January 2008

National Response To South Africa's Electricity Shortage

Background

The recent past has seen unprecedented levels of load shedding nationally. Load shedding has been brought about by a shortage of generation supply capacity and is a last resort measure to prevent a collapse of the national electricity supply system. Load shedding is the last of a number of interventions taken to reduce demand in a system emergency situation. The risk of load shedding will remain high until at least 2013 if we do not take immediate actions to ameliorate the situation, especially during times of high levels of planned maintenance. Specific and immediate interventions are needed to minimise the risk of load shedding until the new peaking plant and baseload electricity generating capacity being built comes online.

South Africa Electricity Consumption

South Africa has seen significant levels of growth in electricity consumption and the level of demand. Figure 1 shows that 4.31% more energy was consumed in 2007 than in 2006.

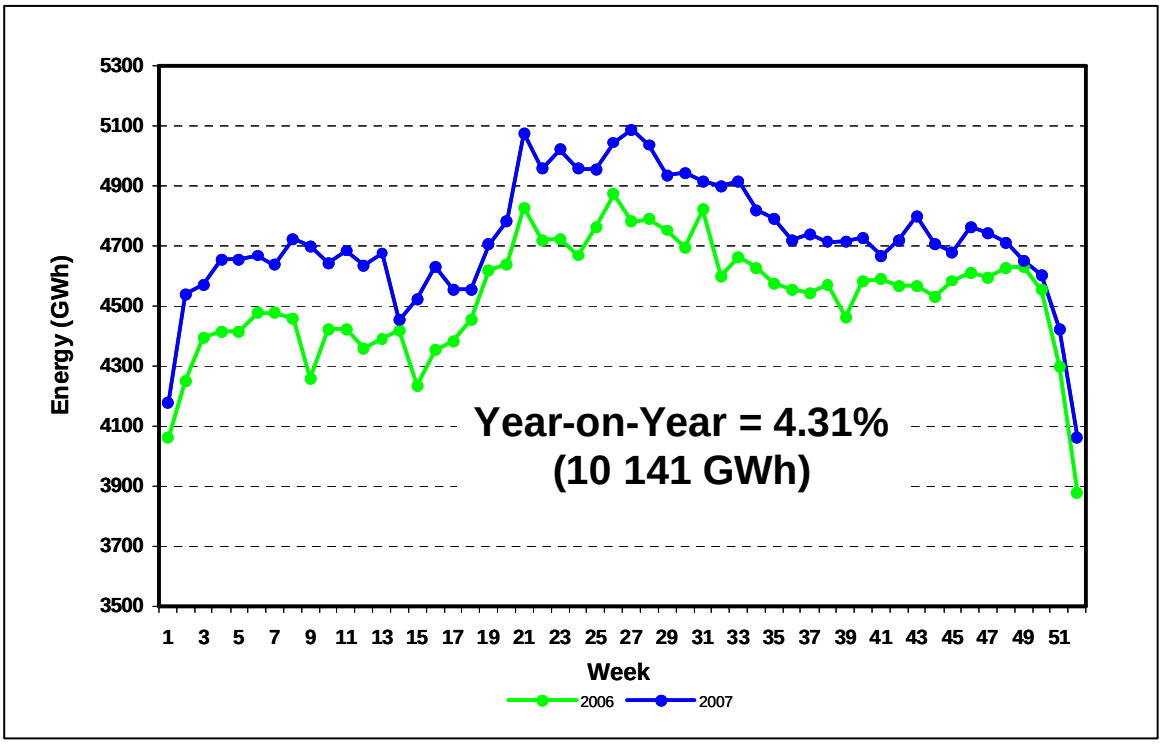

Figure 1: 2006 vs. 2007 Week-on-Week Net Energy Sent Out

In addition to this growth in energy consumption, the growth in peak demand from 2006 to 2007 was 4.90% which is 1 706MW. What is important to note in Figure 2 is that for almost every week in 2007, the peak demand was higher than that of 2006 and significantly so.

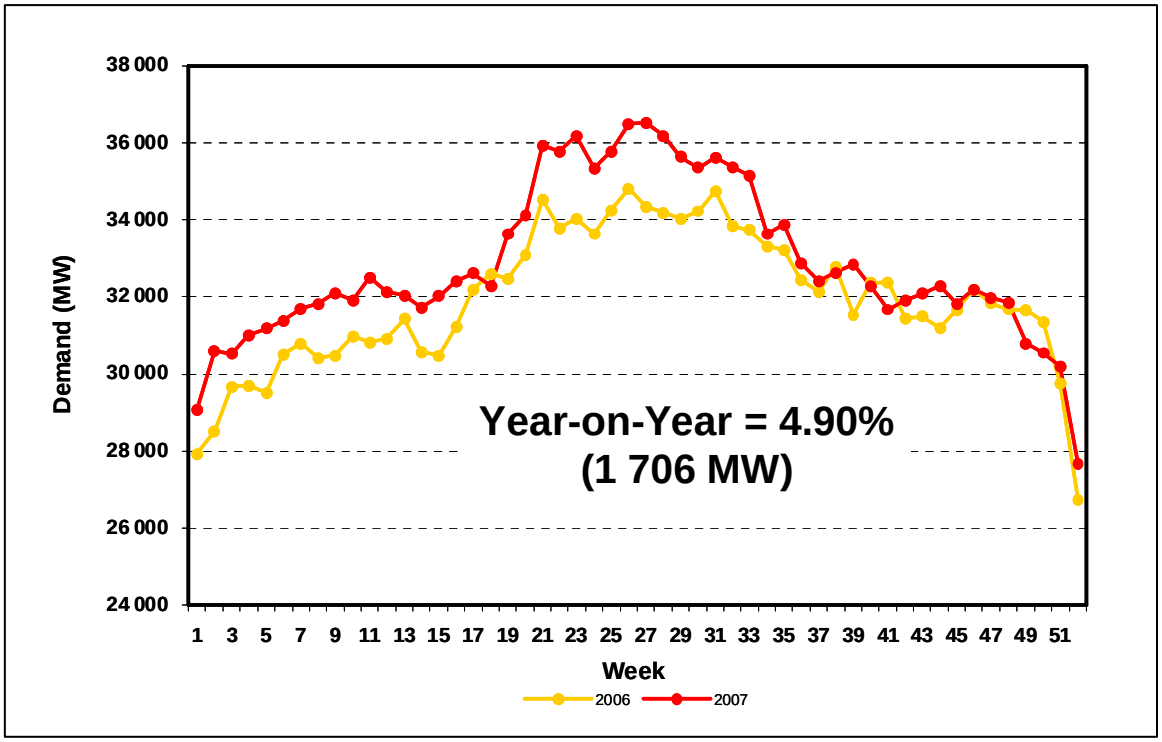

Figure 2: 2006 vs. 2007 Week-on-Week Net Peak Demand

Electricity Pricing

The price of electricity in South Africa is very low compared to other countries around the world. Many countries have also embarked upon large build programmes and the gap between South Africa and the rest of the world is widening. The main issues regarding pricing are:

- 'Gap' to next cheapest increased to 74% in 2007 from 30% in 2006
- Current pricing is half of the replacement value of power plant
- Increases above inflation will be needed to fund capacity expansion
- Prices will still remain competitive (we will still be among the lowest cost producers of electricity)

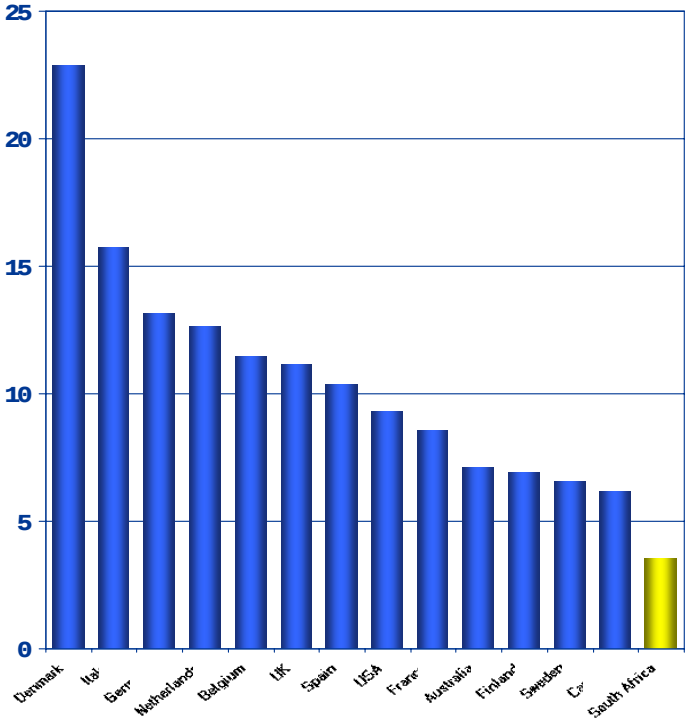

Figure 3.

Electricity prices will need to increase substantially to fund the new capacity being built; the current approved tariff by the Energy Regulator is 22.1c/kWh whereas the Long Term Average Cost is significantly higher. Electricity prices will need to move in the direction of the long term cost to be cost-reflective. This is also needed to ensure that electricity is used more efficiently and effectively in South Africa. In order not to adversely affect poor households, the tariff will have to be pro-poor and discourage wasteful consumption.

Reserve Margin

Peak demand is important to the reserve margin because there has to be enough generation plant available at any time to meet the level of electricity demanded at that time. Failure to do this will result in the national electricity supply system becoming unstable thus leading to supply interruption if left unchecked. If the entire national electricity supply system were to shut down, it would take days, possibly even weeks to restore.

The spare power plant available to provide supply at any time of the day is known as the reserve capacity and the spare plant available when the highest demand of the year is recorded is known as the reserve margin.

South Africa has historically enjoyed a large reserve margin, but that has declined over the recent past as a result of robust economic growth and the associated demand for electricity. This decline is depicted in Figure 4.

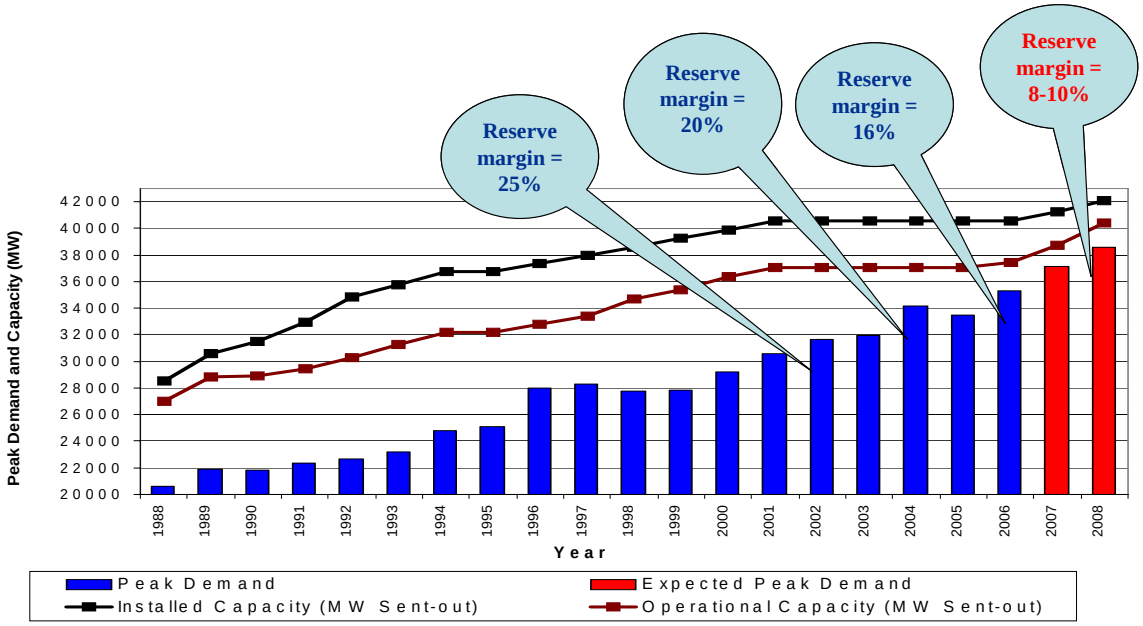

Figure 4.

The targeted reserve margin for South Africa is a minimum of 15%. This allows time for maintenance throughout the year as well as power plant to be operated at levels where equipment is not highly stressed.

The decline in the reserve margin has resulted in:

- Limited opportunities for maintenance, and
- Necessitated that Power Stations are run harder

The Current Situation

The time available for maintenance is limited and high levels of planned maintenance are now performed during the summer months to ensure that maximum generating capacity is available during the winter months when demand levels are traditionally much higher.

Planned maintenance reduces the amount of spare power plant available to provide the reserve margin as is currently the case. Due to the decline in the

reserve margin, the reserve available during this period of planned maintenance is much lower than required.

In addition, the running of the power stations hard means that equipment is highly stressed which has resulted in increases in the level of unplanned outages (equipment failures) and generator trips.

For Example, during the week of 14 January 2008, there were over 5 000MW of power plant not available due to unplanned outages. Some of the reasons for these failures were:

- Boiler Tube leaks/failure
- Various smaller equipment failure
- Generator output reductions (load losses) as a result of coal quality
- Problems with coal supply

It is crucial that Eskom working with DME begin acquiring higher quality coal that will enable generators to run at full capacity.

In addition to these unplanned outages, the system had 3 700MW of capacity on planned maintenance. This resulted in a total of some 8 700MW or 22% of the power supply capacity being unavailable to meet demand. Some of the detailed figures are given in Table 1.

	Generating Capacity	Plant Unavailable		Available Capacity	
		Unplanned	Planned		
	(MW)	(MW)	(MW)	(MW)	(%)
14/01/2008 (Mon)	39 194	4 824	3 675	30 695	78%
15/01/2008 (Tue)	39 194	5 342	3 675	30 177	77%
16/01/2008 (Wed)	39 194	5 647	3 695	29 852	76%
17/01/2008 (Thu)	39 194	5 380	3 695	30 119	77%

Table 1.

The result has been that there has not been sufficient generation supply capacity to meet demand. In such events, the following steps are taken, in this order, by

the system operator to maintain the integrity of the national electricity supply system:

1. Run all available Generation at Maximum Rating (high stress on plant)
2. Demand Market Participation (pay customers to reduce load)
3. Bring Gas Plant into the systems – these are however expensive given the cost of diesel
4. Emergency Water Resources – Pumped Storage
5. Interruptible Contracts (interrupt customers as per contract)
6. Load Shedding (last resort)

Load shedding is the last resort used to prevent a system-wide blackout. Utilisation of this step highlights the seriousness of the situation and the need for immediate intervention to alleviate the situation. The load shedding protocols currently used by Eskom were designed for short system interruptions. New Guidelines for these unprecedented load-shedding situations are being developed to ensure that safety, health and learning institutions and key national points are protected.

Immediate need and the Options to address constraint

The immediate need is to bring the Eskom system back into balance by:

- Restoring a workable reserve margin, thereby,
- Alleviating the strain on the generation assets and the primary energy supply chain, and
- Allowing “breathing space” for maintenance to be done.
- Current estimates are that 3 000MW of capacity needs to be released to provide the necessary “breathing space”.

This need can either be addressed from the Supply Side or the Demand Side. Figure 4 shows a graphical representation of some of the options.

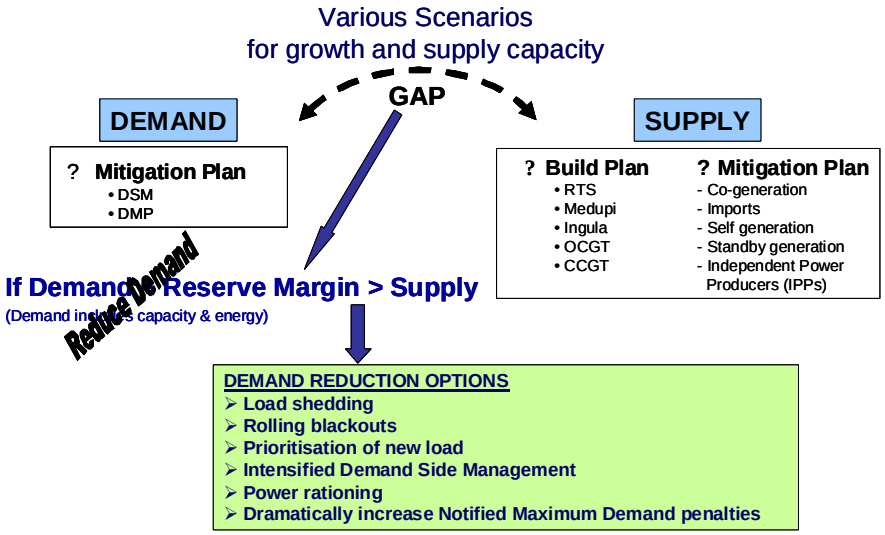

Figure 4.

The Supply Side Options

A power generation capacity expansion programme ("new build") is currently underway. The programme plans for 1 155MW and 2 421MW of new load to be added to the system in 2008 and 2009 respectively.

The Return-to-Service plant (de-mothballing) account for 1 920MW of the new load and Gas plant accounts for 1 036MW. The details of the capacity to be added to the system in the next 2 years is given in Table 2.

Immediate Term Capacity Expansion (MW)		
Project	**2008**	**2009**
Camden (Return-to-Service)	390	
Grootvlei (Return-to-Service)	585	585
Komati (Return-to-Service)	120	240
Ankerlig (Open Cycle Gas Turbines)		740
Gourikwa (Open Cycle Gas Turbines)		296
Arnot Upgrade (Coal-fired)	60	60
Co-generation*		500
Annual Total	**1 155**	**2 421**

Table 2.

A crucial short term supply side intervention is that of co-generation, which will contribute to the system from 2009 onwards. The process to procure co-generation supply has already begun, a summary of the key points are:

- Aspiration of 900 MW when RFP was issued
- Good responses (5 000MW)
- Intend using all viable projects
- Bid date from industry (current participants) extended to end-May 2008
- Bids to be evaluated thereafter
- All co-generation projects on-line before March 2012, with some capacity coming into the system in 2009.

DME and Nersa are working on tariff regime (cost recovery mechanism) for co-generation. Furthermore, modalities for Emergency Power Auctions will be developed in close co-operation with Eskom. Eskom already has a trading system which will be modified.

The details of the current approved projects in the build programme are given in Table 3. Whilst there is capacity being added to the system in the immediate years, the large amounts of additional baseload capacity are only scheduled to come on-stream from 2012 onwards.

Thus, the capacity expansion programme will solve the electricity supply problem in the long term, but the immediate need is to “release” some capacity within the system to allow more time for maintenance and to reduce the levels of stress at which power plant are being operated.

Current Planned Capacity Expansion (MW)										
Project	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**
Camden (Return-to-Service)	390	390								780
Grootvlei (Return-to-Service)		585	585							1 170
Komati (Return-to-Service)		120	240	320	285					965
Ankerlig (Open Cycle Gas Turbines)	589		740							1 329
Gourikwa (Open Cycle Gas Turbines)	439		296							735
Arnot Upgrade (Coal-fired)	75	60	60	30						225
Medupi (Coal-Fired)						798	1 596	798	1 596	4 788
Ingula (Pumped Storage)						666	666			1 332
Bravo (Coal-fired)							803	1 606	803	3 212
Wind Farm (Renewable)				100						100
Co-generation*			500	1 000	1 000	1 000				3 500
IPP (OCGT)				1 000						1 000
Annual Total	**1 493**	**1 155**	**2 421**	**2 450**	**1 285**	**2 464**	**3 065**	**2 404**	**2 399**	**19 136**

Table 3.

*Projected

In addition to the above, Renewable Energy (RE) options are being explored. The plan currently has 100MW of Wind Energy and a Solar Power plant of 100MW is also under consideration. A comprehensive RE plan is being developed and will be submitted to Cabinet during the first half of 2008.

In the short term, Demand Side interventions are the only immediate solution to the problem. These are explored further in this document and a demand side intervention plan is presented.

Demand Side Management

The immediate need for the country is to ensure that our electrical system is brought back into balance. We will need to restore a workable reserve margin in order to alleviate strain on the generation assets. We also need to create breathing space for maintenance to be done.

Intervention timeframes

Our intervention timeframes are classified as:

- Immediate (within 6 months),
- Medium term (within 18 months) and
- Long term (longer than 18 months).

Short term interventions – Core demand reduction programme

- Immediate implementation of the Power Conservation Programme
- Immediate implementation of specific demand side behavioural change programmes
- Fast tracking of medium and long term initiatives

DEMAND REDUCTION OPTIONS	SUPPLY CONSTRAINTS	COUNTRY IMAGE	CLIMATE CHANGE	FINANCIAL SUSTAINABILITY	SA ECONOMY	PROBABILITY OF DESIRED OUTCOME
LOAD SHEDDING	No improvement	Extremely negative impact	No impact	No impact	Extremely negative Indiscriminate allocation Impossible to plan	NOT AN OPTION
ROLLING BLACKOUTS	Some improvement	Extremely negative impact	Limited impact	Limited impact	Extremely negative Indiscriminate allocation Impossible to plan	NOT AN OPTION
PRIORITISATION OF NEW LOAD	Potentially negative	Negative Impact May be considered unfair	Limited benefit	Depends on priorities	Negative Deter investment	LOAD SHEDDING REMAINS BEST USED IN CONJUNCTION WITH POWER RATIONING
INTENSIFIED "ENERGY EFFICIENCY" DSM	Positive in long term	Slight positive impact	Positive in long term	Neutral to Eskom if funded by NERSA/customers	Positive in long term High Initial cost	LOAD SHEDDING REMAINS ELEGANT SOLUTION, BUT SLOW
SEVERE NMD PENALTIES	Some improvement	Neutral	Some improvement	Limited improvement	Neutral	LIMITED IMPACT WILL NOT RELIEVE CURRENT
SUSPEND NEW APPLICATIONS	No improvement	Very negative impact	Mildly positive impact	Neutral in short term Long term risk	Constrains growth Deter investment	LOAD SHEDDING REMAINS TEMPORARY REPRIEVE NEGATIVE LONG TERM IMPACT
POWER CONSERVATION PROGRAMME	Im				Facilitate intensified DSM & co-generation Economy can grow	PROVEN SOLUTION IMMEDIATE IMPACT DELIVERS INTENSIFIED DSM

Power Conservation is the Recommended Option

Positive impact | Neutral | Negative Impact

Most of the Demand Side Management (DSM) consumer behavioural change programmes need immediate implementation, however the impact will only be observed in the medium term. A Power Conservation Programme will have an immediate "quick wins" solution that will reduce and, depending on its success, negate the need for load shedding or significantly reduce these in future.

Power Conservation Programme

The concept proposal for the PCP draws heavily from the publication, "Implementing Power Rationing in a Sensible Way: Lessons Learned and International Best Practices (ESMAP Report 305/05, August 2005)", which commends the energy rationing applied in Brazil in 2001 as best practice in the event of an energy crisis. The key elements of the programme would be as follows:

Quota Allocations

- The programme is designed to achieve the overall savings target of between 10 - 15% over time. This target allows for a moderate growth of approximately 3.6% in electricity consumption. The quota allocation allows for differentiation of customers by class. To illustrate this, for example, based on a possible target of an immediate 8% overall savings, the large energy consumers could be required to reduce their consumption based on the following targets:
    - Industrial = 10%
    - Commercial (general) = 15%
    - Hotels, resorts, shopping malls & conference centres = 20%
    - Large office buildings, government, municipal & electricity utility offices = 15%
    - Agriculture = 5%
    - Residential = 10%
- For special cases, there will no targets that will be imposed. The special cases include, but not limited to hospitals, essential and security installations,
- Focus team to look at 2010 requirements

Penalties & Cut-offs

- Various penalty measures are being explored. The measures that are currently being explored include but not limited to:
    - Penalty tariff rates for energy use above the allocated quota
    - Cut – offs for a specific period for repeat offenders
    - Special cases will be exempt from penalties

Incentives

- An incentive scheme is being established for the smaller consumers that exceed their savings targets

- Trading
    - Large consumers can trade in their unused portion of quota allocation. There will also be possible provision for larger consumers to "take or pay" their allocated portion.

- Built-in Flexibility
    - The plan will be designed to ensure that there are possibilities to be able to adjust the quotas and penalties to address the possible changing needs in future.

Benefits of the Power Conservation Programme

It is expected that the Power Conservation Programme will yield among others, the following benefits:

- The reserve margin will improve
- The need for load shedding will be greatly reduced or eliminated for that matter
- The programme will provide space to perform maintenance of the generation assets
- There will also be a dramatic improvement of energy efficiency viability
- This will have a positive impact on climate change due to reduced energy consumption
- There will be productivity gains in economy through elimination of wasteful energy usage
- There will be behavioural change (energy conservation) forced which could become permanent

Regulatory Environment

The Electricity Regulation Act as amended makes provision for the regulations to be promulgated to ensure that incentives and penalties are legislated. These regulations have been drafted and will be ready for public comments by the 30 January 2008.

In addition, it is expected that the following actions will be undertaken with immediate effect:

- NERSA is responsible for the implementation of rationing in terms of the Electricity Regulation Act of 2006 as amended.

- Upon implementation of the electricity rationing strategy, existing contracts must be brought in line to ensure that existing users are not given preferential treatment over new users, which amounts to discrimination that cannot be justified

Customer Behavioural Change

There are various programmes that are currently being implemented by Eskom and Local Government. These programmes are expected to yield positive results in the medium to long term. These projects include the following:

Efficient lighting roll – out programme

The use of incandescent lights in the domestic and commercial sectors in South Africa presents an opportunity to reduce electricity demand simply by introducing more efficient compact fluorescent lights (or CFL). The CFL provides the same lighting level whilst consuming less than half the power of incandescent lights. Of the 10 million plus electrified households in South Africa, on an estimate of 4 incandescent lights per household, it is projected that 600MW could be saved by replacing with CFL's.

A key consideration is the need to ensure that whilst the retrofitting is done on the basis of free exchange, this does not result in environmental pollution as a result of mercury contamination. The Department of Environment and Tourism is expected to develop protocols for waste disposal of CFL's.

The final target is to reduce the demand by 750 MW by 2010. The programme also accommodates a free CFL exchange for low income households until 2015.

Immediate restriction on the sale of incandescent light bulbs

To ensure that the use of CFL's is sustained legislation that restricts the selling of any lamp that has an efficiency level of less than 20 lumens per watt, will be introduced. There will be certain exclusions granted for lamps for ovens, microwaves and for sensitive buildings and special cases.

Solar Water Heating Programme

The programme is in progress with a target to install 1 million solar water heaters over the next three (3) years. The current cost of the solar heater is prohibitive (it is estimated to cost between R7 000 and R20 000). It is also reported that the South African manufacturing capacity is only 10 000 units per annum. To eliminate these barriers, there is a subsidy of 20 – 30% depending on the cost of the unit. The potential savings of this programme is 650 MW. The programme is

targeting both the households, group houses (e.g. army bases, mine residences) commercial and industrial applications.

National Housing Specifications

To hard wire energy efficiency into the South African economy energy efficient building standards are to be legislated and implemented by the Department of Housing and Public Works for Government buildings. Local government has indicated that the municipal bylaws will entrench energy efficient behaviour.

- Water Heating
  - The Department of Housing will mandate that all new houses are to be fitted with solar water heaters with a back up electrical element that is fitted with a geyser load management switch, a time switch or an interlocker between a geyser and a stove. The interlocker will ensure that the geyser and the stove are never switch on simultaneously. Alternatively the water heater should be gas powered without any electrical backup. SABS will be tasked with the development of the standards and ensure that these are applied nationally.
  - The appropriate energy building standards will be specified for all new buildings as a priority, to include:
    - Ceiling insulation
    - Geyser insulation (including pipe insulation)
    - Double glazing
    - Weather stripping of doors and windows

Medium to Long term interventions

Smart metering for residential customers (Load management)

Although the smart metering can be initiated in the short term, the benefits will be reaped in the medium to long term.

In South Africa the electricity consumer's consumption is measured by means of conventional or pre-paid electricity meters. In the case of the former, the meter is read occasionally (like once a month) and a statistical method is used to adjust the meter reading every three months or so. This tends to be an inaccurate method of billing which is open to abuse.

Smart metering refers to the type of metering that allows for the consumer's consumption to be measured remotely rather than manually. The advantage of such an approach is that the cost of meter reading is drastically reduced and the accuracy of the reading and hence the rendered bill is improved. In the context of energy management, smart metering can be configured to provide for the remote connection and disconnection of consumers when their electricity consumption exceeds a threshold level set by the utility. Smart metering requires the use of wireless technologies which have to be retrofitted to existing conventional and pre-paid meters and are thus costly to retrofit. In this case a quick cost benefit analysis indicates that an improved communication between the utility and the customer meter will result in big energy savings during the peak demand. This is illustrated by the figures below.

The potential reduction is estimated to be 3 265 MW, made up of:

- Geyser = 2 161 MW
- Laundry (2% contribution to peak) = 246 MW
- Pool pumps (1% contribution to peak) = 122 MW
- Other appliances (6% contribution to peak) = 736 MW

The programme will need extensive human resources. The programme provides an opportunity for training and job creation.

Fuel switching

This refers to the substitution of electricity as a domestic energy source with Liquefied Petroleum Gas (LP Gas) in this case, in order to lower the burden of electricity generation. This strategy assists in ensuring that the appropriate energy carrier is used for the application (it is more energy efficient to cook with gas than with electricity). In addition, fuel switching to LP Gas ameliorates the strain experienced by the electricity network during peak times when domestic users are cooking at the same time.

Two challenges have to be overcome in respect of fuel switching to LP Gas. Lessons learned from the Cape Town electricity crisis indicate that supply chain issues and the pricing of LPG will need to be resolved as a matter of urgency. In order to overcome these challenges, the DME has initiated a programme where concessions will be issued with suppliers bidding for these concessions. This is in line with Petroleum Products Amendment Act. The regulated pricing regime for LPG will be completed in the next two months. The opportunity to import gas during supply shortages needs to be explored more, because the gas is actually a by-product in the oil refining process and is readily available in the global market. It is expected that this programme will save 500 MW.

Traffic lights and Public Lighting

All traffic lights and public lights will be converted to solar power with a battery backup. This is another extensive project that will cost approximately R400 million and will also be another opportunity for employment creation and skills development.

Hospitality industry

The DTI and DEAT have to direct the hospitality industry to convert all water heating to solar power. The water heating method can be in the form of solar pre – heaters, thereby ensuring that electricity is not used whenever there is enough solar radiation available to heat water.

Other medium term interventions

Medium term interventions that are likely to influence the behaviour in the long term are the following:

- Implementing the Electricity Regulation Act as amended, especially on the issues pertaining energy efficiency;
- Adjusting the tariff regime to reflect the actual cost of providing electricity;
- Regulation of the maintenance regime of the electricity infrastructure especially at Distribution level;
- Availability of primary energy (especially coal) for power generation including the holding of strategic reserves by the State.

Additional Sectoral Interventions

Government Buildings, SOE and Construction Sector

The following short term interventions are to be implemented by the Department of Public Works (DPW).

- Acceleration of energy audits in all buildings
- Develop common reporting requirements for energy usage from all energy sources, taking into account, where possible, existing internationally recognised and accepted reporting protocols
- Define Department specific projected energy use in the future, based on growth expectations as well as the energy requirements in 2010.

- Develop a generic energy auditing protocol that can be adapted for use by the individual Government Departments and Organs of State.

- Immediate issue of directives to all government-owned building's users and to the landlords in which government is accommodated in respect of day time and night time energy savings interventions such as:
    - Shut down electricity supply after hours;
    - Use of red plugs for special appliances e.g. computers (these are connected to the back – up supply, which could be either a generator or an Uninterrupted Power Supply (UPS));
    - Restricting times for cleaning services;
    - Promoting efficient use of air conditioners and Heaters (e.g. individual vs. central system, etc).

Medium term interventions

To address the medium term intervention, the Department intends to:

- Install energy management devices on appliances such as geysers;
- Install energy efficient lighting in all government buildings;
- Install motion detectors and card controlling devices in government buildings.

Long term initiatives

In the long term the Department intends to:

- Identify methods and procedures that will allow the baseline quantification for energy use / intensity (consumption per unit of production or any other relevant denominator) Government in general
- Fit solar energy systems into government buildings
- Install of sensor lighting

TRANSPORT INTERVENTIONS

RAIL TRANSPORT

Rail runs on a separate circuit supplied from Eskom but they do not have the capacity to generate their own electricity to stave off load shedding. (They have a limited capacity of power generation but this cannot sustain their operations if load shedding was to be extended to them).

Freight movement on the major corridors is through a combination of electrical and diesel locomotives. There is however no possibility of using diesel from origin to destination because there is not enough diesel locomotives.

- **Commuter Rail**

  Commuter rail operation commence at 04h00 until 22h00, morning peak is at 04h00 to 10h00 and the afternoon peak from 15h00 to 1h00.

  - Non – security and non – essential usage of electricity and lighting to be switched off 23H00 and 04H00
  - Energy efficient lighting programme in progress in SARCC

- **Freight**
  - Immediately shut down branch line unscheduled freight movement within branch lines
  - Reprioritisation of secondary network - South African rail network with the region

AVIATION

- Shutting down non – security and non – safety related lighting and services over the peak periods of operation
- Full shutdown of non – essential systems and lighting at smaller airports

ROAD

- Shutdown motorway lighting
- Stop load shedding on traffic lights

INTERMEDIATE INTERVENTIONS

- Rehabilitation of the old diesel locomotive fleet.
- Reduce and limit operational days on certain of the secondary networks within the main network.
- Greater traffic consolidation.

LONG TERM INTERVENTIONS

- Look at a better diesel/electric locomotive split.

CONCLUSION

It is acknowledged that the current load shedding can be better managed. The immediate interventions need to be implemented:

- A multi stakeholder task team will be established to co-ordinate the implementation of this plan. It will also have responsibility to ensure effective communication of the plan and manage energy efficiency protocols. The team will be composed of the following stakeholders: DME, DPE, Eskom, SALGA.
- The programmes as presented will be led by senior officials in government and executives in Eskom and the Municipalities.
- Regulations that will ensure implementation of short term interventions.

National Awareness Campaign

As one of the tasks of the multi stakeholder task team, an awareness campaign will be undertaken that will ensure coordination of messages between DME, Eskom, National Energy Efficiency Agency, GCIS and Local Government.