ensure quick turnaround times to ensure the reliability of supply for the event, given the current shortage of skills globally as well as financial constraints, this impacted the day-to-day business operations in some areas.

The event served as a great training and development opportunity, facilitating the following training:

- Communication staff across Eskom were trained on event and emergency communication
- Technical staff trained on event monitoring, reporting and co-ordination
- Security staff were given exposure to real time electricity operations and this has created an opportunity to further enhance the alignment of the reliability of supply and security related initiatives.

Security

Security plans implemented over the period were focussed on addressing security risks identified. While these security plans proved to be adequate for the 2009 FCC key supply points, areas of enhancement were identified in terms of securing infrastructure beyond key sites. Furthermore, areas of enhancement were also identified in terms of intelligence gathering and the alignment with the key event security structures established.

Collaborative efforts

In the run-up to and over the period of the 2009 FCC, the levels of collaboration with the OC electricity representatives as well as the various key stakeholders such as host cities and municipal electricity departments were continuously improving and this facilitated greater alignment of activities focussed on ensuring reliability of supply. The level of information exchanged in some areas was, however, a concern given that very minimal information was available on network status and incidents pre-during and posts events

There was, however, a lack of alignment of emergency and media communications with the OC and FIFA in terms of electricity supplies and is an area requiring considerable attention for the 2010 FWC.

Lessons for 2010 FWC

- A risk management approach is to be used as the basis for rolling out the Eskom preparations.
- Key information sets that would enhance electricity readiness must be sourced at least six months prior to the event so as to enhance and improve electricity readiness to cater for the 2010 FWC, e.g. key site information together with team and people movement and periods of use.
- Resource requirements need to be quantified and an optimal solution determined so as to deliver on OC and stakeholder expectations while giving due consideration to the resource shortages and financial constraints.
- Pro-active treatment plans need to be investigated and implemented for the treatment of labour risks.
- Alignment of emergency and media communications with the OC and FIFA in terms of electricity supplies.
- Alignment of all intelligence gathering activities so as to enhance decision making and responses to incidents and issues that may arise.
- Need for detailed simulations (people, processes and systems) and trial runs to train staff and test and enhance the adequacy and effectiveness of the various risk treatment plans implemented.
- Defining and agreeing on the levels of information exchange with the various stakeholders.

Host city lessons

Mangaung/Bloemfontein

Mangaung/Bloemfontein was one of the four cities for the 2009 FCC. Feedback is provided below on the performance of the Centlec electrical network and the stadium generators that were the main supply during the 2009 FCC matches. The report will cover the entire event and the testing work done during the period leading to the start of the event.

The following were the key objectives of the city in hosting the FCC matches:

- Processes put in place for the 2010 FWC.
- Testing the generators under conditions similar or close enough to 2010 FWC conditions.
- Highlighting the city's readiness as a 2010 FWC host city.

The Mangaung/Bloemfontein preparations went live on 14 June 2009 and the following is a summary of their 2009 FCC experiences:

Risk identification and treatment

- *Risk:* loss of lighting at stadium due to a network fault.
- *Treatment:* testing performed to determine:
  - How the stadium lights would respond to the voltage dip on Centlec's grid due to faults elsewhere in the Centlec grid.
  - Impact of a voltage dip on the stadium lighting.
  - How the stadium generators would perform under various faults conditions in the Centlec network.
- *Risk:* Single generator incapable of meeting complete stadium load.
- *Treatment:* Stadium loading limited to a maximum of 1100 kVA and some of the stadium load moved to overlay. Furthermore, stadium loading over the match was managed by switching off the air conditioners and boilers if necessary.
- *General risk management:* The risk of supply to the stadium was generally managed in the following manner:
  - The stadium was solely supplied from generators.
  - The load was shared between the two generators. Each generator was capable of supplying the whole load, hence backing-up each other.
  - Back-up to generators – Centlec grid.
  - Dedicated busbar at Park West DC to supply Willows DC and the stadium.
  - Some of stadium load supplied from the overlay.

Reliability of supply

There were no municipal reliability of supply issues that affected the 2009 FCC matches. There were however moments of concern when supply to the stadium was lost one afternoon and the instability of the generators.

The picture in Fig. 2 shows the fluctuations that occurred during the third match.

The supplier of the generators was called in to assist in resolving the problems with fluctuations on the generators.

Resources

The staffing of the team for the event was arranged as follows:

- *Inside the stadium precinct:* The Venue Operating Centre (VOC); generator operating technicians and electricians; generator refuelling electricians; and consultants.
- *Outside the stadium precinct:* Electricians with a test truck.

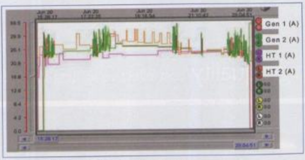


Fig. 2: Fluctuations that occurred during the third match.

- *Away from the stadium precinct:* Standby technicians per distribution centre, and Centlec control room coordinator.

Generator fuel was another major resource which had to be taken into consideration and the following was planned in that regard:

- The generators each have a fuel capacity of 2000 litres.
- The consumption of the generators is 200 litres/hour when at 75% loading and 300 litres hour at full loading. The above translates to 10 hours when 75% loaded and 6 hours 40 minutes when fully loaded.
- Taking the above into account, a steady delivery of diesel to the site was required to cater for the 2009 FCC needs. There were however limitations in terms of onsite diesel storage at the stadium for safety reasons and the refuelling schedule was modified to take this into account.
- Below is an example of a typical refuelling schedule that was implemented:
  - Refuel Friday 12 June 09 for operations on Monday 15 June 09.
  - Refuel on Monday 15 June 09 at 17h20 (20 minutes after half time) to ensure sufficient capacity to run the remainder of the game as well as 4 hours after the game.
  - Refuel on Wednesday 17 June 09 at 07h00.
  - Refuel again on Wednesday 17 June 09 at 17h20 (20 minutes after half time) to ensure sufficient capacity to run the remainder of the game as well as 4 hours after the game.
  - Refuel on Thursday 18 June 09 to be ready for the match of 20 June 09.
  - Refuel on 20 June 09 at 21h50 (20 minutes after half time) since the match commences at 20h30.
  - Refuel on 23 June 09 at 10h00 to be ready for the match of 24 June 09.
  - Refuel on 24 June 09 at 21h50 (20 minutes after half time) since the match commences at 20h30.
- To limit the fire hazard, it is essential that the tanker doing the refuelling should contain only diesel and no petrol at all.
- The maximum amount of fuel required for any refuelling would not exceed 4000 litres at any one refuelling action.
- The driver of the fuel tanker needs to be accredited in order to be allowed in the stadium precinct. The vehicle registration number is required in advance to list it on the delivery schedule. Due to limited access control it was proposed that only two names be tabled by Engen to do all the refuelling.
- In order to ensure timely delivery of the fuel, the tanker needed to report to site 90 minutes prior to delivery and then move to the offices of parks until 10 minutes prior to the refuelling schedule.

Security

The only security threat that Centlec considered was a general blackout to parts of the city in the case of a major distribution centre being sabotaged. Technicians who could respond within minutes were put on standby and assigned distribution centres that they would be responsible for.

Lessons for 2010 FWC

- *Reliability of supply:* Testing of the generators under controlled environment and with rugby matches was not sufficient to uncover the instability problems that were experienced. The following should have been done before the event. Have the suppliers of the generators involved in the testing of the generators during events.Also have the supplier representatives on site with the team that operates the generators.
- *Resources:* The decision to identify key installations and assign experienced technicians was important in restoring the outage experienced on the afternoon of 20 June 09. It is also important to remember that although you have to assign people to the event there is still the normal business of maintenance that must continue and not be impacted on in anyway.

Delivery of fuel to the stadium for refuelling of the generators posed specific logistical challenges. This is one area where we will need some creativity during 2010 FWC. The pressure will be taken off by the plan to use grid as primary supply and the generators as backup.

City of Johannesburg

Upon receiving the venues for 2010 FWC i.e. main stadia, training venues, fan parks, etc., City Power started a comprehensive study to fully understand the impact of additional loading and operational risks on all the affected areas. With 2009 FCC serving as a dry run for 2010 FWC, City Power has re-looked at the study concentrating on FCC impact only.

The Gauteng Regional Task Team formed five working groups to workshop, consolidate, and deliver on the following:

- Infrastructure assessment, planning and project implementation, i.e. capital programme. Scope: to assess and address power requirements to meet the demand related to the 2009 FCC and 2010 FWC.
- Maintenance planning and implementation. Scope: to develop and implement maintenance plans and also to identify 2009 FCC and 2010 FWC related events and implement contingency plans to ensure continuous supply of electricity.
- Integrated emergency response. Scope: to develop and implement integrated emergency response and regional command centres to deal with possible emergencies and load shedding.
- Security of electrical infrastructure. Scope: develop and implement an integrated anti theft and vandalism strategy for the 2009 FCC and 2010 FWC.
- Public lighting. Scope: identify public lighting requirements i.e. major 2010 routes, Fan Parks, Park and Ride etc. and ensure that these areas are well lit during the events.

The city objectives for the event were aligned to those of the mayoral priorities. Below are some of the city objectives:

- To provide an interruption free event which complied with all the FIFA requirements as stipulated in the bid book.
- Create a legacy that will help the city and its residents to realise the goal of becoming the sporting hub of the continent.
- To provide job opportunities and stimulate economic activities through sport.

The City of Johannesburg preparations went live on 14 June 2009 and the following is a

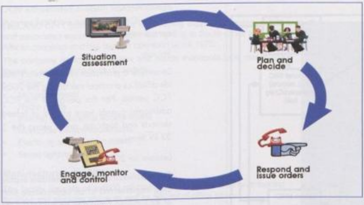


Fig. 3: Key Functions of the JCC.

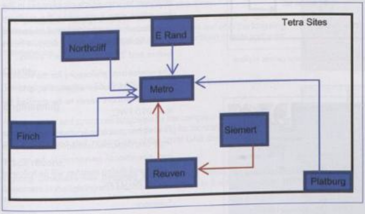


Fig. 4: Tetra installation sites.

summary of their 2009 FCC Experiences:

Reliability of supply – costs:

- Waiving of Ellis Park actual maximum demand.
- Due to OC decision that overlay is a host city responsibility, the costs for provision of overlay power consumed was carried by City Power.

Event co-ordination

All activities were coordinated through the Joint Command Centre (JCC). Joint operations support and collaboration for the City of Johannesburg was achieved through participation of the following in the JCC:

- Emergency Management Services (EMS)
- Johannesburg Metropolitan Police Department (JMPD)
- Bus Rapid Transport (BRT)
- Intelligent Traffic Systems (ITS)
- City Power/ Eskom
- Johannesburg Water
- Waste management (Pikitup)
- 2010 OC

The operation of the JCC is based on a traditional command centre approach. The four key functions of the JCC are represented in Fig. 3.

Accreditation

The FIFA rules specify that a radius of 1 km will be kept as a traffic free zone (TFZ). Entry into this area required prior accreditation to be in place.

City Power implemented specific accreditation for their staff and access requirements into the TFZ.

The following are examples of what was implemented and what was experienced:

- Access to services: City Power had to submit all the Siemert Rd Depot employees' names for accreditation. In addition to these employees, City Power had to request accreditation for the emergency response teams that would have needed to access this area. This access was requested in line with the two types of accreditation allowed by FIFA: Standby accreditation – all operational personnel. Full house accreditation – one senior employee who will get unlimited access throughout the precinct.
- *Experiences:* Sixteen applications were made for accreditation and only six were approved. Access denied for accredited personnel to repair faulty lights on match day – 1.

Communication

To avoid network congestion and to maintain system security, City Power opted to use the TETRA system as the medium of communication. Fig. 4 illustrates the list of TETRA base station sites that were operational for the FCC and each site had a ±15 km radius coverage.

Resources

Standby teams were deployed at major substations for the duration of the event to reduce response and where possible restoration times.

City Power and Eskom personnel deployed at VOC and JCC. The diagram in Fig. 5 illustrates the information flows between the various operations/command centres in place over the 2009 FCC.

Lessons for 2010 FWC

- Voltage regulation at key sites needs to be reviewed and appropriate measures implemented to ensure voltage stability. E.g. high voltage levels were experienced at the overlay (on the load side), due to the transformer fixed tap design. As a result the overlay load was supplied from generators and the grid utilised as back up supply. It is critical the OC electricity representatives provide clarity on the stadium internal supply arrangements at least 6 months prior to the event to prevent a repeat of this type of incident.
- Redundant supplies to the stadium are to be implemented prior to the 2010 FWC
- Clarity needs to be sought from the OC and host city directorate on accountabilities for payment of electricity consumed at stadia and key event sites.

City of Tshwane

Tshwane is a metropolis and was established on 5 December 2000 in terms of the new local government structure. Since it incorporates Pretoria, Tshwane is now the seat of government administration and the capital of South Africa. It is also one of the host cities for the 2009 FCC and the 2010 FWC.

The City of Tshwane preparations went live on 14 June 2009 and the following is a summary of their 2009 FCC experiences:

Risk identification and treatment

- *Risk:* During the early stages of the planning for the FCC and 2010 FWC the likelihood of a loss of supply due to capacity constraints at the River substation was identified as a risk in terms of supply

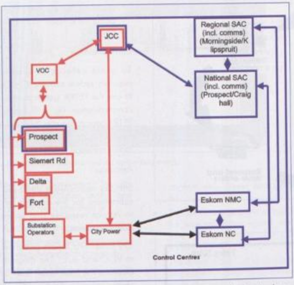


Fig. 5: Information flows between the various operations/command centres in place over the 2009 FCC.

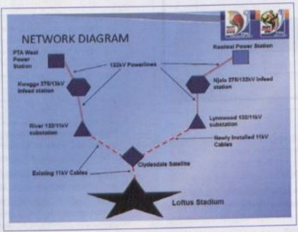


Fig. 6: The network configuration from the Eskom points of supply to the stadium precinct.

for the area surrounding Loftus stadium. To create spare capacity at River, 18 MVA was transferred to Lynwood substation.

- *Treatment:* Load was moved away from River substation and various surrounding infrastructure was upgraded in the run up to the 2009 FCC. This improved the reliability of the supply to Loftus and the local area around Loftus tremendously.

The network diagram in Fig. 6 highlights the network configuration from the Eskom points of supply to the stadium precinct.

Resources

Necessary resources such as vehicles, equipment, spares etc. were stored inside the TFZ which was closed on match days-1.

Additional standby personnel dedicated to maintenance and network operations were available on site four hours before the start of matches and two hours after matches. Standby personnel on site (inside the TFZ) during the 4 hours before and up to 2 hours after the match included maintenance teams for LV and MV equipment, 132 kV maintenance personnel, network operators for 11 kV and 132 kV switching actions , test and protection technicians.

The cellular telephone networks were not considered reliable enough and temporary trunked radio systems were used as a communication medium between the VOC and the City of Tshwane electrical network control room.

Security

Security and protection of the network was identified as a critical risk during the 2009 FCC period. For the period of the FCC additional guards were placed at infeed stations and high risk areas along the 1 32 kV lines.

Lessons for 2010 FWC

The modifications to the Clydesdale supply area implemented at an approximate cost of R23-million proved to be successful for the stability and quick automated restoration of power failures which could occur in the immediate area surrounding the stadium. The stadium however preferred to operate disconnected from the mains supply 4 hours before and 2 hours after match events.

The operational philosophy for the stadium and precinct power supply, i.e. grid vs. onsite generators needs to be clarified for the 2010 FWC.

The same procedures and preparations regarding dedicated additional maintenance and operational personnel to be on site before and during matches will be followed for the 2010 FWC.

Summary

The Loftus venue proved to be successful in presenting the 2009 FCC except for some minor issues the electricity supply network was stable and functioned without any problems during match days. The extensive maintenance actions to replace risky older oil filled switchgear, do preventive maintenance on public lighting and stopping all planned excavation work in the vicinity of the supply network to Loftus resulted in a successful hosting of the 2009 FCC at Loftus as well as the official public viewing areas.

Rustenburg

The Royal Bafokeng Stadium in Rustenburg is directly supplied by Eskom.

The Eskom objectives in Rustenburg over the 2009 FCC were the same as the Eskom national objectives stated earlier.

Risk identification and treatment

While the risks identified for Rustenburg were the same as the national risks identified by Eskom, the treatment of these risks were tailored for Rustenburg. These included:

- The installation and commissioning of a second cable feeder to the stadium

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The company designs, fabricates and erects monopole type masts and towers in seven basic product ranges:

- Railow masts
- Midhinge masts
- Hydro masts
- Internal and external access masts
- Monopole transmission masts
- Electricity transmission masts
- Street lighting poles

Manufacturing facility

The facility consists of a 4000 m² covered factory with extensive loading facilities and stacking space as well as 500 m² of office space.

The facility is well equipped with extensive plant and machinery for the handling and processing of steel plate as well as all other steel work required for the production of monopole type structures.

The production facility employs some 100 people including qualified boilermakers, coded welders and machine operators and offer the following services: wind turbine; solar panel structures; advertising boards and mast maintenance.

Quality

The production facility is EN ISO 9001:2000 certified by Dekra International.

Engineering

All monopoles and structures fabricated by the company are designed by a professional structural engineer, and detailing for fabrication is done by our own experienced staff, making use of the latest CAD drawing facilities.

Track record

Lighting Structures has designed and fabricated masts for numerous customers in the lighting and electrical sectors both in South Africa as well as many other countries in Africa.

Services:

- Design and fabrication of masts from a standard range or special design to suit client specifications
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- Combining the Rustenburg SAC with the Rustenburg JOC as both of these are operated by Eskom.
- A radio link with the Stadium VOC and OC electrical representatives.

Reliability of supply

No incidents were experienced in terms of loss of supply to the Royal Bafokeng Stadium over match times.

Resources

Dedicated technical resources were accredited and posted at the Phokeng substation as per the OC requirements.

The Rustenburg SAC was also manned from 7h00 daily to 24h00 with technical, communications and security personnel.

Security

Given that Phokeng substation is within the stadium precinct, the security for the substation was catered for through the OC security measures put in place for the precinct.

Collaborative efforts

Continuous communication and collaborative efforts were put in place for Rustenburg as a whole with the Rustenburg electricity department.

Lessons for 2010 FWC

As per those stated in the national and host city lessons earlier.

Recommended action

The following recommendations are made to all the ESI members involved in the 2010 FWC:

- Based on the experiences over the 2009 FCC, it is recommended that a risk based approach be utilised to direct the ESI actions for the 2010 FWC as opposed to the current approach which is focussed purely on technical delivery.
- Adequate security and storage measures need to be put in place to store and safeguard equipment in the run up to and during the 2010 FWC.
- Safety considerations need to be identified and adequately addressed at all sites for the 2010 FWC.
- Accreditation requirements (people, vehicles and equipment – this includes any suppliers) must be quantified and the relevant access requirements finalised as far in advance of the event as possible.
- Appropriate fuel supply considerations need to be implemented to take into account any restrictions that could affect fuel delivery.
- Resource planning for the 2010 FWC must be implemented timeously and give due consideration to risks such as labour action over the period.
- Emergency communication and media information dissemination needs to be simulated across the ESI to enhance this and prepare for the 2010 FWC. This includes the critical alignment with FIFA and OC.
- Clarity must be sought from the respective parties, e.g. OC, host city directorates or relevant government department on issues such as costs incurred over the 2010 FWC and re-imbursement for such.

Conclusions

The 2009 FCC as stated earlier was the only test run in preparation for the 2010 FWC. As such the event served its purpose in:

- Providing the ESI with an opportunity to test its event specific readiness, assumptions and real time operations.
- Providing the ESI with an opportunity to test the adequacy and effectiveness of the risk treatment plans implemented.
- Creating an understanding of the magnitude of the 2010 FWC which will be upon us shortly and the necessary actions to be taken to ensure success for this event, i.e. incorporating lessons learnt into our final preparations so as to have a more robust and complete plan of action for the 2010 FWC.

Acknowledgements

The authors would like to acknowledge the contributions made by the 2010 ESI forum.

Renewable energy in South Africa: resources, research and projects

South Africa is blessed with an abundant variety of renewable energy resources. It is well known that sunshine, solar energy, is in abundance in South Africa, especially in the north western parts where some of the best solar irradiation in the world can be found.

by Prof. J L van Niekerk, Stellenbosch University

The wave energy resource along the south western coast is also indicated on most maps as a resource with sufficient power to drive wave energy convertors. The wind energy resource is limited to the Northern, Eastern and Western Cape Provinces but even in this regard South Africa has the potential to generate a number of gigawatts using conventional, land base wind turbine technology.

There are some resources where South Africa is more constrained. Due to the fact that most of South Africa is a water-stressed area large scale biomass production for energy will probably never be realised as a cost effective agricultural sector although energy from agricultural waste has more potential. Due to the lack of water and only a few, large, perennial rivers the potential for hydro power is limited and mostly restricted to pump storage schemes.

South Africa also has very limited potential to exploit geothermal or ocean thermal energy conversion. The Agulhas ocean current shows some potential but technology to harvest the energy from deep sea currents is currently not economically viable.

Resources

A number of projects are currently under way to map the various renewable energy resources. In particular the South African Wind Energy Project is developing a new wind map for South Africa in cooperation with the Riso National Renewable Energy Laboratory of Denmark. This map will be a meso-scale map relying on synoptic weather data to generate a wind map. It is possible to increase the accuracy of this model by more detailed modelling in specific areas.

A geothermal atlas for South Africa is currently under development by a group at the University of South Africa. There is an existing solar map of South Africa and more detailed, satellite derived solar data is available from abroad. A project to verify the solar data with ground measurements is under development.

The wave energy resource around the coast is well understood due to the extensive work on coastal developments that have taken place over the years. This is augmented by wave-rider buoys with data going back 30 years.

Projects

The number of renewable energy projects in South Africa is still extremely limited given the abundant resources available and the profile that renewable energy as a source of clean energy is receiving worldwide. The main reason for this is that as a developing country South Africa has been focused on cheap energy from fossil fuels, in particular electricity from coal-fired power stations.

Some of the larger projects that are under development, or came online recently, are the Darling wind farm and the Bethlehem hydro scheme. These projects will deliver 5,2 MW and 7 MW of clean energy respectively.

Other projects such as landfill to gas and existing hydro-electric power stations are already making a contribution.

It is envisioned that the new REFITs will stimulate the sector and enable the various project developers to implement the projects currently being planned.

Research

There are various groups in South Africa engaged with research on renewable energy, from small one-man operations to larger, reasonably well funded groups at universities and other research organisations such as the CSIR. SANERI identified three spokes of research: solar thermal energy, solar photovoltaic research and wind energy research. The universities involved include Stellenbosch, Cape Town, Pretoria, NMMU and Fort Hare. There is, however, some activity in renewable energy research at most universities and universities of technology in South Africa.

Currently the SA Government has two processes underway to increase the investment in renewable energy research. SANERI is investigating the establishment of a record, Renewable Energy Centre of Research and Development, with subcentres in solar, ocean, photovoltaic and transport energy. At the same time the Department of Science and Technology contracted the CSIR to develop a road map and business plan for a solar energy research programme that will focus on solar thermal energy.

Conclusion

One of the biggest stumbling blocks that inhibited the roll-out of large renewable energy projects was, and still is, the low price of electricity from coal-fired power stations. This is, however, changing fast as Eskom is running out of capacity and the new power stations, coal-fired and nuclear, are becoming much more expensive than anticipated. This will result in a significant increase in the price of electricity over the next few years making electricity from renewable energy sources more cost-competitive.

At the same time the effect of greenhouse gasses from burning fossil fuels is manifesting more and more and the world is contemplating how to deal with this global threat. There are already incentives in place to make use of renewable energy resources and this may increase after the next round of discussions in Copenhagen at the end of the year. What is unclear is what new mechanisms will be put in place and how South Africa, with a very carbon intensive energy sector, will be affected by the new arrangements.

What is clear is that South Africa is well positioned to harness renewable energy and to build a completely new industrial base to service this sector. The sector is very attractive as South Africa can easily enter this market with our existing industrial complex and technology base, and the country is even well positioned to make a contribution towards developing new technology in this area.

Legislation's role in promoting the acceptance of renewable energy into society

This paper begins by discussing the need for renewable energy sources in the world today, particularly with reference to climate change, poverty eradication and political stability.

by Neil Van der Merwe, KV3 Engineers

Thereafter, select policy is discussed, most notably the German Act on Granting Priority to Renewable Energy Sources, the RSA White Paper on Renewable Energy Policy, the National Energy Regulator of South Africa, REFIT Phase 1, the Renewable Energy Summit of 2009 and REFIT Phase 2.

This is followed by a discussion as to why Germany has been so successful in introducing renewable energy technologies into its power-pool, and why the RSA has not been successful.

It is shown that a significant policy vacuum exists in the RSA – with respect to the introduction of renewable energy sources into our power-pool. The paper concludes, after due consideration of the facts and aspirations, with the following recommendations:

- The policy vacuum is filled as soon as is reasonably practicable i.e. the relevant RSA government departments devise an Act for granting priority to renewable energy sources in the RSA.
- The function of generating broader policy aspects must be removed from NERSA completely i.e. NERSA must only provide input on its legislated capacities (this would be licensing and tariff determination).
- The legal vacuum in NERSA's enabling legislation, section 14(4), that does not oblige NERSA to issue licenses for generating plant, must be removed or altered to direct that NERSA shall license all technically feasible renewable plant as being capable of connecting to the grid.
- Smaller renewable energy generators should not be taxed with onerous licensing conditions.
- The purchaser of renewable energy in the RSA must be expanded from the current restrictive SBO in Eskom, to all owners of electrical grid infrastructure in the RSA i.e. the renewable energy policy must take advantage of the dispersed/decentralised nature of renewable energy sources by diversifying the buyer.
- All entities containing 25% or more state ownership must be excluded from benefiting from the REFIT.
- The renewable energy policy must mandate that all technically capable electricity supply grids shall connect as a priority plants generating electrical energy from renewable sources.
- The policy must state that technically capable grids include grids that may need to be upgraded (at the cost of the grid operator) at reasonable economic expense in order to accept electrical energy generated from renewable sources.
- A nation-wide equalisation scheme must be included in the policy, so that the costs of connecting renewable energy sources to the grid can be distributed between grid operators, and ultimately be accounted for by the entire populace connected to the various grids.
- The disclosure of relevant information between the plant and grid operators must be comprehensively mandated.
- The introduction of renewable energy into the RSA must not be capped. Experience has shown that the process of introducing renewable energy sources onto grids in Europe is a steady but slow process that requires reinforcement, not restriction.
- The limitations on renewable source capacity i.e. the smaller role-players (residential and rural entities) must be removed particularly with reference to solar photovoltaic systems.

The need for renewable energy

The need to access renewable energy sources

Popular publications such as *"An Inconvenient Truth"* [1] have galvanised our attention to the strong scientific correlation between global warming and the use of fossil fuels as the primary energy source for mankind. The use of fossil fuels upsets the concentration of greenhouse gases contained within the earth's atmosphere.

The mechanism – simply stated – is as follows:

- Fossil fuels are historically stored solar radiation, a by-product of photosynthesis i.e. the remains of plant and animal life, and consist predominantly of hydrocarbon molecules.
- Mankind, having realised the latent energy potential in fossilised hydrocarbon matter, harvests the fossil fuels from within the earth's crust.
- Mankind converts the energy in fossil fuels into useful energy through the process of combustion, or other chemical processes.
- The combustion of fossil fuels releases heat (directly) and carbon dioxide into the earth's atmosphere.
- Carbon dioxide is a recognised greenhouse gas.
- The greenhouse heating mechanism briefly is the mechanism whereby a greenhouse gas permits the transmission of short-wave radiation from the sun into the earth's atmosphere, but traps the long-wave (infrared) radiation reflected from the earth's surface from escaping the atmosphere, thereby causing a net heating effect of the atmosphere.

It must be noted that industrial activity (and the consequent utilisation of fossil fuels to facilitate industrial activity) produces many greenhouse gases, of which carbon dioxide is but one. Some of the other greenhouse gases released through the utilisation of fossil fuels are methane, nitrous oxides etc.

The net heating of the earth's atmosphere shows a strong correlation with climate change.

The Stern review [2] postulates that climate change can have the following effects on our existence:

- Climate change threatens the basic elements of life by affecting access to water, food production, health and the use of land and the environment.
- The impacts of climate change are not evenly distributed and it is estimated that the poorest countries and people will suffer the change earliest, and to a larger degree when contrasted with developed countries.
- Climate change may have small initial positive effects for some developed countries, but the small initial positive effects will be subsumed by the ensuing negative effects due to continued temperature increases (there is a time-lag between the initiating factors, and the ultimate effects).

Holm in the White Paper "Renewable Energy Future for the Developing World" asks "why is

it essential to transform the developing world energy systems now"? [3]

Holm identifies three main areas for concern, both for the developing and developed countries in the world, namely i) poverty eradication and health concerns, ii) price volatility, instability, security, development and technical failure and iii) the protection of natural life supporting mechanisms. These headings are discussed below with reference to historic and current global events:

- *Poverty eradication and health concerns:* In the less developed and impoverished countries, and concentrated in rural areas, people are dependent upon biomass (basic firewood, harvest residues, charcoal and dung) for their energy needs.

  The biomass is typically consumed in an inefficient manner negatively affecting the health of the impoverished through the toxic emissions and air pollutants released during inefficient combustion (see the discussion on the White Paper below, where it is thought that the RSA consumes approx 115 000 GWh of biomass per annum), and often in confined and poorly ventilated settings.

  The harvesting of biomass materials from the environment is also a driving factor for desertification with the knock-on consequence of the further impoverishment of the affected communities, through the impoverishment of their living environment.

- *Price volatility, economic and socio-political instability, security, development and technical failure:* In an article in the *Business Times*, Ian Mann quotes Thomas L Friedman "Our addiction to oil has led to the rise of petro-dictatorships and the largest wealth transfer in history. Money from consuming countries is being sent to swell the coffers of dictatorships around the world, which are benefiting from not having grown their assets or educating their people" [4].

  From an article by Alf James in the *Mail and Guardian:* "The demand for automotive fuels in Southern Africa exceeds the local production capacity. South Africa is becoming increasingly dependent on importing refined automotive products" [5].

  From *Poisoned Wells:* "An alluring alternative global source of energy is Africa, which is more important to the West than most people know. In 2005, the United States imported more oil from this continent than it did from the Middle East" and when referring to an IMF Working Paper by Xavier Sala-i-Martin *Addressing the Natural Resource Curse: An Illustration from Nigeria:* – "In 1970, just before the oil boom, 19-million Nigerians lived below the poverty line. Now, nearly $400-billion in Nigerian oil earnings later, 90-million or more Nigerians live below that line, and their anger is mounting" [6].

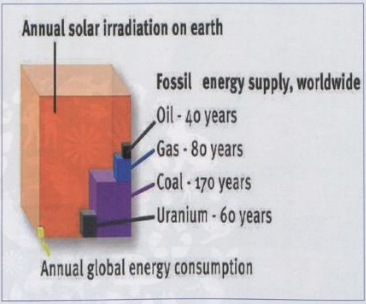


Fig. 1: Annual solar irradiation on earth versus fossil energy capacity [7].

The above sentiments are merely testimony to the risks developing nations have to their national security, when the developing nations possess an abundance of desirable natural resources.

The developed nations face the risk of unstable supply and the effect that this can have on their economies, and the risk they face in having to intervene in the politics of foreign sovereign states when attempting to secure more stable supplies. Additionally, the importing of fossil fuels entails the outflow of capital from developed nations, capital that could ideally have been put to better use i.e. sociopolitical projects, improvement of infrastructure and the consequential opportunity for stimulating job opportunities.

Perhaps a look into the future (by looking to the past, 1973) when fossil fuels may not be readily available – "Already, on 16 October, they politicised oil exports, cut oil production and raised the price 70%. On 23 December they again raised the price, this time by 128%. As a result, crude oil prices quadrupled in less than a year. The decision, as Kissinger put it 'was one of the pivotal events in the history of this century'. It transformed a general but gradual rise in prices into a price-revolution of a kind the world had never before experienced over so short a period. The worst hit were the poorest countries, most of which had acute debt-burdens and imported all their energy" [8].

- *Protection of natural life-supporting mechanisms:* The concerns of the Stern review are echoed here.

Advantages with respect to renewable energy resources

The following advantages or positive aspects may be applicable to renewable energy resources:

- Although the source for renewable energy resources (the sun predominantly) is finite, it is less finite than the earth's fossil fuels available for viable energy production;
- Renewable energy resources may alleviate our dependence on the environment and mineral reserves;
- Renewable energy resources may reduce the production of greenhouse gases, and their dispersion into the atmosphere, and may (in the long run) result in the stabilisation of the average global temperature (an independent audit on the energy payback time for a universally available 3 MW wind generator shows energy payback within 7 to 9 months i.e. for the remaining 19 years of the operation of the machine the energy obtained is carbonfree) [9].
- The use of renewable energy resources engenders a positive reaction between members of the human race, a feeling and/or belief that a worthwhile viable and sustainable cause (a shared cause) with positive consequences to our continued existence is being pursued.
- Renewable energy resources (particularly solar radiation and wind) are difficult to monopolise, although it can be foreseen that there may be a new colonisation of resources in the future (as occurred with fossil fuels).
- Unlike contemporary fossil fuel generation

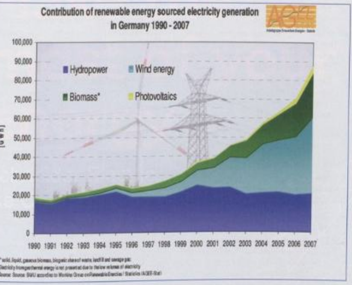


Fig. 2: Contribution of renewable energy sourced electricity generation in Germany, 1990 to 2007 [10].

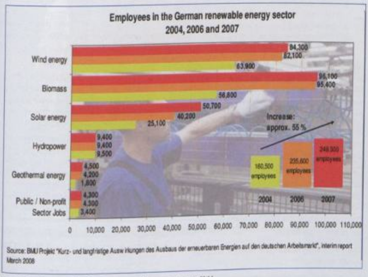


Fig. 3: Employees in the German renewable energy sector [11].

plant (and in most instances contemporary nuclear), renewable energy plant is more discrete in scale and modular (this holds true for solar photo-voltaic, wind and wave generation) and easily permits modular and incremental expansion of plant in financially viable stages.

- Initially, alternative energies won't usurp fossil fuel generation plant (due to the apparent relative disparity in cost between the two groups of technologies), thereby stimulating a complimentary parallel industry and the attendant employment opportunities and consequent economic stimulation and sociopolitical stability.
- Like fossil fuel technologies, renewable energy technologies may stimulate intense research and development drives, particularly due to the fact that renewable energy resources tend not to be as densely packaged as fossil fuels; therefore dictating keen efficiencies in converting the alternative energies into practical and efficient forms of energy applicable to the end-user requirement.
- Due to the dispersed nature of renewable energy resources, and provided that good policy permits the practice, renewable energy resources may be the pension of providers and converters of the resource, keeping rural areas populated and productive, thereby securing the provision of biomass and foodstuff from the rural areas (this has been the case in Germany).

Challenges to the introduction of alternate energy resources into society

It would appear that the introduction of renewable energy technologies into society is not a "naturally" occurring process. Some of the reasons for this may be the following:

- In many instances the technologies required to convert alternative energies into useful forms is in the initial stages of development with consequent low conversion efficiencies.
- The challenge facing intermittent renewable energy resources (solar, wind, tidal) is the storage of the energy generated, for times of demand.
- The penetration of renewable energy conversion devices into the market-place is low, has yet to attract the benefits of economy of scale and is therefore attracting prejudice based upon perceived cost.
- The historic subsidisation of fossil fuel technologies and economies is not readily ascertainable, tending to render the impression that alternative technologies require disproportionate subsidisation when compared to fossil fuel equivalents (this more so when the consequential costs of utilising fossil fuels is not brought into account).
- Some initial investments in biomass renewable energy technologies have had negative consequences on foodstuff security, thereby sensitising the populace to the consequences of poor policy decisions disguised as being an inherent weakness of the technology itself.
- In many instances the best renewable energy resources are located remotely from urban areas (high solar concentration occurring in deserts, good wind resources located within the laminar winds over large water masses etc.), thereby bringing about the situation that the resource and point of generation are remote from the intended recipient load, requiring the concomitant investment in extensive and expensive electrical transmission networks (servitudes and political approval for transmission networks are proving more and more difficult to obtain).
- Due to the low energy densities prevalent in many renewable energy resources, large installations of mechanical machinery are required to harvest the energy, resulting in expansive and visible infrastructure, and in some instances audible interference, and interference in the local environment.
- Policy will have to guard against monopolistic tendencies of large institutions in securing access to prime sources of renewable energy.
- Not to be underestimated – the importance to impress upon policy-makers that for some of the renewable energy technologies it is required that caution be exercised in over-legislating from a top-down perspective, but that there must be a popular ground-swell of acceptance from the recipient (or even ideally, the initiating) community.

Select renewable energy policy and legislation

This section begins with a discussion of the theoretical (i.e. academic) elements that would render sustainable alternative feed in policy effective i.e. feasible and sustainable.

Thereafter a discussion on possibly the best renewable energy policy in the world today – the German Act on the Granting of Priority to Renewable Energy Sources.

An excellent policy statement – the White Paper on Renewable Energy Policy in the RSA is dismantled in a fairly structured manner, in order to show the tragic consequences of the RSA not having progressed (from the White Paper) to the promulgation of a "Renewable Energy Act" – by comparing the aspirations of the White Paper with the often questionable efforts of NERSA (which does not have the legal capacity to formulate policy), specifically with reference to the Renewable Energy Feed-in Tariffs, Phases 1 and 2.

Proposed elements of successful and sustainable alternative feed in policy

The following are proposed as essential elements to successful and sustainable feed in policy:

- Clear and unambiguous policy that evaluates each renewable energy technology on its own merits specifically with reference to the strategic desirability for the technology.
- Policy that seeks not to over-regulate, but to guide and stimulate, within a framework of nationally applicable standards.
- Policy that is inclusive and permits availability of finance and incentives to private individuals, self-employed professionals, small micro and medium enterprises, municipal entities and nonprofit organisations, while considering the effect of the present lack of economies of scale, import duties and direct costs.
- Policy that permits certainty and consistency in the availability of finance and incentives for a fixed term, typically 20 years.
- The promotion of specific and appropriate renewable energy resources that will be viable and sustainable in the circumstances.
- Policy that explicitly includes the various national government role-players i.e. agriculture, energy, trade and industry, finance, land affairs i.e. policy that explicitly strives to avoid monopolistic practices by larger role-players, through the proper selection of incentive (feed in tariffs).
- Policy that makes advance provision for the identification of technologies and appropriate sites for their location, through the institution of adequate research and development initiatives.
- Policy that facilitates grid connection and avoids the need for excessive licensing of renewable energy resources and punitive grid connection costs.
- Policy that institutes attractive drivers facilitating the reduction in reliance mankind places on energy i.e. energy efficiency programs.
- Policy that robustly provides for periodic review of incentives with respect to individual renewable energy technologies.

German legislation – the Act on Granting Priority to Renewable Energy Sources

Article 1 "The Purpose" of the Act is clear when it states that the purpose is to facilitate the sustainable development of energy particularly with reference to:

- The protection of the climate and nature.
- To reduce the cost of the provision of electrical energy to the German economy *particularly by taking into account any long-term external effects of utilising fossil fuels as an energy source* (my emphasis).
- To facilitate the introduction of renewable energy into the national energy mix (proportionately) from the initial 12,5% in 2010, now increased to 20% by 2020.

Article 2 gives specific mention to the granting of priority to the purchase, transmission of, payment for any of the applicable sources of renewable energy – the energy to be purchased by the closest feasible connection point i.e. the nearest grid.

Most importantly, Article 2 specifically excludes any entities where any affiliate of the State owns over 25% of that entity [12].

Of crucial importance is the fact that the current Act removes the restrictions placed upon certain renewable energy sources, as was the case (the restrictions) in the previous Act (the previous Act [13] has the same title but is entirely different).

The excluded renewable energy sources were:

- Hydroelectric plants exceeding 5 MWe installed capacity.
- Installations fueled by gas from landfill or sewerage exceeding 5 MWe installed capacity.
- Biomass plants exceeding 20 MWe.
- Solar radiation energy installations exceeding 5 MWe electrical energy.
- Solar radiation energy installations exceeding 100 kW, where the energy produced is not electrical.

The newer Act is therefore more inclusive of renewable energy sources, possibly due to a combination of factors such as a maturing renewable energy market resulting in better funding and increased plant size (as a result of research and experiential knowledge, and the gradual diminishing of investor prejudice).

Article 3 contains many definitions vitally important to the reach and application of the legislation. Some of the more important definitions are:

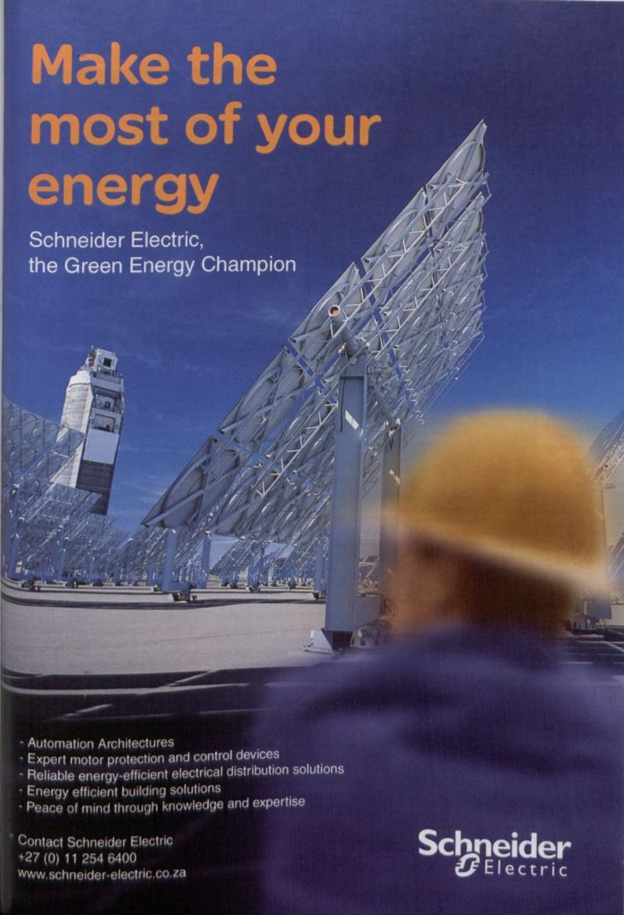
- Renewable energy sources are defined as hydropower, wave power, tidal power, salt gradient and flow energy, wind energy, solar energy, geothermal energy, energy from biomass (which includes landfill gas, sewerage treatment plant gas as well as the biodegradable fraction of municipal and industrial waste) [14].
- Plant is defined as "any independent technical facility generating electrical energy from renewable sources or mine gas" [15].
- The grid is defined as "all the interconnected facilities used for the transmission and distribution of electricity for general supply" [16].
- Grid system operators are defined as the operators of all types of voltage systems for general electrical supply [17].

Article 4 of the Act contains the obligation to purchase electrical energy produced from renewable sources.

It is important to note that the Act directs "grid system operators" to act in a certain way i.e. the Act is characterised by mandatory provisions, rather than discretionary provisions:

- Grid system operators shall and as a priority connect plants generating electrical energy from renewable energy sources and guarantee purchase and transmission of that energy [18].
- The obligation above applies to the most closely located technically suitable grid system, and the grid is deemed technically suitable even when the upgrade of the grid is required in order to accept the electrical energy generated from renewable sources – the cost of such must be at reasonable economic expense (an objective test).

  When it is a reasonable economic expense to upgrade the grid, it must be done without delay by the grid operator, if requested by the party wanting to feed electrical energy into the grid (from renewable sources). The request for grid upgrade, from the plant operator to the grid operator must incorporate any licensing conditions or requirements (if applicable) prior to the obligation to connect and purchase becoming effective [19].
- The obligation for the priority connection of renewable energy generators (to the grid) even applies in situations where all the energy supplied to the affected grid is substituted for electrical energy from renewable sources i.e. the electrical energy from renewable sources substitutes for the energy produced from fossil fuel sources. This condition applies generally, unless the renewable energy plant so connected lacks the technical capacity for reducing the infeed of electrical energy in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instances of grid overload. This condition also does not apply where the grid is already saturated with electrical energy from renewable sources (and this is objectively verifiable) [20].

- There is a mandatory provision for the exchange of information in order for either party (grid operator and the renewable energy plant operator) to verify and establish grid compatibility – the information to be provided by either party within 8 weeks of request [21].
- The costs for the purchase of the electrical energy are to be transmitted throughout the system i.e. from source until eventual point of sale (i.e. a "pass-through" or "equalisation" provision) [22]. This provision prevents the closest technically suitable grid from rejecting electrical energy produced by renewable energy sources – on the grounds that the grid operator has no point of sale for such energy [23].

Article 5 places an obligation on grid system operators to pay fees for all electrical energy injected into their grids from plants utilising renewable energy sources. Where renewable energy plants exceed 500 kWe, the obligation to pay fees is only enforceable where the output from such plant is measured and recorded [24].

Articles 6 to 11 deal directly with the specific tariff applicable to specific sources of electrical energy from renewable energy sources (size of plant and date of commissioning are included in the means of calculation of compensation).

A basic overview of the relevant feed-in tariffs 25 is as follows (many qualifications apply and the reader is therefore directed to the specific provisions in the Act for further reading):

- Hydropower [26]
  - P ≤ 500 kWe – R1,068 / kWh
  - 500 kW < P ≤ 5 MWe – R0,734 / kWh
- *Landfill, sewerage and mine gas* [27]
  - P ≤ 500 kWe – R0,847 / kWh
  - 500 kW < P ≤ 5 MWe – R0,734 / kWh
- Biomass [28]
  - P ≤ 150 kWe – R1,270 / kWh
  - 150 kW < P ≤ 500 kWe – R1,093 / kWh
  - 500 kW < P ≤ 5 MWe – R0,983 / kWh
  - P > 5 MWe – R0,928 / kWh
- Geothermal [29]
  - P ≤ 5 MWe – R1,657 / kWh
  - 5 MW < P ≤ 10 MWe – R1,546 / kWh
  - 10 MW < P ≤ 20 MWe – R0,988 / kWh
  - P > 20 MWe – R0,791 / kWh
- Wind [30]
  at least R0,607 / kWh[1]

  For off-shore plant, at least R0,684 / kWh[1]

  It is important to note that plant operators are rewarded where their plant exceeds 150% of the independently calculated reference yield of the installation.

  Reference yield is defined as "the quantity of electricity which each specific type of wind powered plant, including its hub height, would, if calculated on the basis of measured P-V curves, yield during five years of operation if it were built at the reference site", as measured against a reference plant at a reference site.
- Solar [31]

  In general – R5,047 / kWh where integrated into buildings / roofs / noise protection walls.
  - P ≤ 30 kWe – R6,339 / kWh
  - 30 kW < P ≤ 100 kWe – R6,030 / kWh
  - P > 100 kWe – R5,963 / kWh

The previous Act provided for the following feed-in tariffs:

- Hydropower and biogas – R0,847 / kWh
- Biomass – R1,126 / kWh
- Geothermal – R0,991 / kWh
- Wind – R1,008 / kWh
- Solar – R5,589 / kWh

The abovementioned fees are not contingent upon a valid contract having been entered into between the parties [32]. The fees are generally payable for a period of 20 years from the date of commissioning (including the year of commissioning), but the term is extended to 30 years for hydropower (≤ 500 kWe) and reduced to 15 years for hydropower exceeding 500 kWe (not exceeding 5 MWe) [33]. The minimum fees as listed exclude value added tax [34].

The cost of connecting the renewable energy plant to the closest technically feasible accepting grid is for the plant operator [35]. The cost of upgrading the grid itself (i.e. to render sufficient capacity to transmit the electrical energy) is for the grid operator, and these costs may be included in the calculation for determining the costs of using the grid [36].

The Act makes provision for a nation-wide equalisation scheme in terms of costs attributed to and incurred by the grid operators associated with the connection and distribution of renewable electrical energy. The Act directs that the grid operators shall record the volumes of electricity (and associated time periods) paid for electrical energy from renewable sources (including fees) and that these costs be equalised amongst the respective grid operators [37].

White Paper on Renewable Energy Policy in the RSA [38].

The White Paper proceeds by stating that it is the responsibility of government (a Constitutional [39] imperative) to establish a national energy policy that:

- Ensures the efficient utilisation of energy resources within the country.
- The delivery of energy to the nation, based upon need.
- The production and distribution of energy should (a discretionary term) be sustainable.
- Leading to an improvement in the living standard of citizens.

The policy position is stated as follows:

"Ensuring that an equitable level of national resources is invested in renewable technologies, given their potential and compared to investments in other energy supply options."

The fundamental drivers of the policy are:

- The skewed reliance on fossil fuels as primary energy source in the RSA (90% of the energy generated in the country is reliant on a form of fossil fuel).
- The significant release of greenhouse gases into the atmosphere by the RSA energy industry (SASOL is the single largest point-source of CO_2 in the world [40], and Eskom if listed as a country would feature in the top 25 CO_2 emitting countries in the world [41].
- The correlation between greenhouse gas emissions and global climate change.
- The RSA is specifically well-endowed with natural sources of renewable energy (particularly solar energy).

The concept of energy security is discussed with reference to:

- The concepts of public health, safety and environmental considerations, particularly when considering that South Africans in 2000 already consumed an estimated 115 278 GWh of renewable energy within their homes (in the form of polluting biomass i.e. combustion of animal and plant matter for purposes of heating and lighting, with the concomitant release of noxious vapors within the immediate area of application).
- Entrepreneurship and the concept of innovation within the industrial and financial sectors of the economy (in the form of venture finance, direct investment, innovation in industry to meet the physical demand for apparatus that can capture and utilise energy from renewable sources etc).

[1] The proposed plant must reach 60% of its reference yield before payment can be enforced.

Fig. 4: Geothermal plant in Bavaria (40 MW heat, 3,4 MWe)

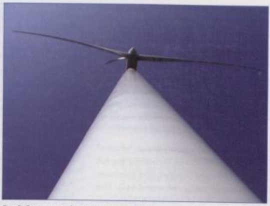


Fig. 5: Perspective of a wind-turbine with 60 m diameter blades.

- The development of appropriate policies geared towards the introduction of renewable energy sources within the country, by government.
- That the target for formal renewable energy be 10 000 GWh by 2013 (contra the informal renewable energy as discussed above).
- All within a policy framework that is characterised by flexibility and capable of being phased i.e. scaleable.
- That low-cost technologies be introduced first (mention is made of biomass co-generation, solar water heating, wind power and small capacity hydroelectric plant).

The stated essential elements for the implementation of renewable energy interventions are:

- Development of renewable energy sources and the consequential transfer of reliance from fossil fuel energy to renewable energy must form part of a holistically sustainable process.
- A clear intervention from government in the creation of an enabling environment for the introduction and sustainable proliferation of renewable energy sources via "fiscal and financial support mechanisms within an appropriate legal and regulatory framework" and the development of mechanisms to overcome the "barrier of non-discriminatory third party access to the grid".
- The application of NERSA in encouraging the phased introduction of renewable energy into the RSA energy market (with the corresponding "corporatisation" of Eskom and the formation of regional energy electricity distributors i.e. the antimonopolistic restructuring of the RSA energy sector).
- The promotion of existing renewable technology within the RSA, particularly with reference to affordability and employment possibilities.

Strategic goals and objectives are discussed, broadly falling within the categories of

Fig. 6: Solar photovoltaic installation on old landfill site.

financial and legal instruments, technology development, awareness, capacity building and education.

The two legal instruments of note are:

- To develop an appropriate legal and regulatory framework for pricing and tariff structures to support the integration of renewable energy into the energy economy and to attract investment.
- To develop an enabling legislative and regulatory framework to integrate independent power producers into the existing electricity system.

The Department of Minerals and Energy is tasked with the responsibility for the overall formulation of renewable energy policy within the RSA, whilst the "future energy regulator" is tasked with regulating market access through licensing and by deciding and approving appropriate renewable energy electricity tariffs.

National Energy Regulator of South Africa

In terms of the Electricity Regulation Act [42] the regulator must consider applications for licenses, regulate tariffs and prices, register applicable persons, issue rules designed to implement the national governments electricity policy framework and the integrated resource plan and enforce performance and compliance and take appropriate steps in instances of non-performance.

An important point to note is that the regulator is not empowered to formulate policy (with respect to the electricity industry), but may (must) merely "issue rules designed to implement the national government's electricity policy framework, the integrated resource plan and this Act".

It is clear that the function for formulating electricity policy for the RSA is clearly vested in the government.

The Act clearly defines activities [43] for which a license is mandatory, namely: the operation of any generation, distribution or transmission facility, the importation or exportation of electricity and any trading in electricity. Instances where a license is not required: generation plant constructed and operated for demonstration purposes (off-grid), generation plant constructed and used for own purposes and any non-grid supply of electricity (unless for commercial purposes) [44].

The Act injects a certain amount of uncertainty into the application for, and granting of licenses. The generator is not "obliged" to issue a license [45]. The typical meaning of "oblige" being to "bind (a person) by oath, promise, or contract; put under an obligation, commit. Of an oath etc.: make legally or morally bound; be binding on" [46].

The Act makes it mandatory that an "efficient" licensee be capable of recovering the full cost of its licensed activities, and to recover a "reasonable margin of return" [47]. This would imply that a licensee is permitted, in law, to profit from its activities (activities permitted in terms of the Act).

Of some concern is the discretionary power afforded the regulator in the revocation of licenses, particularly on the following grounds [48]:

- The licensed facility or activity is not economically viable.
- Another person is willing and demonstrably able to assume the rights and obligations of that licensee in accordance with the requirements and objectives of this Act, and a new license is issued to such a person.

Renewable Energy Feed-In Tariff

The Renewable Energy Feed-In Tariff (REFIT), as it now stands, has been the product of publication of proposals, the return of comment, and the subsequent modification of the proposals.

It would appear that there have been at least four iterations of the REFIT:

- 15 May 2008
- 14 August 2008
- 2 December 2008
- 26 March 2009

The 26 March 2009 iteration was published in the Government Gazette [49].

The process of arriving at the gazetted iteration is commendable, and significant differences are clear between the iterations; most notably the tariff determinations.

Technologies theoretically capable of applying for the REFIT are:

- Land-fill gas plant.
- Small hydro-plant less than 10 MW in installed capacity.
- Wind power-plant.
- Concentrated solar plant.

Table 1 indicates the calculated and published tariffs per technology for the 2008 year (merely for purposes of comparison).

Technology	May 2008	Aug 2008	Dec 2008	March 2009
Wind	38,56 (12)	65,48 (15)	65,48 (15)	125 (20)
Small hydro	31,35 (12)	73,76 (15)	73,76 (15)	94 (20)
Biomass	26,55 (12)	43,21 (15)	43,21 (15)	90 (20)
Concentrated solar	32,93 (12)	32,93 (15)	60,64 (15)	210 (20)

Table. 1: Comparison of published tariffs for year 2008. All prices are in South African cents. The bracketed figure is the period for which the tariff is guaranteed, in years.

Table 1 merely illustrates the complexities involved in arriving at a suitable REFIT – the 2008 tariffs were all calculated using a "bespoke spreadsheet-based tariff model that analyses and quantifies the key policy framework decisions" [50].

The distinction between the 2008 and 2009 tariffs being "the FIT were adjusted using the latest publicly available international cost and performance data for renewable energy sources and the screening curves (levelised cost) model of the National Integrated Resource Plan 3 (NIRP3)" [51].

Degression rates apply to the 2008 tariffs, but not the 2009 iteration.

The feed-in tariff is planned for annual review for the first 5-year period of implementation, and every 3-year period thereafter. The tariffs resulting from the review process will only apply to new projects.

The renewable energy power purchase agency (REPA) is located within Eskom's single buyer's office (SBO). All monitoring and verification in terms of the renewable feed-in tariff to be performed by REPA.

The standard power purchase agreement (PPA) from the medium term power purchase program (MTPPP), through facilitation from Nersa, is intended as the basis for the REFIT program.

Renewable Energy Summit 2009

The Renewable Energy Summit of 2009 [52] was primarily intended as an update mechanism to the undertakings entered into in the 2003 White Paper.

Agreement was reached at the summit that significant constraints still existed within the RSA energy market (with respect to the planned introduction of renewable energy sources), particularly due to inadequate legal and regulatory frameworks, and:

- Inadequate research and development.
- Inadequate funding.
- Low electrical tariffs rendering the introduction of independent sources of electrical energy non-profitable.
- Lack of technical capacity within the country.

The summit essentially resolved to commit to similar principles as contained in the 2003 White Paper.

Renewable Energy Feed-In Tariff Phase 2

The Renewable Energy Feed-In Tariff Phase 2 [53] represents a continuation on the REFIT, and consists of two distinct parts:

- Principles and technologies qualifying the REFIT (additional technologies are considered)
- An appendix (Appendix A) containing a draft power purchase agreement (PPA).

In this iteration it is stated that the renewable energy purchasing agency (REPA, as located in the Eskom SBO) will be under an obligation [54] to purchase – electrical energy, gaseous and liquid fuels, heat, or a combination of the aforementioned – generated from applicable renewable sources, where the renewable energy plant and operators have been licensed by NERSA to do so (in terms of both phases of the REFIT).

Conditions for qualification as a renewable energy generator are:

- The energy must be produced from naturally occurring renewable sources.
- Qualifying sources are solar, wind, biomass, hydropower, tidal, wave, ocean current and geothermal.

Phase 2 of the REFIT introduces specific qualifying technologies [55]:

- Concentrated solar power plant, without energy storage capacity.
- Solid biomass.
- Biogas.
- Large ground or roof-mounted solar photovoltaic systems.
- Concentrating solar photovoltaic systems.
- Concentrated solar power with central tower.

The following technologies and/or processes are deemed not to be eligible for the REFIT, being classified as cogeneration:

- Pulp and paper.
- Sugar bagasse.
- Mill waste from industrial processes.

Further exclusions (oddly so, as the technologies are initially included) are:

- Wave
- Tidal
- Geothermal technologies

The reasoning provided for the exclusion is the lack of commercial availability of the listed technologies.

The REFIT Phase 2 then continues to describe and define the qualifying technologies:

- *Biomass [56]:* Biomass includes various sources of organic matter that can be converted into a fuel-stock that can be used in the generation of electrical energy i.e. wood, plant matter remaining from the activities of agriculture, mariculture, forestry, municipal and industrial waste.
- *Biogas [57]:* The tariff is only available for gas obtained through the process of anaerobic digestion of waste to produce methane. Land-fill gas plant is excluded.
- *Solar photovoltaic [58]:* The tariff is only available for large-scale solar photovoltaic systems in excess of 1 MWe. Smaller plant is excluded, the reason being "economies of scale".
- *Concentrated solar plant without storage [59]:* The REFIT (phase 1) was only available for concentrated solar plant with 6 hours of energy storage. The phase 2 tariff has relaxed this condition to exclude the need for energy storage.
- *Concentrating solar photovoltaic [60]:* The tariff is only available for plant in excess of 10 MWe.
- *Concentrated solar power including central tower [61]:* The tariff is available for plant with at least 6 hours of energy storage.

Table 2 indicates the proposed tariffs (in South African cents) for the qualifying technologies:

Qualifying technology	Phase 2 tariff proposal
Biomass (solid)	118,1
Biogas	96,2
Solar photovoltaic≥ 1 MWe	448,8
Concentrated solar plant without storage	548,1
Concentrating solar photovoltaic ≥ 10 MWe	313,2
Concentrated solar power including central tower ≥ 6 hours storage	230,8

Table. 2: Proposed tariffs in South African cents in Phase 2 of the Renewable Energy Feed-In Tariff.

A brief overview of the proposed draft power purchase agreement (Appendix A reveals the following:

- The draft agreement consistently refers to the "independent power producer" when it may be advisable to refer to the "renewable energy generator" (which happens to be an independent power producer) [62].
- The independent power producer is "awarded the right" to participate in the REFIT. It is suggested that this statement diminishes the rights of the renewable energy generator – this statement should state that the renewable energy generator has the right to the REFIT should it meet criteria i.e. there is no award [63].
- The independent power producer either holds or will hold the license to produce electrical energy (in order to be connected to the grid), this license to be provided by NERSA. As discussed above, section 14(4) of the Electricity Regulation Act (creating NERSA) does not oblige NERSA to grant licenses to renewable energy generators [64].
- Recitals D and E make mention of arrangements not attaching to the independent power producer i.e. "wheeling charges" and provisions with respect to calculating the cost to consumers via the "pass-through" arrangements. It is suggested that the (renewable energy generator) power purchase agreement should only refer to matters directly related to the parties to the agreement [65].
- It is not clear why mention is made that the sale of electrical energy (by the independent power producer) on a selfdispatch basis "will assist the buyer in carrying out its business". The buyer's business (and the carrying on of such) should not be the concern of the renewable energy generator [66].
- "Buyer failure" – it is of concern that the buyer will escape any liability for not purchasing electrical energy from the renewable energy generator through a change in law. This provision injects uncertainty into the contract [67].
- "Capacity" is defined as the capacity (in kW) of a generation facility to generate and provide energy. It is suggested that capacity should be defined as installed capacity (referred to as the "gross capacity" later in the definitions) with reference to a utilisation factor for the plant [68].
- "Commercial energy" contains a statement "provided that the net energy output volume shall not exceed the contracted supply". This statement is anomalous in the renewable energy context, particularly when considering that successful REFITs and programs reward the renewable energy generator when it exceeds its reference yield (a term oft applied to wind generation systems) [69].
- The "competent authority" is defined very broadly, including all spheres of government, but then excludes the buyer. This is in essence disingenuous considering the government is the sole share-holder in the buyer [70].
- The definition of "law" is too inclusive, and has the potential of elevating mere operational policy or "directive, requirement, instruction, request, order, regulation, condition of or limitation in any necessary approval, permission, permit, approval, consent, license, authorisation, registration, grant, acknowledgement, exemption or agreement to be obtained from any competent authority" to effectively be a "law". A competent authority is defined as "government, any sphere thereof, any ministry, any executive, legislative, administrative or quasi-governmental regulator, department, body, instrumentality, agency or authority of South Africa having jurisdiction over this Agreement" [71].

The remainder of the agreement is not evaluated here (it is suggested that the evaluation of the power purchase agreement could or should form part of a separate publication or investigation).

Discussion

Introduction

The issue of cost is always raised when entertaining a discussion on the introduction of renewable energy technologies into society. The cost of the utilisation of fossil fuels, and energy inefficient practices, oddly, is seldom entertained.

The German Act, "The Act on Granting Priority to Renewable Energy Resources" of 2000 clearly states within the preamble that "The Act should put an end to any fears of excessive financial burdens. The contribution resulting from the new cost-sharing mechanism amounts to a mere 0,552 cent per kWh [2]. Even if, as we hope, there is powerful growth in renewable energy sources, this would still only rise to 1,104 cent per kWh in a few years time [2]. That, indeed, is a small price to pay for the development of this key sector" [72].

Often the argument then proceeds along the lines "Yes, but the German economy is significantly larger when compared to ours in the RSA, and that is why the cost is lower. Using the equalisation mechanisms, the cost per kWh is low".

Fortunately this argument is spurious. The Federal Republic of Germany (the largest economy in Europe) consumed 549,1-billion kWh in 2007 [73] ranking it 8th in the world. The RSA economy consumed 224-billion kWh in 2007 [74] ranking it 13th in the world.

Using simple linear extrapolation – if the RSA were to institute a renewable energy program of the magnitude of the Federal Republic of Germany, it would cost approximately 2,7 cents per kWh.

[2] The prices have been adjusted to reflect current exchange rates between the Euro and the ZAR.

This cost would therefore appear to be insignificant when considering the following Eskom statistical data in Table 3.

Year	Energy sold GWh	Cost of fuel	Total cost to Produce 1 kWh	Specific cost of fuel per kWh
2006/07	218 120	R13,040-billion		R0,0598 / kWh
2007/08	224 366	R18,314-billion	R0,199 / kWh	R0,0816 / kWh
2008/09	214 850	R25,351-billion	R0,296 / kWh	R0,1180 / kWh

Table. 3: Eskom statistical data.

Further statistics relating to the provision of electrical energy in the RSA, specifically Eskom:

- Fuel price escalation from 2006/07 to 2007/08: 37% (specific fuel cost).
- Fuel price escalation from 2007/08 to 2008/09: 45% (specific fuel cost).
- Total cost to produce 1 kWh in 2008/09 versus 2007/08 – 49% escalation.
- Escalation in sales 2006/07 to 2007/08: 2,9%.
- Escalation in sales 2007/08 to 2008/09: minus 4,2%.
- CO_2 emissions 2007/08 = 954 g/kWh.
- CO_2 emissions 2008/09 = 1030 g / kWh (8% increase).

Using the new Mdupi conventionally fired (coal) power station as an example:

- Planned cost estimate : R80-billion.
- Estimated final cost (2009): R137-billion.
- Cost of capital (excluding interest and running costs) to produce 1 kWh from Mdupi: R0,3582/kWh (current published estimates put this figure closer to R0,48/kWh).

This power station will pump 34,54-million tons of CO_2 into the earth's atmosphere on an annual basis (based upon a plant utilisation factor of 85%).

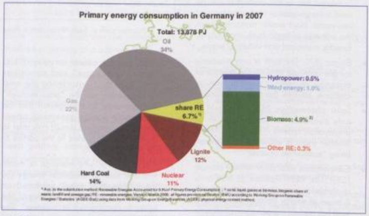


Fig. 7: Primary energy consumption in Germany in 2007, indicating the renewable energy share and distribution of renewable energy technologies within that share.

Why is Germany successful at introducing renewable energy technologies into its powerpool?

The estimated renewable electrical power capacity per listed country in 2008 is seen in Table 4.

If the effect of the small hydropower and the collective EU-27 grouping is discounted in Table 4, then Germany ranks 2nd behind the United States of America in the introduction of renewable energy capacity into its power-pool.

Germany is not far behind the USA, even though the USA had introduced feed-in tariffs 12 years (1978) prior to Germany (1990). It is possibly a fair assumption to make: the German REFIT works, and probably for the following reasons:

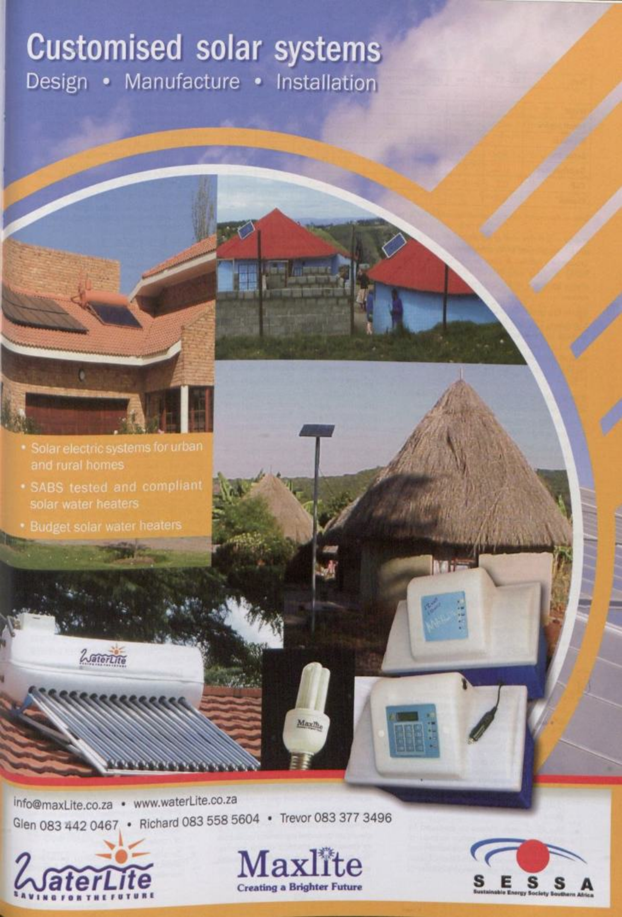
- The Act is clear in its policy direction, and is remarkably uncomplicated and leaves the technical and legal aspects relating to the actual renewable energy plant and its connection to the grid to the appropriate competent entities to manage as they see fit (within their relevant frameworks).
- The purpose of the Act is clear – it mandates a priority to renewable energy sources.
- The Act sets clear targets: 12,5% and 20% renewable energy production by 2010 and 2020, respectively.
- The Act attempts to avoid the possibility of the monopolisation of renewable energy sources, by explicitly rendering any entity with 25% or more state ownership ineligible for the REFIT.
- By removing the State from eligibility in terms of the Act, the Act avoids a conflict of interest between state-owned conventional generation and renewable energy sources i.e. it is not in the State's interest to manipulate the market so that it can attract the REFIT revenue to itself, by building its own renewable energy plant. The Act therefore propels the renewable energy initiative into the hands of efficient private and corporate capital.
- The Act provides certainty with respect to the various tariffs available for each of the applicable technologies, and the tariffs are minimum values i.e. should the situation demand a higher feed-in tariff for a particular installation then this is possible in terms of the Act. This is designed to prevent investors from only building plant in the most suitable positions only i.e. creating swathes of renewable plant in few favourable locations. The aim of the Act is to allow for as dispersed a renewable resource as is reasonably possible.
- The REFIT is guaranteed for a feasible investment period i.e. 20 years for most plant, 30 years for small hydropower, 15 years for larger hydropower.
- The Act does not permit the grid operator a discretion – if the renewable energy plant operator requests a connection to the grid, and it is technically feasible to do so – then the grid operator MUST connect the plant.
- The Act rewards producers of renewable energy for exceeding their plants designed delivery expectation i.e. the Act encourages efficiency.
- The Act makes the transfer of information between the proposed renewable plant operator and the grid operator mandatory i.e. a mandatory disclosure of information. This is in order for both parties to be able to adequately plan for their respective responsibilities (the grid operator may have to improve its grid, and the plant operator needs information in order to build a proper financial feasibility study).
- The Act spreads the cost of the renewable energy program across all users and grids through a nationwide equalisation scheme.

Why is the RSA not successful at introducing renewable energy technologies into its powerpool?

To date, the RSA has no renewable energy resources to speak of.

In the Western Cape, the Darling wind-farm (installed capacity of 5,2 MWe) provides electrical energy to the City of Cape Town via an independent power purchase agreement, this agreement not affected by or in terms of any feed-in tariffs i.e. it is based on the willing-seller, willing-buyer principle.

The project is insignificant with respect to the provision of electrical energy. The site has a utilisation factor of approximately 25%, the amount of energy produced approximately 11,4 GWh perannum. In 1999, Eskom's Megawatt Park offices consumed 35 GWh [76] of electrical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Tech	EU-27	China	USA	Germany	Spain	India	Japan	RSA
	GWe							
Wind	65	12	25	24	17	9,6	1,9	0
Small hydro	12	60	3	1,7	2	2	3,5	0
Biomass	15	4	8	3	0,4	1,5	0,1	0
Solar PV	9,5	0,1	0,7	5,4	3,3	0	2	0
Geothermal	0,8	0	3	0	0	0	0,5	0
CSP	0,1	0	0,4	0	0,1	0	0	0
Ocean	0,3	0	0	0	0	0	0	0

Table 4: Renewable electrical power capacity in 2008, per country [75].

energy – and this after a significant efficiency drive. The project is most significant for its proceeding without a clear legal framework being in place with respect to renewable energy sources – and is commendable for this reason.

Eskom has performed wind power research at Klipheuwel [77] and had planned significant projects in the Western (wind) and Northern Cape (concentrated solar) – these projects have all been avoided due to Eskom's problems relating to liquidity and the raising of capital [78].

It is possibly a fair assumption to make: the introduction of renewable energy technologies into the RSA power-pool is severely curtailed because of the following reasons:

- There is a legislative vacuum in the RSA – to date the only policy document on renewable energy sources is the (excellent) White Paper of 2004. The White Paper considers generic policy and not policy unique to incorporating renewable energy sources into a highly monopolised powerpool where the state is the sole shareholder.
- There is a conflict of interest between the various role-players – the state has created a regulator (NERSA) who is supposed to regulate the electricity industry. Yet, the state is the sole share-holder in Eskom, the monopoly power producer for the RSA. This state of affairs does not engender investment confidence at all as NERSA's impartiality is questionable.
- The policy directive (White Paper) merely aims for 10 000 GWh of renewable energy by 2013, which is not achievable. The policy requires revision, and needs to be appropriately distilled into an Act of government.
- In the absence of an Act of government, NERSA is forced to produce renewable energy policy. NERSA is not competent, in law, to produce policy.
- Although NERSA has produced two REFIT documents, ostensibly placing a duty on the grid (i.e. Eskom) to accept energy produced from renewable energy sources if the source is licensed by NERSA, the anomalous situation exists that NERSA is under no obligation to provide the license in the first place.
- The REFIT (both phases as produced by NERSA) are arguably policy in favor of Eskom. The REFIT forces private industry and capital into competition with Eskom. Eskom is the monopoly state-owned producer of electrical energy in the RSA, and owner of the transmission and distribution grids. As it is in Germany, all entities with 25% or more state ownership must be excluded from the REFIT – in order to produce an environment that favours private industry and private capital investment.
- The REFIT permits only one buyer of electrical energy from renewable energy sources – Eskom. The REFIT should be expanded to permit the closest technically feasible grid operator as the purchaser of electrical energy from renewable sources.
- The REFIT is too restricted in terms of applicable technologies and their capacities. Solar photovoltaic plants currently need to be larger than 1 MWe (which rules out residential/private individuals).
- The REFIT curiously concerns itself with economic viability of installations. This is folly. If an entity can construct and run a plant that complies to the technical standards of the grid operator, having established that it can do so economically, feasibly and sustainably – then NERSA should allow the principles of a free and open market to prevail, rather than attempt to manage financial viability from a topdown perspective.
- The tariffs as contained in the REFIT are fixed values i.e. they are not minimum value tariffs. This is inflexible and not encouraging of development in the renewable energy sector, as the tariffs do not cater for cost impacts due to geographical location, site resource capacity etc. The present REFIT will merely encourage highly concentrated development of renewable energy plant in the most favorable locations, which is entirely undesirable.
- The REFIT penalises plant operators for exceeding their (estimated) stated net energy output. The REFIT should be encouraging such efficiencies.
- The REFIT makes no provision for the transfer of information between the purchaser (the grid operator) and the supplier (the plant operator). This is most undesirable and will not facilitate either party in establishing economic feasibility and grid suitability.
- The draft independent power purchase agreement as attached to REFIT Phase 2 is clearly an amended agreement applicable to conventional electrical energy sources. The terminology fails to reflect renewable energy concepts.
- Uncertainty has been injected into the entire REFIT process – it has been stated that the REFIT will be dispensed by means of a tender process. Entities who wish to construct renewable energy sources would therefore have to tender for an allocation of capacity. This is entirely contradictory to the ethos of a REFIT [79]. In fact, the very essence of tendering for the opportunity of providing renewable energy plant was discussed by NERSA themselves, and the following was stated: "Under a tendering system, potential renewable energy developers bid either for power purchase agreements, or for access to a renewable energy fund, on a competitive basis.

Tendering systems tend to favour established businesses and can allow existing companies to keep potential competitors out of the market by bidding low on projects, regardless of whether or not the company has any intention or ability to actually build the renewable energy project" [80] - my emphasis.

Conclusion

The renewable energy industry forms part of a greater social contract, a contract between all members of society. The contract entails the move from unsustainable energy sources, to renewable energy sources – at a rate commensurate with the (reasonable) cost and sustainability of this energy source migration.

The renewable energy industry should not become or be monopolised by governments, parastatals or even large private entities – for the purposes of becoming a cash-cow. Renewable energy policy, ideally, should ultimately empower individuals to become self-sufficient in providing for their own energy needs – after all, we all own a little piece of sunshine. This may not be achievable in the short-term, but it must remain on the long-term policy planning agenda.

The Federal Republic of Germany has experienced extraordinary success in promoting their renewable energy industry. It is not proposed that we copy their approach verbatim, but it certainly would be within our interests (the RSA) to learn from their experiences.

In conclusion, the following is therefore recommended for our renewable energy industry (and this includes the policy driving this industry):

- The policy vacuum is filled as soon as is reasonably practicable i.e. the relevant RSA government departments devise an Act for granting priority to renewable energy sources in the RSA.
- The function of generating broader policy aspects must be removed from NERSA completely i.e. NERSA must only provide input on its legislated capacities (this would be licensing and tariff determination).
- The legal vacuum in NERSA's enabling legislation, section 14(4), that does not oblige NERSA to issue licenses for generating plant, must be removed or altered to direct that NERSA shall license all technically feasible renewable plant as being capable of connecting to the grid.
- Smaller renewable energy generators should not be taxed with onerous licensing conditions.

- The purchaser of renewable energy in the RSA must be expanded from the current restrictive SBO in Eskom, to all owners of electrical grid infrastructure in the RSA i.e. the renewable energy policy must take advantage of the dispersed / decentralised nature of renewable energy sources by diversifying the buyer.
- All entities containing 25% or more state ownership must be excluded from benefiting from the REFIT.
- The renewable energy policy must mandate that all technically capable electricity supply grids shall connect as a priority plants generating electrical energy from renewable sources.
- The policy must state that technically capable grids include grids that may need to be upgraded (at the cost of the grid operator) at reasonable economic expense in order to accept electrical energy generated from renewable sources.
- A nation-wide equalisation scheme must be included in the policy, so that the costs of connecting renewable energy sources to the grid can be distributed between grid operators, and ultimately be accounted for by the entire populace connected to the various grids.
- The disclosure of relevant information between the plant and grid operators must be comprehensively mandated.
- The introduction of renewable energy into the RSA must not be capped. Experience has shown that the process of introducing renewable energy sources onto grids in Europe is a steady but slow process that requires reinforcement, not restriction.
- The limitations on renewable source capacity i.e. the smaller role-players (residential and rural entities) must be removed, particularly with reference to solar photovoltaic systems.

There is a dream doing the rounds... that the installed renewable energy sources obtain a critical mass, and begin to power the creation of further renewable energy sources i.e. renewable energy creating its own opportunities.

Is it not time to awake from the nightmare, to the reality of that dream?

Acknowledgement

The author wishes to acknowledge and thank the following persons/entities for their valuable contributions (in no particular sequence):

- KV3 Engineers – Durr Pieters
- Dr. Dieter Holm
- Johan Nel, Oudsthoorn Municipality
- Joe Renny, Western Cape Provincial Government
- Inwent
- The Democracy Foundation REACT – Dr. Ruth Rabinowitz
- The AMEU (National and KZN and Western Cape Branches)
- NERSA
- Eskom

It must be noted that all errors, omissions, opinions or bias expressed in this paper are solely attributable to the author, and none of the parties mentioned above. The author writes in his own capacity.

References

[1] Gore, A., "An Inconvenient Truth", Participant Productions, 2006

[2] Stern Review - IG Patel Professor of Economics and Government and Chair of the Grantham Institute for Climate Change and the Environment at the London School of Economics (LSE), for the British Government, 30 October 2006.

[3] Holm, D. "Renewable Energy Future for the Developing World", White Paper, ISES International Solar Energy Society, 2005.

[4] Mann, Ian. "Fresh Eye on Earth", The Business Times, Sunday Times, 9 November 2008. This article, although notacceptable as an academic reference, quotes from Thomas L. Friedman, "Hot, Flat and Crowded", a three-time Pulitzer prize winner.

[5] James, Alf. "Securing SA's Fuel Supply", Mail and Guardian,31 October 2008.

[6] Shaxson, N. "Poisoned Wells, The Dirty Politics of African Oil", Palgrave Macmillan, 2007.

[7] Ecostream Presentation, Bavaria, September 2008.

[8] Johnson, P. "A History of the Modern World From 1917 to the 1980's", p. 669, Weidenfeld and Nicolson, London, 1983.

[9] "Life-cycle assessment of off-shore and on-shore sited wind power-plants based on VESTAS V90 3.0 MW turbines", VESTAS Wind Systems, 2005 (as audited by FORCE Technology).

[10] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany.

[11] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany

[12] Article 2(2).

[13] Bundestag, "The Act on Granting Priority to Renewable Energy Sources", 17th March 2000.

[14] Bundestag, "The Act on Granting Priority to Renewable Energy Sources", The Act Revising the Legislation on Renewable Energy Sources in the Electricity Sector, 21st July 2004, Article 3(1).

[15] Ibid. Article 3(2).

[16] Ibid. Article 3(6).

[17] Ibid. Article 3(7).

[18] Ibid. Article 4(1).

[19] Ibid. Article 4(2).

[20] Ibid. Article 4(3).

[21] Ibid. Article 4(4).

[22] Ibid Article 14.

[23] Ibid. Articles 4(5) and 4(6).

[24] Ibid. Article 5(1).

[25] An exchange rate of R11.0433 to the Euro was applied.

[26] Ibid. Article 6.

[27] Ibid. Article 7.

[28] Ibid. Article 8.

[29] Ibid. Article 9.

[30] Ibid. Article 10.

[31] Ibid. Article 11.

[32] Ibid. Article 12(1).

[33] Ibid. Article 12(3).

[34] Ibid. Article 12(7).

[35] Ibid. Article 13(1).

[36] Ibid. Article 13(2).

[37] Ibid Article 14(1).

[38] Department of Minerals and Energy, Government Gazette, Number 26169, Notice 513 of 2004, 14 May 2004.

[39] The Constitution of the Republic of South Africa, Act 108 of 1996.

[40] Perry, A., Time Magazine, "Dirty Little Secret", 4 September 2008.

[41] Internationale Weiterbildung und Entwicklung GmbH (Inwent).

[42] Electricity Regulation Act, 4 of 2006, Section 4.

[43] Ibid. Section 8.

[44] Ibid. Schedule 2.

[45] Ibid. Section 14(4).

[46] New Shorter Oxford English Dictionary, January 1997.

[47] Electricity Regulation Act, 4 of 2006, Section 16(1)(a).

[48] Electricity Regulation Act, 4 of 2006, Section 18(1)(b) and (c).

[49] Government Gazette No. 32122, Notice 302 of 2009, 17 April 2009, p3.

[50] South Africa Renewable Energy Feed-In Tariff (Draft Guidelines), Appendix 3, Section 7, p. 35, May 2008.

[51] Government Gazette #32122, South Africa Renewable Energy Feed-In Tariff (26 March 2009) Regulatory Guidelines, Notice 382 or 2009, Appendix 2, Section 7, p.27.

[52] Department of Minerals and Energy, Renewable Energy Summit 2009, Summit Resolutions, 6 April 2009.

[53] NERSA, Consultation Paper, Renewable Feed-In Tariff Phase 2, June 2009.

[54] Ibid. Section 3(1).

[55] Ibid. Section 3(2).

[56] Ibid. Section 3(3)(1).

[57] Ibid. Section 3(3)(2).

[58] Ibid. Section 3(3)(3).

[59] Ibid. Section 3(3)(4).

[60] Ibid. Section 3(3)(5).

[61] Ibid. Section 3(3)(6).

[62] NERSA, Consultation Paper, Renewable Feed-In Tariff Phase 2, Appendix A, June 2009.

[63] Ibid. Recital A, p1.

[64] Ibid. Recital B, p1.

[65] Ibid. Recitals D and E, p1.

[66] Ibid. Recital I, p2.

[67] Ibid. Definitions and Interpretation, section 1(1.1), p3.

[68] Ibid. section 1(1.1), p.3.

[69] Ibid. section 1(1.1), p4.

[70] Ibid. section 1(1.1), p4.

[71] Ibid. section 1(1.1), p11.

[72] Bundestag, "The Act on Granting Priority to Renewable Energy Sources", 17th March 2000.

[73] Central Intelligence Agency, United States of America.

[74] Eskom Annual Report, 2007.

[75] Renewables Global Status Report 2009 Update, REN21. The author included the column headed 'RSA'.

[76] "DSM Case Study: Eskom's Megawatt Park", Eskom DSM, uncertain date.

[77] Smit, I., "Sharing Eskom's experiences in wind energy", Eskom Power Conference, 2008.

[78] vd Merwe, C., "Eskom defers smaller, mainly renewable projects", Engineering News, 28th August 2009.

[79] "Notes from workshop relating to mechanisms that underpin the REFIT Implementation: PPA and process towards securing a REFIT for RE projects", Democracy Foundation REACT, 2009.

[80] NERSA, South Africa Renewable Energy Feed-In Tariff Draft Guidelines, 15th May 2008.


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Kgatelopele Municipality	G Lategan	P O Box 43, Danielskuil, 8405	053 384-8600	053 384-0326
Khai-Ma Municipality	Engineering Rep.	P O Box 108, Pofadder, 8890	054 933-0066	054 933-0252
Khara Hais	Hennie Auret	Private Bag X6003, Upington, 8800	054 338-7145	054 338-7367
Knysna Municipality	Leonard Richardson	P O Box 21, Knysna, 6570	044 384-0422	044 384-1816
Kungwini LC	Electrical Engineer	Posbus 40, Bronkhorstspruit, 1020	013 932-6200	013 935-1311
Kwadukuza Municipality	Leon Klopper	P O Box 72, Stanger, 4450	032 437-5089	032 551-5500
Lekwa LC	Dawie Lottering	P O Box 66, Standerton, 2430	017 712-9819	017 712-9816
Lephalale Municipality	M F Loots	Privaat Sak X136, Ellisras, 0555	014 763-2193	014 763-5662
Lesedi Local Municipality	Hennie Coetsee	P O Box 201, Heidelberg, 2400	016 340-4300	016 341-6458
Lesotho Electricity Company (Pty) Ltd	Johan Jonkowitz	P O Box 423, Maseru, 100	051 522-6979	051 522-6979
Letsemeng LC	Electrical Engineer	P O Box 7, Koffiefontein, 9986	053 205-9200	053 205-0128

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Makhado Municipality	Erns Joubert	Private Bag 2596, Makhado, 0920	015 519-3000	015 516-1195
Maletswai LC	S J Mosenene	Private Bag X1011, Aliwal North, 9750	051 633-2406	051 633-2401
Mangaung LM	L D Liba	Centlec, Private Bag X14, Brandfort, 9324	0514092-241	051409-2366
Mantsopa Municipality	HD Potgieter	P O Box64, Ladybrand, 9745	051 924-0654	051 924-5144
Masilonyana Municipality	G Makaukau	P O Box 8 Theunissen, 9410	057 733-1768	057 733-1774
Matatiele Electricity	Mark White	P O Box 35 Matatiele, 4730	039 737-3135	039 737-3611
Matjhabeng Municipality	William Sephton	P O Box 708, Welkom, 9640	057 391-3116	057 398-1756
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Mbombela Local Municipality	Boiling Twala	P O Box 45, Nelspruit, 1200	013 759-2268	013 654-8877
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Modimolle Local Municipality	Hannes Kasselman	Private Bag X1008, Nylstroom, 0510	014 717-5211	014 717-4077
Mogale City Local Municipality	Frikkie Erasmus	P O Box 94 Krugersdorp, 1740	011 951-2425	011 951-2434
Mookgophong Municipality	CP Cloete	Private Bag X340, Naboomspruit 0560	014 743-6600	014 743-2434
Moqhaka Municipality	Mike Leloka	P O Box 302 Kroonstad, 9500	056 216-9283	056 216-9284
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Mossel Bay LC	Dick Naidoo	P O Box 25, Mosselbay, 6500	044 606-5081	044 691-1903
Mpofana Municipality	T Maseko	P O Box 47 Mooi Rivier, 3300	033 263-1221	033 263-1127
Msukaligwa Municipality	TJ Bezuidenthout	P O Box 48, Ermelo, 2350	017 624-3059	017 624-5232
Msunduzi Municipality	Pieter Opperman	P O Box 399 Pietermaritzburg, 3200	033 392-5003	033 392-5150
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Re A Ipelo LC	BA Roth	P O Box 5, Postmasburg, 8420	053 313-0343	053 331-0238
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uMhlathuze Municipality	Dwayne Baker	Private Bag X1004, Richards Bay, 3900	035 907-5350	035 907-5444
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Umkhanyakude LC	Thandazile Mnguni	P O Box 449, Mkuze, 3965	035 573-8600	035 573-1386
uMlalazi Municipality	Jaap le Grange	P O Box 37 Eshowe ,3815	035 473-3410	086 645-7937
Umtshezi Municipality	Vuyovic Dragan	P O Box 15 Estcourt 3310	036 342-7800	036 352-5103
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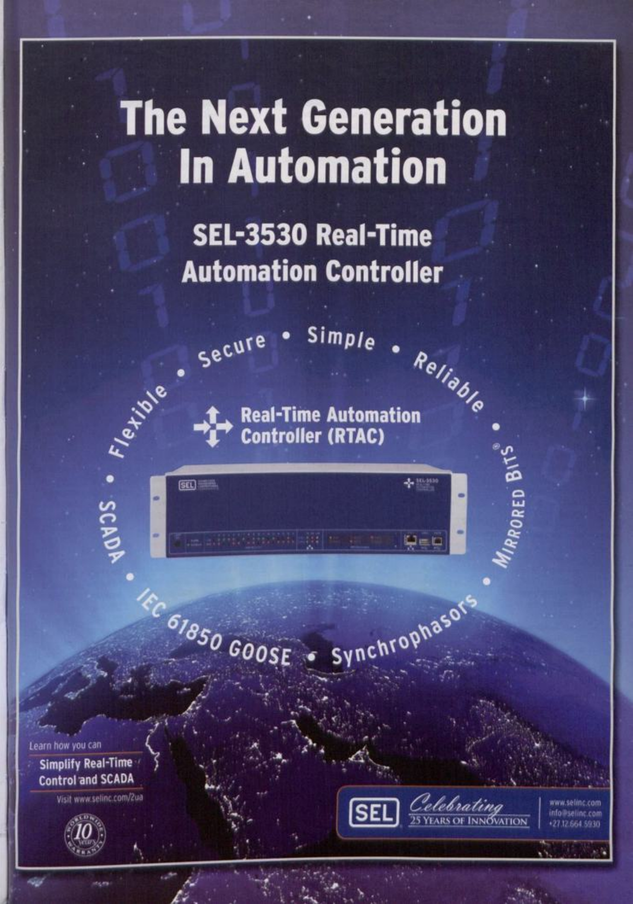
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