1. Introduction

The Benoni/Nigel Township Electrical Network normalisation project was initiated to upgrade, refurbish and normalise the Benoni & Nigel townships in order to improve safety, network performance and the quality of supply. The project also addressed issues of non-technical losses by using split metering technology.

Eskom North Western Region appointed external consultants to do an independent audit of the networks supplying these townships networks. The audit conducted provided a detailed, independent analysis of the existing electricity supply network and lists all aspects of safety, electrical and supply constraints.

The audit highlighted some critical deficiencies on the aspects of public safety and the reliability of supply to the consumers. The total estimated costs to refurbish/normalise 9 townships in the Benoni & Nigel Field Services Areas (FSA) will be approximately R2 Billion phased over 5 years (2011 – 2016).
2. Problem Statement

The electrical networks of the townships under discussion are in a very poor condition. The network has been vandalised and illegal connections are found all over the network. As a result the networks are overloaded, trip frequently and impact network performance negatively. Exposed mini subs, low hanging conductors and vandalised equipment posing safety hazard to the public.

3. Background and Customer

The customer base (Benoni/Nigel Townships) was taken over by Eskom. The project focuses on the normalisation/refurbishment, strengthening and installation of split metering for the following townships: Aston, Clayville, Wattville, Katlehong, Tsakane, Vosloorus, Dayveton, Etwatwa and Duduza. The customer base is made up of 161 950 consumers.

These townships are supplied by a combination of underground and overhead electrical network. The electricity consumers are metered by a mix of conventional and prepayment meters. The existing electrical system is in a very poor state and is unsafe to both the public and the Eskom personnel.

The non-technical energy loses experienced in these townships is the highest in the North Western Region if compared to other townships within the region. The high energy loses can be attributed to vandalism and illegal connections (theft). The loss of revenue due to theft runs into millions of Rands per annum.

Illegal electricity connections cause the network to overload, causing unnecessary interruptions to the customers. In some townships both the MV and LV networks are mid-block design (Between houses) this causes problems with clearances and accessibility for maintenance purposes. Owing to the age of the networks, a decision was taken to rebuild the network.

The existing network drawings do not reflect the existing system configuration/layout.

4. Triggers for the Project

A major refurbishment, strengthening and normalisation project was initiated due to the following reasons:

- Unsafe conditions
- High Non-Technical Losses
  - Illegal Connections
  - Vandalism
- Low payment levels
- High network demand
- Poor performance
5. Network Investigation / Audit

The figure 1 below show the steps/process followed when the project was initiated.

The audit conducted provided a detail, independent analysis of the existing electricity supply network and listed all aspects of safety, electrical and supply constraints.

Five steps were followed to compile a business case for the rebuilding of these electrical networks:

1. Establishment of Scope for Consultants
2. Conduct Field Audit/Data Collection
3. Compile Audit Report
4. Develop Business Case
5. Conduct Pilot/Split Metering
6. Rollout Project in Phases

Consultant Scope: Eskom North Western Region compiled a scope for the consultants to carry out inspections/audits/investigations.

Conduct Audit: The audit conducted provided a detail, independent analysis of the existing electricity supply network and lists all aspects of safety, electrical and supply constraints. The purpose of the audit was to establish the general condition, accessibility, operational labeling, safety compliance and loads/loading of the network.

Compile Audit Report: The consultants compiled a detailed audit report for each township. All defects and findings were recorded in the audits report.

Develop a Business Case: A business case in the form of a project proposal was developed for management approval. The findings from the investigations / technical audit were used as motivation for the business case.

Conduct Pilot / (Split Metering Technology): The region conducted a Pilot for testing the Split Metering technology. The business required a solution that will reduce vandalism and illegal connections. The split metering technology was never used in the region before, hence the need for a pilot.

Rollout Project in Phases: After successfully piloting the technology, the total project was approved for implementation. The projects were prioritised and will be rolled out in phases from 2011 - 2015.
6. Investigation / Audit Findings

6.1 Summary of Field Inspection

![Figure 2: Summary of Field Inspection](image)

6.2 High Energy Loses

The graph below shows the Energy Delivered vs. the Sales over a 12 Month period (2008). The high energy losses (Non-technical) can be attributed to vandalism and illegal connections (theft).

![Figure 3: Energy Delivered vs. Sales](image)
6.3 Condition of Electrical Network

Figure 4: Site Photos from Technical Audit

6.4 Maintenance
The maintenance on these networks has been reactive. There was no comprehensive mechanism/process to deal with problems regarding the reporting and maintenance of customer meters and the network as a whole. Very little planned maintenance took place due to the many unplanned maintenance work on these networks.

6.5 Load Growth Triggers
The absence of time based trigger mechanism of the infrastructure as it goes through the time phases has resulted in the network not being upgraded as required.

6.6 Performance of Electrical Networks
Inadequate focus and attention to the performance of electrification networks results in:

- Increasing complaints from electrification customers about their power quality
- Ageing network infrastructure - growing need for refurbishment and replacement of assets
- Increasing operational expenditure, overtime trend, etc.'
6.7 Illegal Connections
These townships are also plugged by illegal electricity connection. This causes the network to overload, causing unnecessary interruptions to the customers.

6.8 Regulations and Operations Requirements
In some townships both the MV and LV networks are mid-block design (Between houses) this causes problems with clearances and accessibility for maintenance purposes. The drawings and single lines do not reflect the existing system configuration. This poses a risk to both the public and personnel when operating has to be done.

7. Proposed Solutions
A pilot was conducted to test the technology that was proposed before rolling out the scope proposed below.

High Level Scope for Benoni & Nigel Township’s electrical Network:

Short Team (Immediately)

• Repair all priority issues as highlighted in the audit report (safety risks).

Long to Medium Term (2-5yrs)

• Normalise, replace and refurbish the existing electrical MV and LV networks by:
  - Replacing old, vandalised and obsolete MV and LV equipment.
  - Rebuilding some sections of the network.
  - Data collection (Customer and Network data)

• Install split metering for all households in the townships by (New Technology):
  - Installing prepaid split meter’s with comms.
  - Installing protective shells for all mini subs
  - Installing protective kiosks (Housing Meter) with protective
8. Pilot

8.1 Objective of Pilot
Eskom North Western Region conducted a pilot project to test the new split metering and vandal proof enclosure technology. The objective of the project was to implement remote metering that will ensure that the North West Region will reduce its non-technical losses and prevent vandalism of equipment.

8.2 Selected Site
A split metering + use of protective enclosures pilot was conducted in the in Katlehong Ndlapo section.

8.3 Statistics of Pilot

<table>
<thead>
<tr>
<th>Item</th>
<th>No</th>
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<tbody>
<tr>
<td>Number of Mini Subs</td>
<td>22</td>
</tr>
<tr>
<td>Number of Kiosks:</td>
<td>138X8Way - 75X12Way</td>
</tr>
<tr>
<td>Number of Meters</td>
<td>1442</td>
</tr>
<tr>
<td>Number of CIU</td>
<td>1442</td>
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<tr>
<td>Cost of Pilot:</td>
<td>R12m</td>
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<tr>
<td>Implementation:</td>
<td>1 Year</td>
</tr>
</tbody>
</table>

8.4 Technology Employed

Meter:
Kiosk Management as opposed to Meter management. The split prepayment meter consists of two parts, the meter (MIU) and the customer interface unit (CIU). Communication between the meter and the customer interface unit is by means of Power line Communication. The prepayment meter is STS compliant and is installed in a secure enclosure.

Secure Enclosure:
A secure enclosures/protective shell is used to cover the kiosks. The kiosk must be able to give of tamper alarms and use GPRS technology to communicate alarms to a control points.

Figure 5: Split Metering
8.5 Pilot Results
The pilot was conducted over a period of one year. The pilot project resulted in a reduction in non-technical losses and an increase in purchasing levels. There was no serious vandalism, except for various attempts to open the enclosed mini subs. The pilot project managed to reduce illegal connections and prevent vandalism to the system. The loading on mini substations also reduce considerably. This also resulted in a reduction of unplanned events in the area where the pilot was conducted.

9. Conclusion

9.1 Learning Points / Way Forward

- The community involvement is very important, there should be extensive consultation before the implementation of new technology.
- Customer interaction (marketing) and re-enforcement of improved service from technology must be done.
- Technology is vandal resistant and can prevent unauthorised entry into mini substations.
- To ensure proper first line maintenance, Field staff must be well trained on the technology.

9.2 Project Implementation
The project is currently being implemented in phases. The project aims among other things to achieve the following:

- Reduce the combined non-technical loses from 47% to 8% (improve revenue collection).
- Reduce maintenance costs due to unplanned events and improve the network performance.
- Improve accuracy of customer information and reduce risk of community being electrocuted.

It is envisaged that the sales per year will increase by approximately 55% once the project has been implemented in its entirety.

Implementing this technology can delay strengthening of the network and it also gives the customer the power to control their consumption within their means.