City Power Johannesburg : Response to Potential Load Shedding

Author : Stuart Webb B.Sc. (Hons) Electrical Engineering

General Manager : Plant Condition Monitoring

1. Abstract

This paper will provide a brief history of City Power, the electricity utility which distributes power to consumers within the City of Johannesburg's licenced area of supply, and will describe the various options available to mitigate the impact of future load shedding should this be necessary to maintain the stability of the national grid.

2. Background

For any electrical grid to remain stable the available generation capacity must match the load demand of the consumers, in simple terms 'supply must match demand'. At any one time the generation capacity of a system will generally be less than the installed capacity as certain plant will be out of service as a result of planned or forced outages. The difference between the national maximum demand and the available generating capacity is referred to as the 'Reserve Margin' and in an ideal world this should be around 15%.

If the system demand at any instant in time is greater than the available generation the system will become unstable and extensive and progressive blackouts may result. This would be catastrophic for the country and must be avoided even if drastic measures are necessary. If the demand cannot be quickly reduced to match generation large blocks of load must be intentionally disconnected.

In 2008 the national generation levels could not meet demand during peak periods due to unplanned unavailability of plant and the country experienced a series of forced outages which quickly became known as 'Load Shedding'. These forced outages resulted in extreme inconvenience to the public and adversely affected companies, businesses and the national economy. This was a new phenomenon for which the country was ill-prepared.

3. A Brief History of City Power

When the now defunct Metro Electricity, which was the City of Johannesburg's electricity service provider, was formed it amalgamated several former municipal electricity undertakings into one new utility. It brought together 5 essentially independent systems, namely

- Johannesburg
- Randburg
- Roodepoort
- Sandton
- Johannesburg South

There were also a few minor networks included such as Alexandra, Dainfern, Lenasia and Brink's Vlakfontein.

In 2001 Metro Electricity was rebranded as a new company and called City Power Johannesburg. More recently the Modderfontein and Midrand areas have been added to the supply area.

The technical designs of the former municipal areas are diverse in terms of plant and equipment, voltages and operating philosophies. These technical differences made interconnection of the various networks

of little benefit and the systems are essentially operated independently.

City Power purchases the majority of its energy from the national generator, Eskom, for onward distribution to its customers. In addition a small amount of power is supplied from the independently owned and operated Kelvin Power station.

City Power's customer base is in excess of 360 000 and the maximum demand around 2 600 MW's.

4. The Challenges

As alluded to above, City Power procures the vast majority of its power from Eskom and an alternative source of such magnitude is not available. Over the years countrywide load growth and development has resulted in Eskom's reserve margin falling below the internationally accepted level of around 15% due to various factors not always within its control.

In addition, Eskom's build program has experienced several delays and a significant reduction in grid capacity pressure is only expected to be realised in two to three years.

As a result the possibility of having to quickly reduce system demand during peak periods or following a major system event is ever present. Although a concerted effort has been made by all parties to inform the public of the precarious situation and the response from consumers has been positive the threat of load shedding still remains.

The impact of load shedding has a significant negative impact on the economy of region and, indeed, on the country as well as adversely affecting the lives of the citizens.

5. Curtailment Stages

In terms of NRS 048 – 9 various stages of load shedding are described.

- *Stage 1* is defined as a 5% reduction in winter maximum demand
- *Stage 2* is defined as a 10% reduction in winter maximum demand
- *Stage 3* is defined as a 20% reduction in winter maximum demand

In City Power's case these stages would equate to around 130MW's, 260MW's and 520MW's respectively.

The duration of load shedding can vary greatly from a few hours up to 8 hours or even longer in extreme cases.

6. Opportunities

The City of Johannesburg and City Power have recognised the negative impact of load shedding on the economy and the citizens of the city. As a result the city has made a commitment to avoid a repeat of 2008.

Several mitigating opportunities to avoid emergency load reduction have been identified by City Power and have been or will be introduced. The various initiatives available will be described and discussed in the following sections.

7. Key Customer Demand Response

City Power has a number of high consumption key customers whose annual usage exceeds 5 GWh's. The activities of these companies differ widely but all have a potential ability to reduce or shift load without necessarily halting or adversely affecting their production of operation. These companies are fully aware of the impact of complete load shedding on their businesses as a result of the prevailing conditions and are willing to assist City Power to mitigate this situation.

Presently City Power has identified around 112 key customers who have confirmed their willingness to voluntarily participate in a demand response scheme. The proposed, but as yet unconfirmed, repayment incentive rate is R1,11 per kWh and certain criteria will apply for the companies to participate.

It is estimated the potential load curtailment to be gained from this initiative will be around 80 MW's.

8. Geyser Control

City Power has installed, over several years, an extensive network of geyser control infrastructure utilising ripple control technology. This form of demand side management is normally aimed at reducing the city's maximum demand during the morning and evening peak periods when energy purchase costs are at their highest. Geyser control can, in addition, be called upon to reduce demand when system capacity is tight or in an emergency situation.

Illustration 1 Ripple Control Coupling Cell

The existing coverage is limited to around 60% of domestic premises although further expansions are planned. The present capacity of the ripple control system allows for an immediate reduction in demand of between 50 to 80 MW's depending on the time of day and the season.

9. Gas Turbines

City Power has three Gas Turbine installations situated around the JHB CBD. The capacity of these units is 40MW's each or 120MW's in total. The units had not been used for several years and had been mothballed. Following the 2008 load shedding experience two new refurbished engines were sourced and installed. The units were then operated but it was found the control circuits were unstable and unsuitable for reliable operation.

It is an option going forward to modernise the control systems allowing City Power to run these units to off-set demand curtailment requests at times of system constraints.

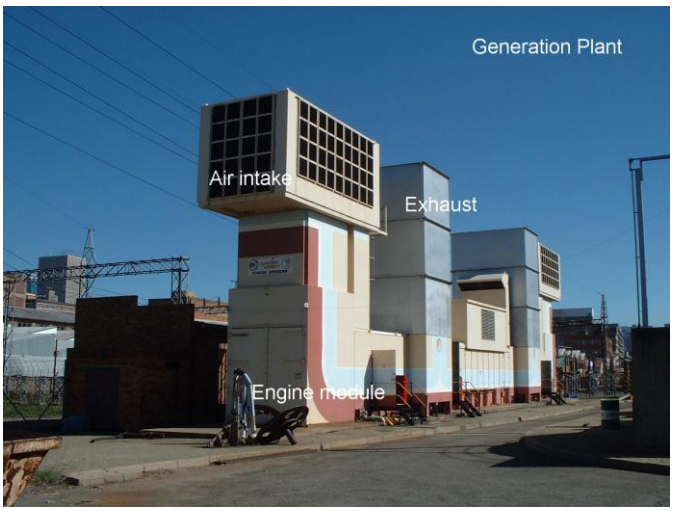

Illustration 2 Cottesloe 40 MW Gas Turbine Installation

10. Kelvin Power

City Power has a 20 year PPA (Power Purchase Agreement) with Kelvin Power which commenced in 2001. Kelvin has a reduced capacity availability of around 300MW's following the recent decommissioning of the obsolete 'A' Station. The unit price of Kelvin is higher than the Eskom Megaflex tariff and presently Eskom has contracted to purchase all output at the higher rate.

However, CP has an opportunity to utilise Kelvin's full available output as a contribution to its load shedding quota although this clearly has financial implications.

Illustration 3 Kelvin 'B' Power Station

11. Solar Geysers

A roll-out of solar water geysers was initiated in late 2012 and the first phase involved the installation of some 60 000 Units in various areas. It is the intention in the current financial year to continue with the installation of a further 10 000 units

It is estimated these installations equate to an evening peak demand reduction of around 7MW's and avoids a future potential load of 45MW's from conventional electric geysers.

Illustration 4 Typical Solar Geyser Installation

12. Photovoltaic Generation

Presently City Power has received a significant number of applications to connect PV to its grid. Eskom funded projects amount to some 4MW's alone with further privately sponsored projects in the pipeline. Fully regulated PV programs could yield tens of megawatts of power. Approval for grid connected PV and surplus power buy-back tariffs is awaited from NERSA. In addition a number of larger companies have installed generation plant and they could also be contracted to operate their plant at times of system constraints.

The repayment rate and applicable conditions are presently being developed for submission to NERSA.

Illustration 5 Typical Photovoltaic Installation

13. Smart Metering

A strategic decision to introduce smart metering has been taken by City Power. Both credit and prepaid options are available to customers. Generally consumers presently consuming < 1000kWh's per month will be offered a prepaid meter. In addition to automatic reading functionality the meters have a capability for communication and to switch domestic appliances such as geysers and pool pumps. It is the intention to fully utilise this functionality to control residential demand, where necessary.

Illustration 6 Domestic Smart Meter

14. Residential Time of Use (TOU) Tariff

A residential TOU tariff is now available to City Power customers. The previously installed, older technology, meters were not capable of metering TOU consumption. With the roll-out of smart meters the introduction of TOU tariffs is now supported. The intention is to incentivise residential customers, through tariff signals, to reduce consumption during peak periods.

It is also possible to control the actual consumption during periods of constraint by remotely setting a load limit which, if exceeded, would result in disconnection.

15. Summary

Currently several options to mitigate the possibility of load shedding are available to City Power, albeit at significant cost. With the options available City Power can accommodate up to a Stage 2 request but any appeal beyond this cannot be complied with without the deliberately disconnection of customers.

City Power will continue expanding its geyser control systems to all areas – load can be quickly reduced and held off until constraints ease up. The roll-out of smart meters will proceed and the use of these meters to control network loading will also be implemented.

New renewable and energy efficient technologies are being investigated such as PV power and energy efficient streetlighting - the City of Johannesburg, in conjunction with City Power, has initiated a project to generate electricity from the gas produced at two landfill sites.

The Demand Response initiative will be expanded.

It is confidently expected that these measures will significantly contribute to the national effort to reduce system demand and thereby minimise the need for the re-introduction of load shedding.