STELLENBOSCH MUNICIPALITY

ELECTRICAL INFRASTRUCTURE MASTER PLAN

FINAL REPORT

Prepared by:

NETGroup South Africa (Pty) Ltd.

In partnership with Shanduka Energy (Pty) Ltd







Document History

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1.0	May 2006	First Draft Issue	DJ Vrey J Roech H vd Merwe	
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EXECUTIVE SUMMARY

NETGroup South Africa (Pty) Ltd has been appointed by Stellenbosch Municipality to develop a master plan to facilitate the future growth and upgrading needs of the Municipality's 66/11kV and 11kV electricity distribution network.

The main objective of the study was to produce an electrical network master plan for the distribution networks for the Stellenbosch Municipality.

Study Tasks and Objectives

The study consisted of a number of tasks of which the following formed the basis of the study:

<u>Information Review</u>

During this task as much existing information as possible was obtained. Information included mostly network and load related information. This task further entailed the review of all obtained information.

<u>Field Inspection</u>

During this Task a field team performs data collection and visual inspections at all 66/11kV substations and 11kV switching substations within the study area. Information included all primary equipment (Power Transformers, HV Instrument Transformers etc.) and Civil works.

<u>Refurbishment Planning</u>

During this Tasks site specific assessment were conducted to provide a systematic across the board estimate of the life remaining in substation facilities, and in conjunction with the life extension methodologies, provide a plan to extend the life to meet future needs. The Refurbishment plan was developed on the criteria and methods discussed in the refurbishment Criteria provided in Addendum B to this report.

<u>Load Forecast</u>

The load forecast is a crucial input to the network expansion study. During this task a geographical load forecast was developed that is based on regional demographic and historical load growth patterns. The anticipated Long-term load forecast was directly used as input to the expansion plan.

<u>Strengthening Options and Technical Evaluation</u>

The objective of this task was to identify network strengthening and expansion options and to perform technical evaluations to ensure that load and performance criteria are met.

Network analysis aimed to test compliance with the following minimum requirements:

- Thermal loading,
- Voltage standards, and
- Contingency requirements as defined in the Planning Criteria provided in addendum A to this report.

Network studies were performed for distinct system loads, developed from the geographical load forecast.

The time frames and load representation were for:

- Base year (2006),
- Short-term (2008, 2010), and
- Longer-term (2012, 2015, 2020 and 2025).

<u>Cost Estimates</u>

The objective of this task was to estimate the cost of the technically viable expansion and strengthening options. The cost estimates were based on the requirements for:

- Expansion,
- Strengthening, and
- Performance improvement projects.

Recommendations for Expansion and Strengthening Requirements

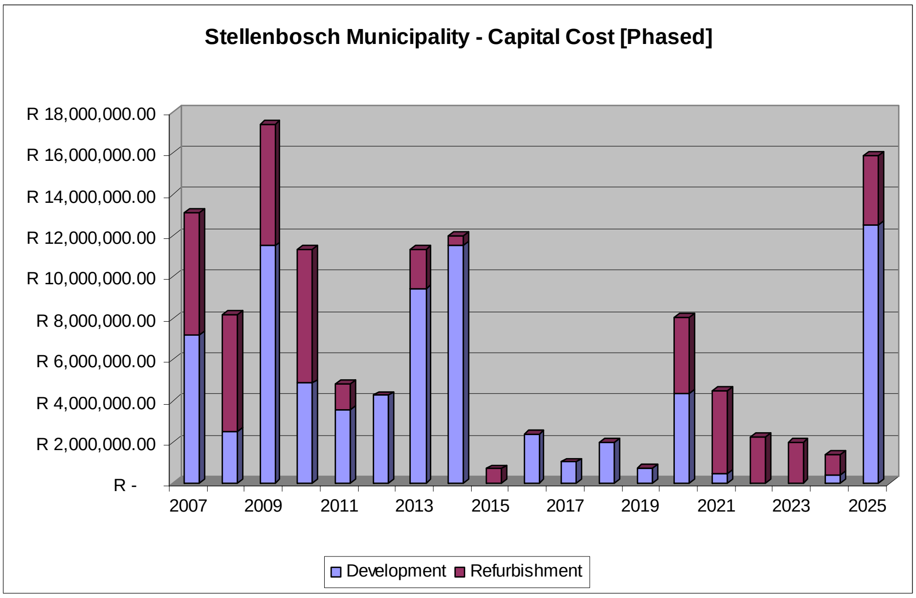
The study has identified and documented expansion and strengthening projects to ensure the adequate performance of the network within the Short- and Longer-term. It is recommended that these projects be implemented in the phased manner as indicated.

Capital Program

The capital program was developed by using standard equipment cost, contained in an equipment library. The output from the various evaluation systems was used to set up two capital program scenarios. The expected capital program is shown below.

The capital program allow for:

- Distribution network Development and optimization, as well as
- Refurbishment Requirements.



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NETGroup

1 Project Background

NETGroup South Africa (Pty) Ltd has been appointed by Stellenbosch Municipality for the survey and development of a master plan to facilitate the future expansion and refurbishment needs of the Stellenbosch Municipality 66/11kV and 11kV electrical distribution networks.

The main objective of the study was to provide the Stellenbosch Municipality with a clear view and long-term plan for the development of electrical infrastructure required to support the envisaged demand growth in Stellenbosch and surrounding areas. The study further evaluated the long-term viability of existing infrastructure and proposed the expansion and refurbishment requirements thereof. The study further clearly identified where new infrastructure should be located and what components, either existing or new, will be required.

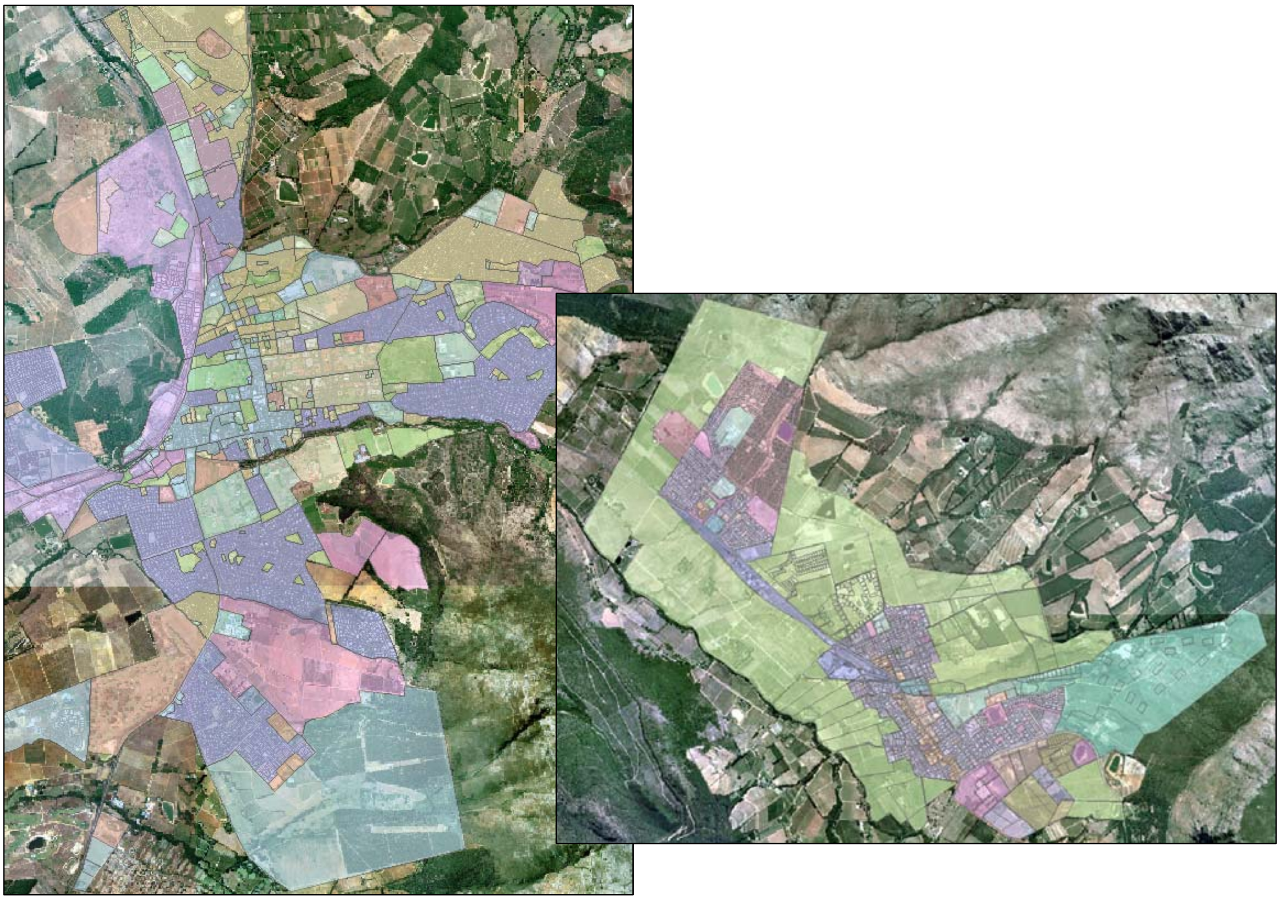


Figure 1-1: Study Area

This document reports on the above project objectives.

1.1 Document Structure

This report consists of two Volumes.

Volume A consists of a technical report providing fundamental methodology, data, analysis aspects, results recommendations with Volume B providing a geo-schematic presentation of proposed strengthening projects.

Volume A of this report consists of the following Sections:

Section 2 – Provides background with regard to the Methodology and Data that was used during the study,

Section 3 – Provides background to the Physical Field Inspection that was conducted at all substation and switching stations,

Section 4 – Discusses the approach that was followed to develop the Distribution Network Model,

Section 5 – Provides the Load Forecast, Methodology and Results,

Section 6 – Provides the analysis framework for the Distribution Network Assessment. Aspects such as network performance under various loading scenarios and results and recommendations to proposed network strengthening strategies are dealt with,

Section 7 - Provides the Capital and Financial Evaluation of the alternatives.

Various Addendums are also provided to support the study document.

The Addendums to the document includes:

Addendum A: Planning Criteria,

Addendum B: Refurbishment Audit and Methodology,

Addendum C: Network Assessment under Contingency,

Volume B provides a set of geographical diagrams that systematically show the network development plan for the Stellenbosch Distribution network.

2 Methodology and Data

2.1 Methodology

The Long-term expansion and strengthening plan followed the basic process as outlined in Figure 2-1. The Sections below provide a high-level description of the objective for each task displayed in the process.

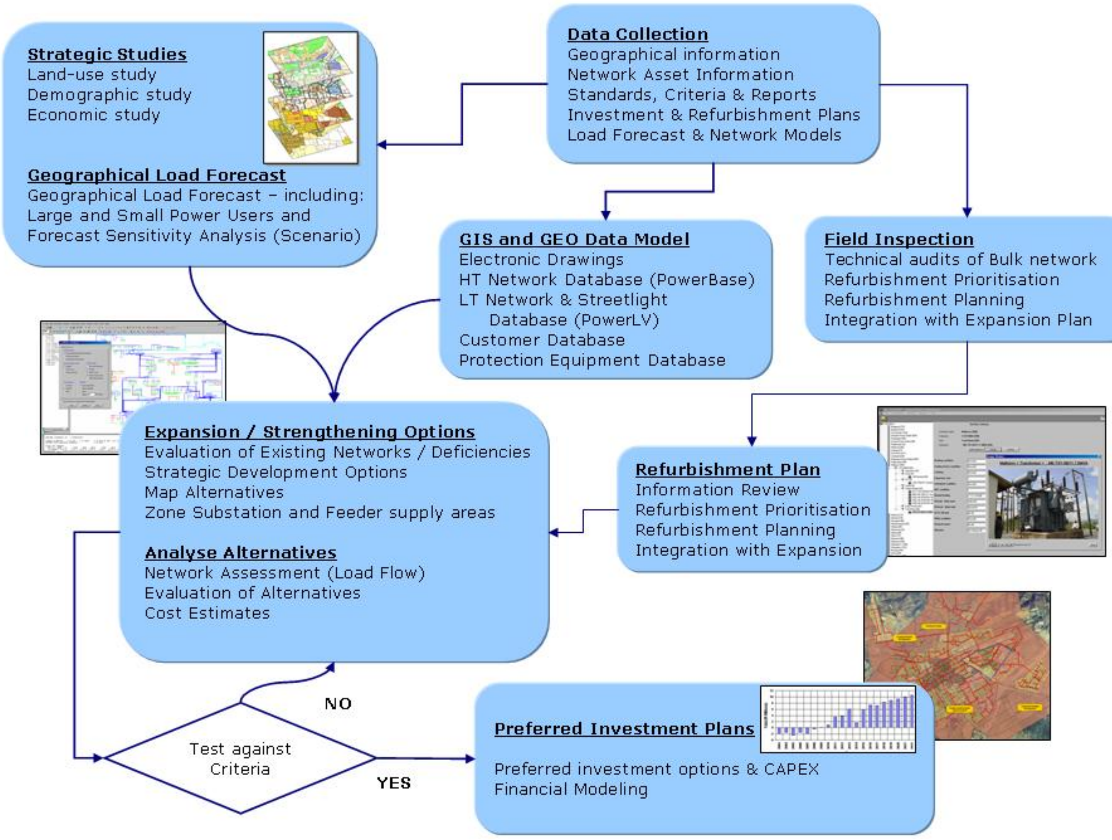


Figure 2-1: Network Expansion and Strengthening Planning Process

2.1.1 Information Review

During this task as much existing information as possible is obtained. Information includes mostly network and load related information. This task further entails the review of all obtained information.

2.1.2 Field Inspection

During this Task a field team performs data collection in all 66/11kV substations and 11kV switching substations within the study area. Information included all primary equipment and visual condition assessment inspections (Power Transformers, HV Instrument Transformers etc.) and Civil works.

2.1.3 Refurbishment Plan

During this Task site specific assessment were conducted to provide a systematic across the board estimate of the life remaining in substation and line facilities, and in conjunction with the life extension methodologies, provide a plan to extend that life to meet future needs.

2.1.4 Load Forecast

The load forecast is a crucial input to the network strengthening study. During this task a load forecast is developed that is based on regional demographic and historical load growth patterns. The anticipated long-term load forecast is directly used as input to the long-term expansion plan.

2.1.5 Distribution Model

The objective of this Task was to develop an adequate network model representing the entire Stellenbosch Distribution network up-to 11kV main feeder level. Various load points, representing the feeder load will be modelled at sufficient intervals along the feeder to assess adequacy in terms of thermal and voltage criteria.

2.1.6 Strengthening Options and Technical Evaluation

The objective of this task was to identify network-strengthening options and to perform technical evaluations to ensure that load and performance criteria are met.

Network analysis will aim to test compliance with the following minimum requirements:

- Thermal loading,
- Voltage standards, and
- Contingency requirements.

2.1.7 Cost Estimates

The objective of this task was to estimate the cost of the technically viable options. The cost estimates are based on the requirements for:

- Expansion and Strengthening, and
- Refurbishment projects.

2.2 Data

2.2.1 Documentation

The following information was received for review purposes:

- Previous planning reports,
- Historical billing information for key customers: Key Customer information (KWh and KVA readings for 2005) was obtained in hard copy for both

Stellenbosch and Franschhoek. These were documented in an excel spreadsheet. Meter factor information was obtained from the financial department and used to calculate Key customer maximum demand figures for 2005.

- Mini-substation readings for Stellenbosch were obtained and documented in an excel spreadsheet,
- Load data for distribution substations and feeders were obtained from the telemetry system for both Stellenbosch and Franschhoek.
- Historical Eskom supply information (three years),
- Land-use information was obtained from GIS Global Image as well as TV3. Discussions with regard to new developments were also conducted with Dennis Moss and Partners.
- Development initiatives as discussed with Town Planners,
- Spatial development Framework for Franschhoek developed by Taylor, van Rensburg and van der Spuy,
- Existing network single line diagrams for Stellenbosch HV / MV networks.

2.2.2 Other Information

The following is a list of information that was sourced by NETGroup or obtained from other organizations that was used to develop portions of the Geographical Load Forecast:

- Ortho photos (Obtained form the Department of Land Affairs),
- Cadastral information, and
- Basic topological information.

2.3 Software

2.3.1 Mapping

All mapping and geographical presentation of information and data was done using ESRI ArcMap 9 and Microstation CAD Ver8.0.

2.3.2 Network Analysis

The PTI power flow analysis program, PSS/Adept Rev 5.0 was used throughout the analysis.

3 Field Inspection

3.1 Background and Objective

The objective of this activity was to capture equipment information on the existing network elements, within substations. A field team performed data collection in all 66/11kV substations and 11kV switching substations within the study area. Information included all primary equipment (Power Transformers, HV Instrument Transformers etc.) and Civil works. Visual condition assessment inspections were also conducted.

3.2 Inspection Outcome

The information and findings of the physical inspection were used primarily as input to the:

- Network Model to allow load flow, contingency and scenario analysis, and
- Refurbishment analysis.

3.3 General Findings and Network Condition

The following are general findings and comments regarding the Stellenbosch and Franschhoek networks:

- The Franschhoek substation and switching stations are in an exceptionally good condition, any of which could be used as an example of a well maintained station,
- The Stellenbosch network is ageing and this is evident by the old equipment still in use. Some of the building structures are also showing ageing,
- 90% of all the switching stations do not have security fences which might be problematic and can lead to unwanted access and vandalism,
- The stations with security fences have been damaged, graffiti is evident with vegetation having grown in the yards,
- Most switching stations do not have ceilings. Dust and leaves filter through and gives the impression that the stations have not been cleaned out for an extended period of time,
- The switching stations with ceilings however are damaged through water leaks,
- In some buildings, cable trench covers have been removed and not replaced,
- Old unused and redundant equipment is stored or lying around in certain stations,
- Both Bison Board and Boord stations, battery systems have been neglected to such an extent that protection systems could be inoperative,

- Kayamandi station, circuit breaker covers have been removed.

All captured information was documented in a refurbishment system from which refurbishment analysis was conducted.

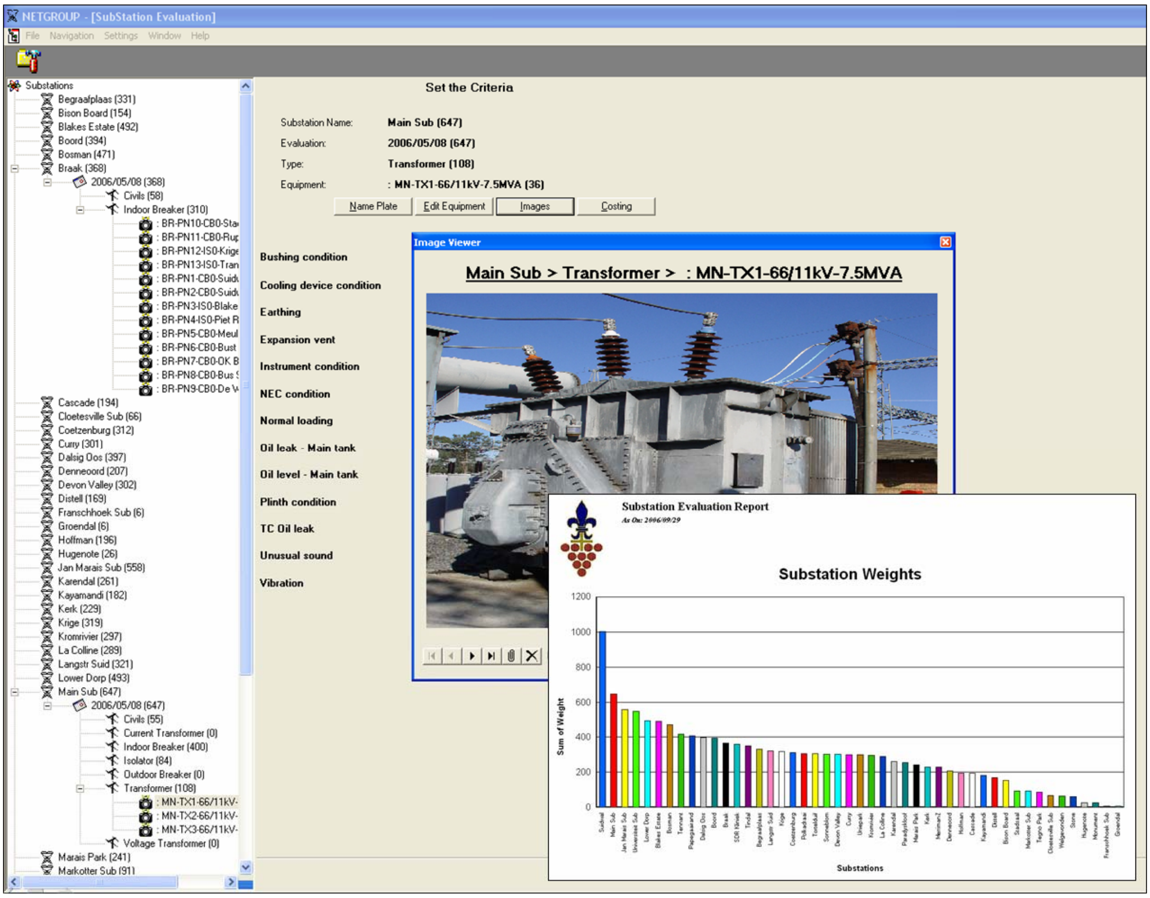


Figure 3-1: Refurbishment System

4 Distribution Network Model

4.1 Distribution Model

The objective of this task was to develop an adequate network model representing the entire Stellenbosch and Franschhoek Distribution networks up-to 11kV main feeder level. A main feeder was defined as the main feeder being supplied from a distribution substation protected through a feeder circuit breaker. The main feeder model did not include spur networks or transformers supplied from this feeder. Various load points, representing the feeder load were modelled at sufficient intervals along the feeder to assess adequacy in terms of thermal and voltage criteria.

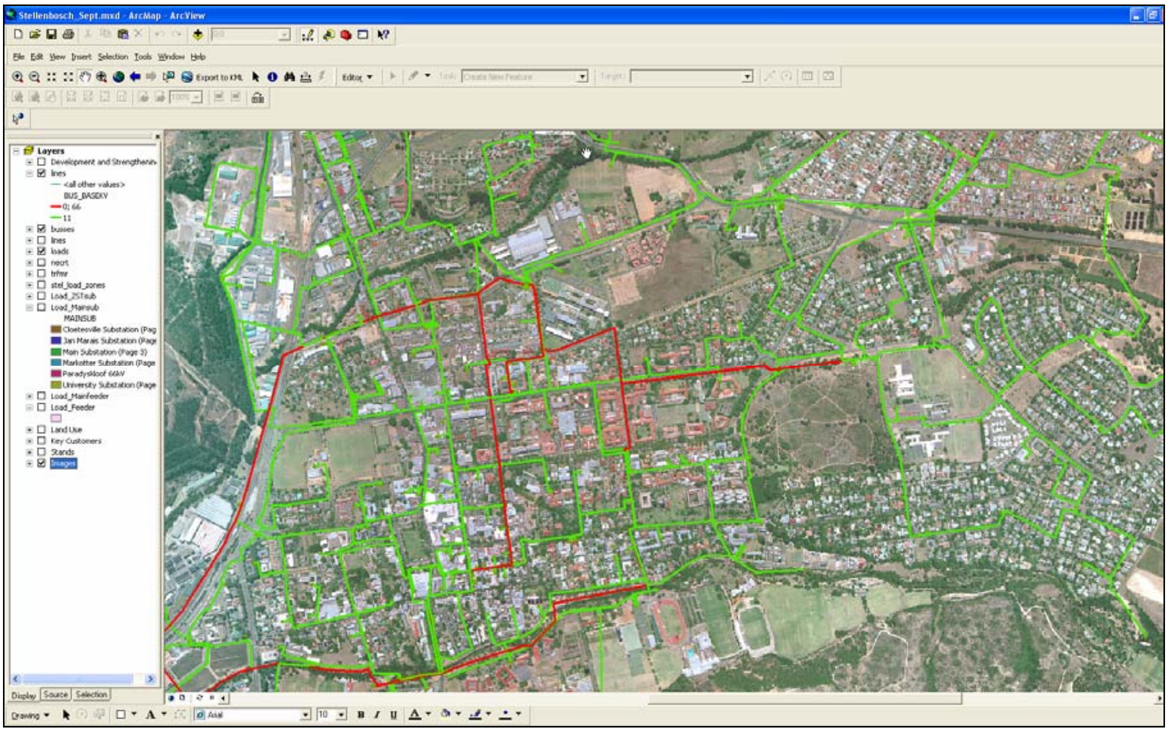


Figure 4-1: Overview of the Stellenbosch Geographical Distribution Model

Figure 4-1 provides an overview of the Distribution model within ArcMap.

Figure 4-2 shows the Stellenbosch network in PTI's PSS/Adept that was used for load flow and contingency analysis.

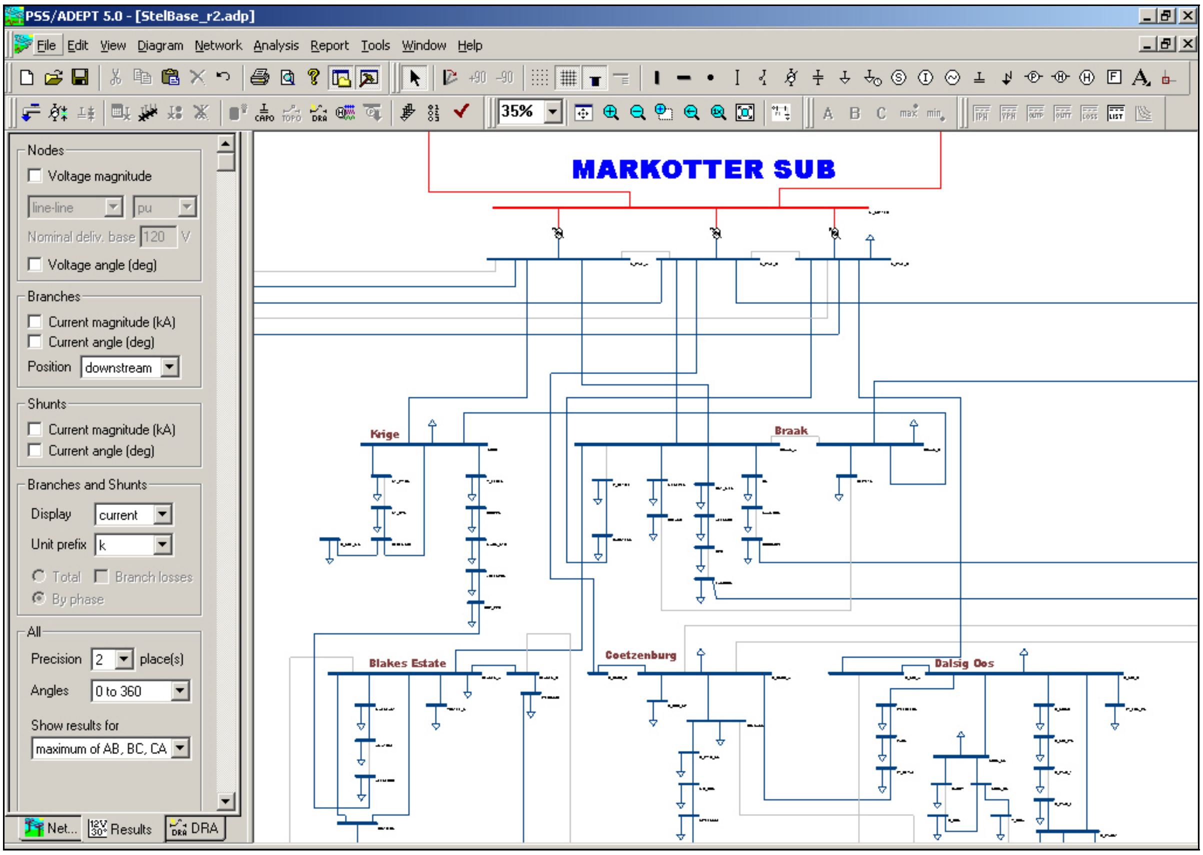


Figure 4-2: Distribution Network in PSS/Adept

5 Load Forecast

5.1 Demand Forecast

5.1.1 Background

A comprehensive Demand - and Energy forecast was required to establish:

- The basis for the distribution system expansion plan, and
- A basis for the future forecast purchases, and sales of Energy, and Maximum Demand per customer category.

A 20 year Demand and Energy forecast was developed based on international best practice techniques. The load forecasting technique was based on the research done by H. Lee Willis from North Carolina, USA and as documented in his reputable text book "Spatial Electric Load Forecasting" dated 1996.

5.2 Methodology

The load forecast is deterministic in nature and was performed in NETGroup's PowerGLF application where the loads were summated, taking load diversity into account, for each transformer zone.

The load forecast used as basis:

- Futuristic economic information,
- Demographic data,
- Available land use data, and
- Future development initiatives.

The summation hierarchy used to complete the Geographical Load Forecast is shown below:

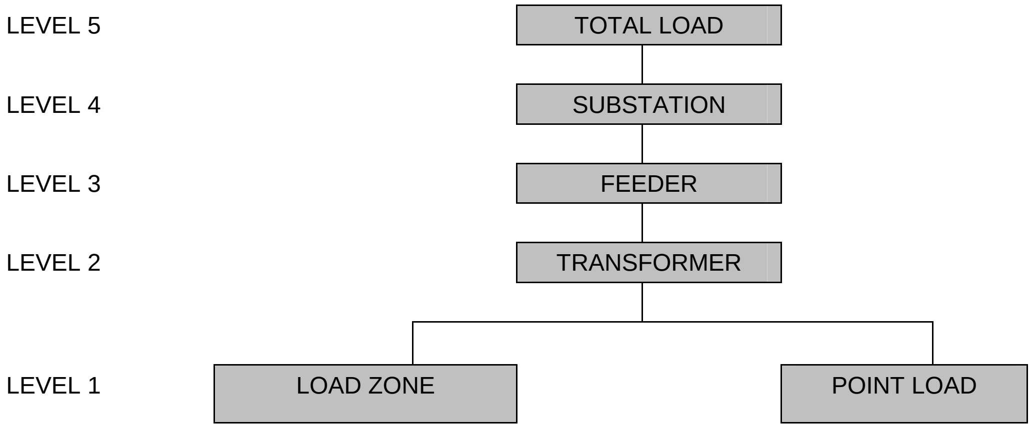


Figure 5-1: Summation Hierarchy

5.2.1 Strategic Inputs

A development perspective was obtained from the Spatial Development framework that was developed by Urban Dynamics.

5.2.2 Geographical Load Zoning

The complete study area was zoned in order to obtain a geographical base for the load forecast. The load zones varied in size depending on the activity and density of a specific area. The load zone boundaries follow existing transformer supply areas. This is important to be able to derive the current load per load zone. Arial photography, as illustrated, as well as cadastral information was used to further guide this zoning. All load zones were captured in a GIS as database, which enabled proper reporting.

A typical portion of the load zones as captured in ArcMap is shown below:

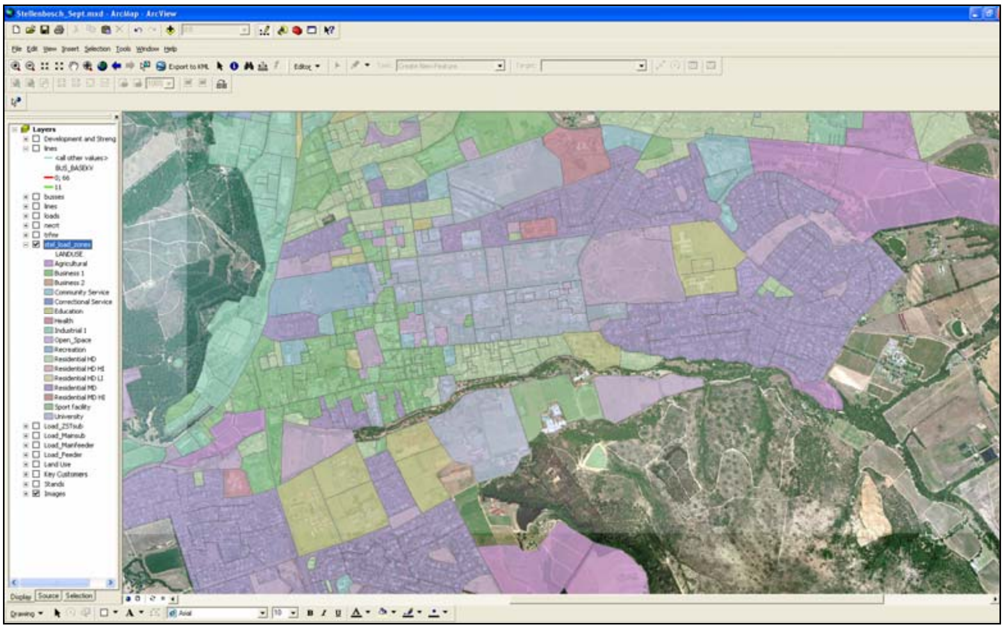


Figure 5-2: Stellenbosch Load Zones According to Land-use

5.2.2.1 Land-use Characteristics

The number of load classifications that was used in the load forecast was determined in consultation with Stellenbosch Municipality. Weekly load profiles for a number of these classifications were further measured. The table below shows the definitions for the various classifications that were used.

	Land Use Data	
Land Use ID	**Land Use Description**	**Profile ID**
AGR	Agricultural	AGR
BUS-1	Business 1	BUS-1
BUS-2	Business 2	BUS-2
COM-S	Community Service	COM-S
COR-S	Correctional Service	COR-S
EDU	Educational	EDU
HEL	Health	HEL
IND-1	Industrial 1	IND-1
OS	Open Space	OS
REC	Recreation	REC
H-D	High Density Residential	H-D
H-D, L-I	High density – Low income Residential	H-D, L-I
H-D, H-I,	High density – High income Residential	H-D, H-I
M-D	Medium Density Residential	M-D
M-D, H-I	Medium Density – High income Residential	M-D, H-I
SF	Sport Facility	SF
UV	University	UV

Table 5-1: Land Use Type Matrix

5.2.2.2 Large Customers

A total number of 106 key customers were identified from the available billing data and were geographically positioned on the GIS. Modelling the large customers as point loads substantially increased the overall accuracy of the forecast.

5.3 Geographical Load Forecasting

5.3.1 Set-up Load Forecast Database

All load zones were entered into PowerGLF and linked to the GIS. This enabled reporting on maps, providing a visual perception of growth areas. The measured load profiles per load classification were further linked and calibrated to load zones.

5.3.2 Short- and Long-term Forecasting

For the Long-term forecast, the inputs from the development perspective were used to determine saturation loads. An S-curve was fitted between the Short-term forecast and the saturation load. The PowerGLF package automates a substantial portion of the above-mentioned process.

Special attention was given to the previously mentioned, envisaged development initiatives.

5.4 Base Load Verification

5.4.1 Check Load Densities

The calculation of existing land use load must be equal to the existing load measured. It must be ensured that when the load density is multiplied by the area of the load zone and then multiplied by the coincidence factor, with regard to the maximum time value for that supply zone, the different summated load should be equal to the measured value for that supply zone.

This calculation is done by using the load densities and load portion area and then multiplying that with the specific day profile for the maximum of the supply area. The different load zones are then summated to find a new daily profile, which is then normalized back to the measured theoretical profile. This determines the initial load zones load and also the initial density of each load zone.

5.4.2 Allocate Correct S-Curves

The S-Curves were chosen to simulate a specific land use “road” to saturation. The S-curve’s are mathematically defined as follow:

$$f(n) = A + \frac{D}{(1 + C \cdot e^{-B \cdot n})} \qquad (5.1)$$

Where:

- A defines the initial departure point in per unit,

- B defines the time till saturation,
- C defines the initial slope of the S-Curve, and
- D is always one.

The S-Curves that were used are shown in the following Figure 5-3:

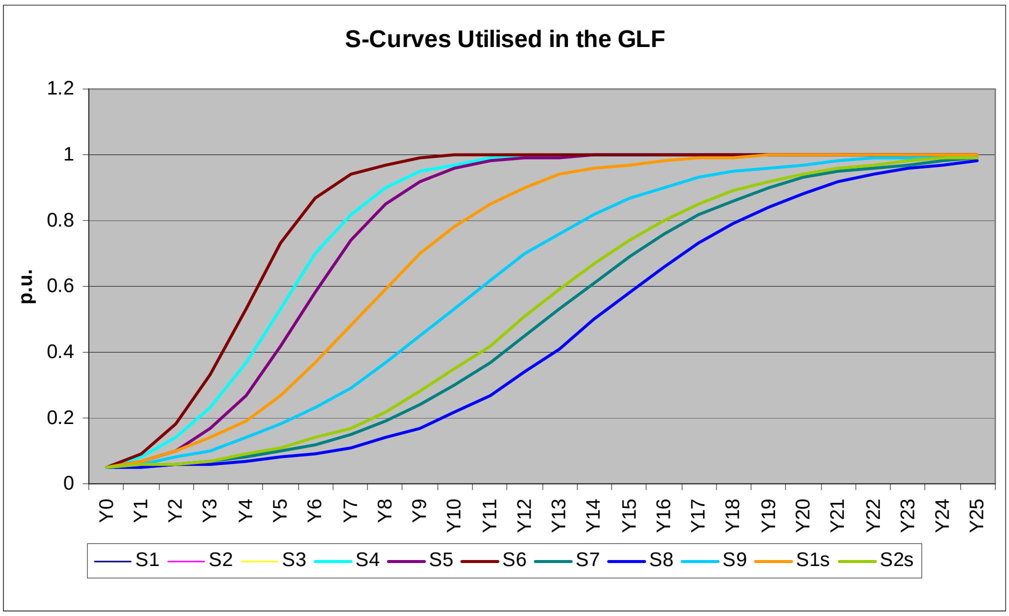


Figure 5-3: Load Category S-Curves

The different types of land uses were appointed different S-curves as follows:

Land Use Data		
Land Use ID	Profile ID	S Curve ID
Business 1	BUS-1	S5
Business 2	BUS-2	S1
Community Service	COM-S	S1 S
Correctional Service	COR-S	S9
Educational	EDU	S2
Health	HEL	S2 S
Industrial 1	IND-1	S9
Recreation	REC	S9
High Density Residential	H-D	S9
High density – Low income Residential	H-D, L-I	S9
High density – High income Residential	H-D, H-I	S9
Medium Density Residential	M-D	S9
Medium Density – High income Residential	M-D, H-I	S9
Sport Facility	SF	S6
University	UV	S4

Table 5-2: Load Category S – Curves

The allocation of S-Curves was based on experience in other utilities and should be sufficient to describe the growth pattern.

5.4.3 Confirm Growth

After the first calculation has been done the growth of each load zone is monitored to ensure that no irregular growth takes place. In the event of a load zone that has no land use change, the growth pattern is expected to be normal load growth of say an annual rate of 3%.

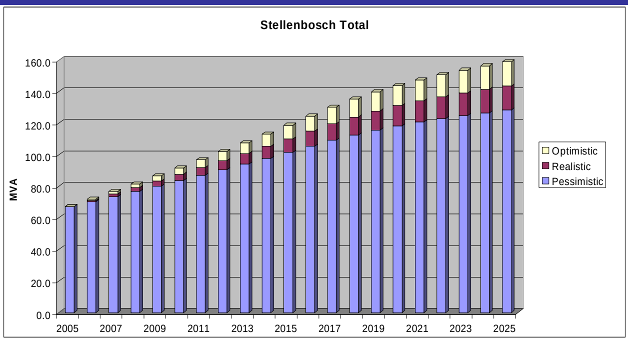
Land use changes that do occur will also be limited to similar land use density in that same supply area (although some exceptions can occur). These are all checked and densities modified until all growth rates are within expectations.

5.4.4 Verify Total Load

The diversified summated forecast to the top level, namely infeed supply areas must also be acceptable. Historically measured loads are always a good reference to determine whether the forecast is valid.

5.5 Results

The calculated value corresponds to an average yearly growth of 4.0% from year 2006 to 2025 for the region. Graphs showing the annual demand growth and installed transformer capacity are shown below.

Existing Transformer Load Substation / Description	Load Profile
Stellenbosch Total	

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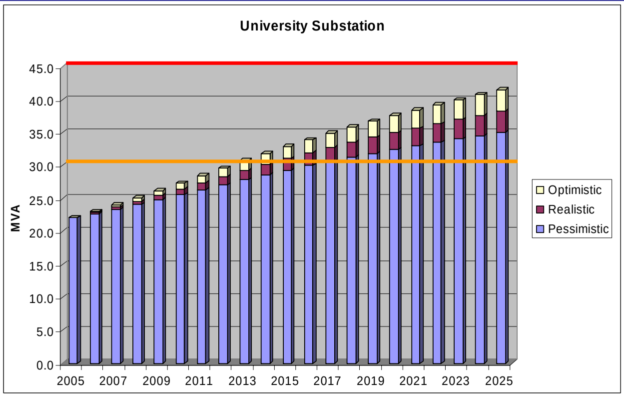
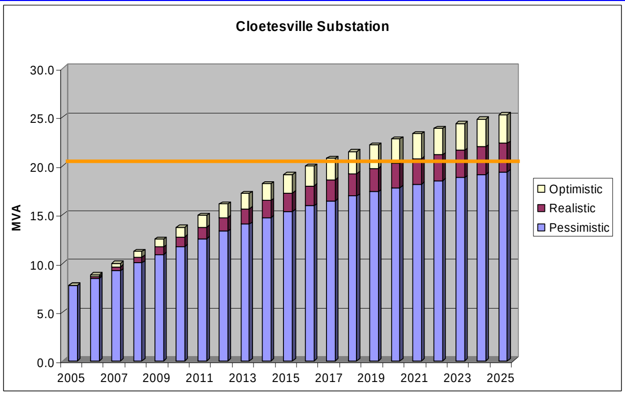
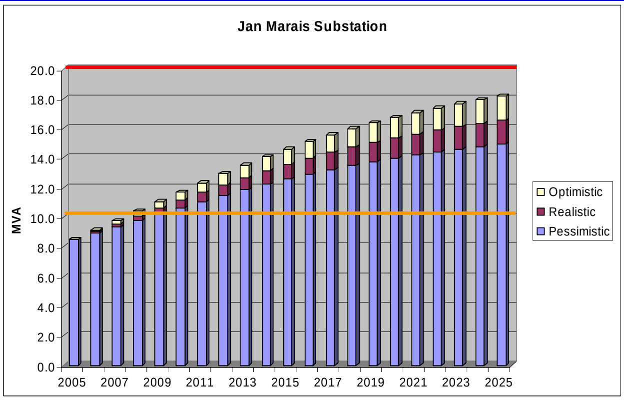
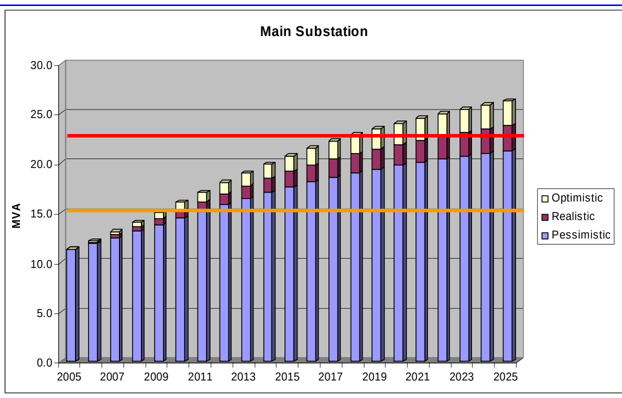
Existing Transformer Load Substation / Description	Load Profile
University Substation ▪ Load 2006 – 22,9MVA ▪ Load 2025 – 38,3MVA ▪ Firm Capacity – 30MVA at 2014 ▪ Installed Capacity – 45MVA	
Cloetesville Substation ▪ Load 2006 – 8,7MVA ▪ Load 2025 – 22,3MVA ▪ Firm Capacity – 20MVA at 2020 ▪ Installed Capacity – 40MVA	
Jan Marais Substation ▪ Load 2006 – 9,0MVA ▪ Load 2025 – 16,6MVA ▪ Firm Capacity – 10MVA at 2008 ▪ Installed Capacity – 20MVA	
Main Substation ▪ Load 2006 – 12,0MVA ▪ Load 2025 – 23,8MVA ▪ Firm Capacity – 15MVA at 2010 ▪ Installed Capacity – 22.5MVA at 2022	

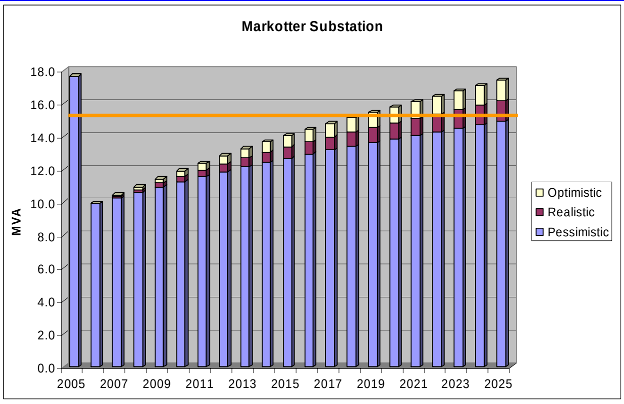
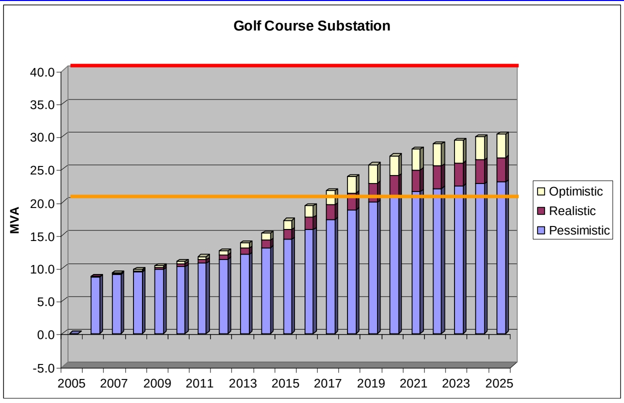
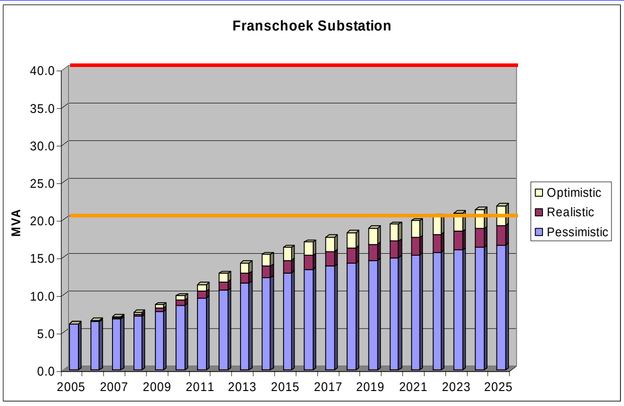
<table>
<tr><th>Existing Transformer Load
Substation / Description</th><th>Load Profile</th></tr>
<tr><td>Markotter Substation
▪ Load 2006 – 9,9MVA
▪ Load 2025 – 16,2MVA
▪ Firm Capacity – 15MVA at 2021
▪ Installed Capacity – 22.5MVA</td><td>
</td></tr>
<tr><td>Golf Course Substation
▪ Load 2006 – 8,6MVA
▪ Load 2025 – 26,7MVA
▪ Firm Capacity – 20MVA at 2018
▪ Installed Capacity – 40MVA</td><td>
</td></tr>
<tr><td>Franschoek Substation
▪ Load 2006 – 6,5MVA
▪ Load 2025 – 19,2MVA
▪ Firm Capacity – 20MVA
▪ Installed Capacity – 40MVA</td><td>
</td></tr>
</table>

Table 5-3: Stellenbosch Municipality Expected Yearly Demand Growth

Substation	Installed	Capacity	Ferm	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Main Substation	Pessimistic	22.5	15	11.3	11.9	12.5	13.1	13.8	14.5	15.1	15.8	16.4	17.0	17.6	18.1	18.6	19.0	19.4	19.8	20.1	20.4	20.7	21.0	21.3
	Realistic	22.5	15	11.3	12.0	12.8	13.6	14.4	15.3	16.1	16.9	17.7	18.5	19.2	19.8	20.4	20.9	21.4	21.9	22.3	22.7	23.1	23.4	23.8
	Optimistic	22.5	15	11.3	12.2	13.1	14.0	15.0	16.0	17.1	18.0	19.0	19.9	20.7	21.5	22.2	22.9	23.5	24.0	24.5	25.0	25.4	25.8	26.3
Jan Marais Substation	Pessimistic	20	10	8.5	8.9	9.4	9.8	10.2	10.6	11.1	11.5	11.8	12.2	12.6	12.9	13.2	13.5	13.7	14.0	14.2	14.4	14.6	14.8	14.9
	Realistic	20	10	8.5	9.0	9.6	10.1	10.6	11.2	11.7	12.2	12.7	13.1	13.6	14.0	14.4	14.7	15.1	15.4	15.6	15.9	16.1	16.3	16.6
	Optimistic	20	10	8.5	9.1	9.8	10.4	11.1	11.7	12.3	12.9	13.5	14.1	14.6	15.1	15.5	16.0	16.4	16.7	17.1	17.4	17.6	17.9	18.2
Cloetesville Substation	Pessimistic	40	20	7.7	8.5	9.3	10.1	10.9	11.7	12.5	13.3	14.0	14.7	15.3	15.9	16.4	16.9	17.3	17.7	18.1	18.5	18.8	19.1	19.4
	Realistic	40	20	7.7	8.7	9.6	10.6	11.7	12.7	13.7	14.7	15.6	16.4	17.2	17.9	18.6	19.2	19.7	20.2	20.7	21.1	21.6	21.9	22.3
	Optimistic	40	20	7.7	8.8	10.0	11.2	12.5	13.7	14.9	16.1	17.1	18.2	19.1	20.0	20.7	21.5	22.1	22.7	23.3	23.8	24.3	24.8	25.2
Markotter Substation	Pessimistic	22.5	15	17.6	9.9	10.3	10.6	10.9	11.2	11.5	11.9	12.1	12.4	12.7	12.9	13.2	13.4	13.6	13.8	14.1	14.3	14.5	14.7	14.9
	Realistic	22.5	15	17.6	9.9	10.3	10.8	11.2	11.6	12.0	12.3	12.7	13.0	13.4	13.7	14.0	14.3	14.5	14.8	15.1	15.4	15.6	15.9	16.2
	Optimistic	22.5	15	17.6	9.9	10.4	10.9	11.4	11.9	12.4	12.8	13.2	13.7	14.0	14.4	14.8	15.1	15.5	15.8	16.1	16.4	16.8	17.1	17.4
Golf Course	Pessimistic	40	20	0.0	8.6	9.0	9.3	9.7	10.1	10.6	11.2	12.0	13.0	14.3	15.8	17.3	18.7	19.9	20.8	21.5	22.0	22.4	22.8	23.0
	Realistic	40	20	0.0	8.6	9.1	9.5	10.0	10.6	11.2	11.9	12.9	14.2	15.8	17.6	19.5	21.3	22.8	23.9	24.8	25.4	25.9	26.3	26.7
	Optimistic	40	20	0.0	8.6	9.2	9.7	10.3	10.9	11.7	12.6	13.7	15.2	17.2	19.4	21.7	23.8	25.6	27.0	28.0	28.7	29.3	29.8	30.3
University Substation	Pessimistic	45	30	22.1	22.7	23.4	24.1	24.8	25.6	26.3	27.1	27.9	28.6	29.3	30.0	30.6	31.3	31.9	32.4	33.0	33.5	34.0	34.5	35.0
	Realistic	45	30	22.1	22.9	23.7	24.6	25.5	26.4	27.4	28.4	29.3	30.2	31.1	32.0	32.8	33.6	34.3	35.0	35.7	36.4	37.0	37.6	38.3
	Optimistic	45	30	22.1	23.0	24.0	25.1	26.2	27.3	28.5	29.6	30.7	31.8	32.9	33.9	34.9	35.9	36.7	37.6	38.4	39.2	40.0	40.7	41.5
Stellenbosch Total	Pessimistic	190	110	67.3	70.4	73.6	76.8	80.2	83.6	87.1	90.6	94.2	97.8	101.6	105.4	109.2	112.6	115.7	118.5	120.8	122.9	124.9	126.7	128.4
	Realistic			67.3	71.2	75.2	79.2	83.4	87.7	92.0	96.4	100.9	105.5	110.2	115.0	119.6	124.0	127.9	131.2	134.2	136.9	139.3	141.6	143.7
	Optimistic			67.3	71.9	76.8	81.6	86.6	91.8	97.0	102.2	107.6	113.1	118.8	124.5	130.1	135.3	140.0	144.0	147.6	150.8	153.7	156.4	159.0
Franschoek Substation	Pessimistic	40	20	6.1	6.4	6.8	7.1	7.8	8.6	9.6	10.6	11.5	12.3	12.9	13.4	13.8	14.2	14.6	15.0	15.3	15.6	16.0	16.3	16.6
	Realistic	40	20	6.1	6.5	6.9	7.4	8.2	9.2	10.5	11.7	12.9	13.8	14.6	15.2	15.8	16.3	16.7	17.2	17.6	18.0	18.4	18.8	19.2
	Optimistic	40	20	6.1	6.6	7.1	7.7	8.7	9.9	11.3	12.9	14.2	15.4	16.3	17.0	17.7	18.3	18.9	19.4	19.9	20.4	20.9	21.4	21.9

Table 5-4: Substation Transformer Firm / Installed Capacity vs. Loading

6 Distribution Network Assessment

The following sections present aspects of the technical evaluation which include network analysis as well as operational considerations and results for the Stellenbosch and Franschhoek networks.

6.1 Network Analysis

Network simulations were conducted on the existing and future Stellenbosch and Franschhoek networks. Network simulations included:

- System Healthy analysis. Analyses were conducted on various network load level and configurations to effectively identify thermal and voltage violations occurring due to existing and future load growth. Alternatives were identified and tested to ensure technical viable solutions to these violations.
- Selective Contingency analysis was further carried out where a specific network element was taken out of service and the result thereof tested through a load flow. In order to relief voltage and flow violations identified during the contingency analysis, the addition or upgrade of network facilities was identified and tested technically.

6.2 System Healthy Analysis

The following sections deals with both the Stellenbosch and Franschhoek networks during system healthy conditions. Each section makes specific reference to a substation and its associated sub-systems dealing with the existing network topology, expected load forecast, proposed most effective network configuration (open point optimization) as well development requirements (Substation transformer and MV network expansion requirements). The capital requirements to achieve the development objectives are provided in Section 7 of this report.

6.2.1 Main 66/11 KV Substation

6.2.1.1 Background

This substation is situated next to the Eskom 132 kV Substation, with 3 x 7.5 MVA 66/11 kV transformers. The supply area is situated on the Western side of Stellenbosch on either side of the main road from Kuils River. The 11 kV substations supplied by this substation include Devon Valley, Begraafplaas, Lowerdorp, Tortelduif, Distell and Polkadraai. Various tie-feeders exist, including the Lowerdorp to Suidwal and Blakes Estate Substations tie-feeders.

6.2.1.2 Load Forecast

The Load Forecast Model was balanced with the latest telemetry data, as well as inputs from the Structure plan and future developments. The present maximum demand is approximately 13MVA and is expected to increase to 25MVA over the planning period. The load forecast results for Main substation is shown in Figure 6-1.

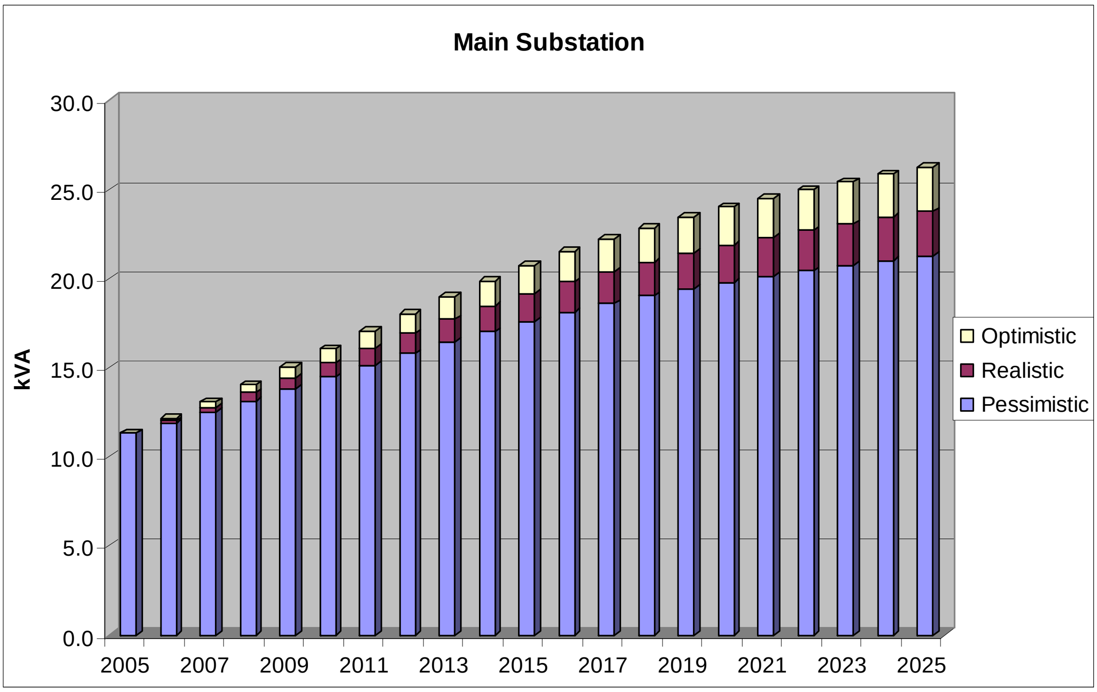


Figure 6-1: Main Substation Load Forecast Results

6.2.1.3 Open Points

Optimal open points were determined through load flow studies.

The following open points are proposed:

- Mainsub Bus B – Bison Board,
- Begraafplaas Bus A – Begraafplaas Bus B,
- Begraafplaas – Mondi Timbers,
- Begraafplaas – Lower Dorp,
- Devon Valley – Tortelduif,
- Loerie – Jan Frederick,
- WPK – Sonop,
- FBC – Gilbeys kantore,
- SFW – Vineyard,
- Riool / Kragopwekker – Riool / Damme,
- Begraafplaas – Distell,
- Lowerdorp – Suidwal (both feeders), and

- Lowerdorp – Weidenhof.

6.2.1.4 Network Analysis

6.2.1.4.1 Main 66/11 kV Substation

The existing 3 x 7.5 MVA 66/11 kV transformers will reach firm capacity by 2014 and will reach supply capacity in 2022. It is proposed to replace the 3 x 7.5 MVA 66/11 kV transformers with 3 x 15 MVA 66/11 kV transformers before 2014.

6.2.1.4.2 Bison Board Ring

The Bison Board supply consists of 3 x 95 mm^2 Cu cables, with a firm capacity of 7.6MVA. The Bison Board load forecast shows 2.4 MVA at the end of the planning period, which is within the capacity of the supply cables. The municipality however indicated that Bison Board will terminate their operations at the current plant in 2009.

6.2.1.4.3 Devon Valley Sub-system

The loading on the Devon Valley feeder increases from 3.2MVA to 4.5MVA over the planning period. The supply cable is currently a 150 mm^2 Al cable, with a 4.5 MVA capacity. An alternative supply is available from Begraafplaas Substation for contingency of the Devon Valley feeder. This alternative feed from Begraafplaas however is only possible with both Industry - Begraafplaas supply cables in service, and the Begraafplaas buscouplers closed. The Tortelduif feeder is within capacity for the planning period. The Geluksoord feeder will reach its thermal limits at the end of the study period.

6.2.1.4.4 Begraafplaas Sub-system

Begraafplaas Substation is supplied via 2 x 185 mm^2 Cu cables, with a firm capacity of 6.4 MVA. The load is expected to increas to 6.7MVA over the planning period. Although the anticipated load is more than the firm capacity, load can be moved by feeding Lowerdorp from Suidwal under contingency of one of the Main – Begraafplaas feeders.

6.2.1.4.5 Lowerdorp Sub-system

Lowerdorp is situated on the Begraafplaas/Lowerdorp/Suidwal 185 mm^2 Cu ring, with a firm capacity of 6.4MVA, and has an alternative supply from Blakes Estate. The current load of Lowerdorp is 1.3MVA and it is anticipated that this load will increase to 2.7MVA towards the end of the study period. Lowerdorp Substation can therefore be supplied without a problem.

6.2.1.4.6 Distell 11 kV Ring

Distell forms part of the Begraafplaas/Distell/Polkadraai ring, which is a 150 mm^2 Al cable with 4.5MVA capacity. The Distell/Polkadraai load increases from the current 4.2MVA to 10.8MVA over the planning period, which is more than the current cable capacity. To overcome the supply problem it is proposed to operate the Main Substation – Polkadraai, Main Substation Distell and Polkadraai – Distell feeders close in the medium term (2008). A 2nd Main Substation – Polkadraai 150 mm^2 Al cable needs to be installed to provide necessary supply capacity on the long term (2014).

6.2.1.5 Network Development and Strengthening

The following projects are required to develop and strengthen the Main Substation networks. (The progressive development of these projects is shown geographically in Volume B of this report);

- 2008: Devon Valley – RMU 11kV Feeder,
- 2014: Main Substation Transformers,
- 2014: Main Substation – Polkadraai 11kV Feeder.

6.2.1.5.1 Devon Valley – RMU 11kV Feeder

The 16mm² Cu cable between Devon Valley and Oord (radial) will not be able to supply the future load under normal conditions. It is proposed to install a RMU between Hagen and Riool. This RMU will be supplied with a 70mm² Cu cable (500m) from Devon Valley and needs to be in operation in 2008.

6.2.1.5.2 Main Substation Transformers

The existing 3 x 7.5 MVA 66/11 kV transformers will reach firm capacity in 2014 and will reach supply capacity in 2022. It is proposed to replace the 3 x 7.5 MVA 66/11 kV transformers with 3 x 15 MVA 66/11 kV transformers in 2014.

6.2.1.5.3 Main Substation – Polkadraai 11kV Feeder

A 2nd Main Substation – Polkadraai 150 mm² Al cable (500m) should be installed to provide the necessary supply capacity in the long term. This cable should be in operation in 2014.

6.2.2 Markotter 66/11 KV substation

6.2.2.1 Introduction

This substation is situated next to the Eersterivier close to the Town Centre. The substation is equipped with 3 x 7.5 MVA 66/11 kV transformers. The main 11 kV substations supplied from this substation includes Dalsig Oos, Coetzenburg, Braak, Krige and Blakes Estate. Boord, Paradyskloof and Tegnopark that were previously supplied from Markotter are now supplied from the new Golf Course 66/11kV Substation. Many tie-feeders exist on the primary 11 kV network, including Suidwal – Lowerdorp, Coetzenburg – Bosman, Blakes Estate – Hofman and Braak – Stadsaal.

6.2.2.2 Load Forecast

According to the Load Forecast, the maximum demand will increase from 10MVA to 16.5MVA over the planning period. The load forecast results for Markotter substation is shown in Figure 6-2.

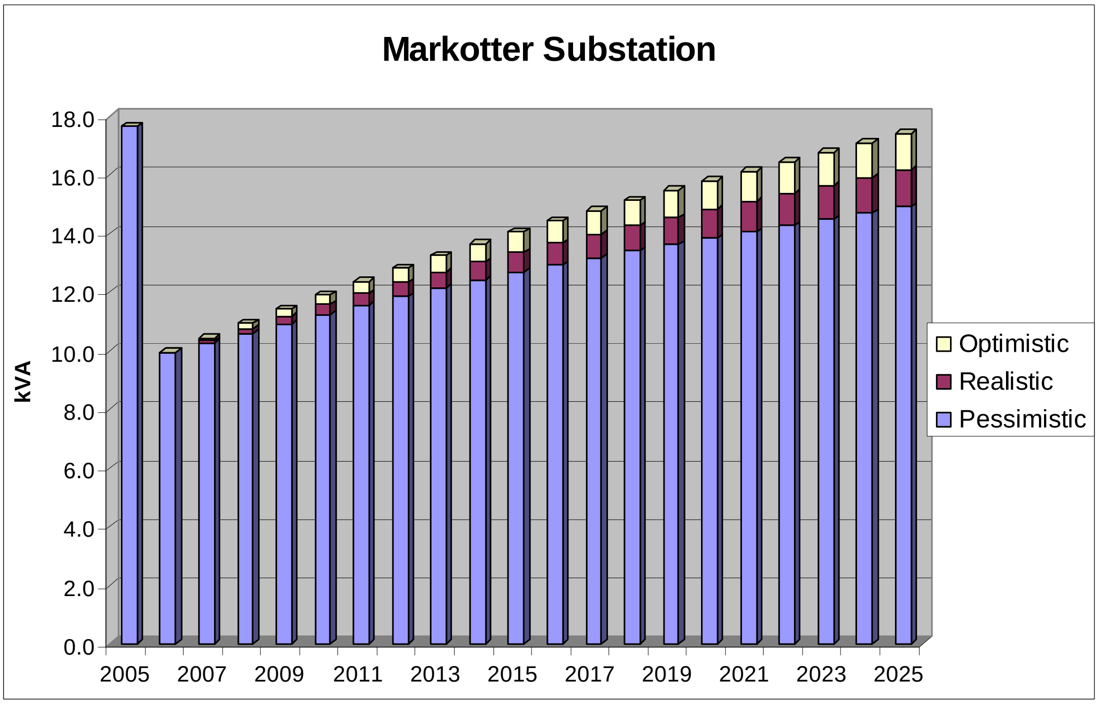


Figure 6-2: Markotter Substation Load Forecast Results

6.2.2.3 Open Points

Optimal open points were determined through load flow studies.

The following open points are proposed:

- Faber-Le Seur,
- Valerida-Gymnasium,
- Barry-Doornbosch,
- Die Laan-Ratray,
- Welgelegen-Park,
- Stellenryk – Bloemhof,
- Jolespark - Dorp/Papegaai,
- De Wets- Coetzenburg,
- Landros – Polisie,
- Rembrandt – Stadsaal,
- SA Perm –Stadsaal,
- Trust Bank-Eeste Nasionaal,
- Blakes Estate - Hofman 70 mm^2 Cu,

- Weidenhof – Lowerdorp,
- Stadsaal-Braak,
- Lower Dorp-Suidwal (both feeders),
- Boord - Suidwal (all three feeders),
- Boord-Dalsig Oos, and
- Brandwacht – Brandwacht 2.

6.2.2.4 Network Analysis

6.2.2.4.1 Markotter 66/11 kV Substation

From the load forecast it was shown that the total load can increase to 16.5MVA, with firm transformer capacity being 18MVA. Transformer No. 2 is expected to be overloaded by 2025. At this point bus-coupler 2 should be operated as normally closed.

6.2.2.4.2 Dalsig Oos Sub-system

Dalsig Oos is supplied from Suidwal Substation with a 185 mm² Cu cable and has an alternative supply from Boord Substation. The load forecast shows that the load is expected to increas from 3.1MVA to 4.7MVA over the planning period. The present network can supply this load for the planning period.

6.2.2.4.3 Dalsig Oos secondary 11kV Rings

<u>Binnekring/Brandwacht</u>

The Binnekring/Brandwacht ring is limited by some 25 mm² Al and 35 mm² Cu sections.

The loading on the ring will increase to 2.7 MVA over the planning period. The 25mm² Al cable between Brandwacht and Brandwacht 2 will not be able to supply the load under contingency conditions. This portion of feeder needs to be upgraded to at least 70mm² Cu cable (180m).

<u>Koch/Gymnasium/Coetzenburg</u>

The load on the Koch/Gymnasium/Coetzenburg ring increases to 2.47 MVA, which is within the 3.14 MVA capacity of the ring.

6.2.2.4.4 Coetzenburg Sub-system

Coetzenburg Substation is normally supplied from Suidwal Substation via a 185 mm² Cu cable, with alternative supplies from Bosman substation (185 mm² Cu) and Bosman substation (70 mm² Cu). The load forecast indicates that the load will increase from 1.6MVA to 2.4MVA, which is within the capacity of the supply cables.

6.2.2.4.5 Krige Sub-system

Krige Substation forms part of the Suidwal/Krige/Braak 185 mm² Cu ring. Braak Substation forms part of the Suidwal/Braak/Stadsaal and Braak/Blakes Estate/Lowerdorp 185 mm² Cu ring. The Braak busbar is normally open, with one section supplied from Krige and the other from Suidwal Substation. The Load Forecast

Model indicates that the load on the Braak/Krige ring increases from 2.6MVA to 4.1MVA. This ring will not be able to supply the full load for the planning period. (This is with Suidwal –Krige out of service.) The ring will be able to supply the load (with Suidwal-Krige out of service) if Blakes Estate is supplied from Lowerdorp and the Braak busbar coupler is closed (for the duration of the contingency only).

6.2.2.4.6 Braak Sub-system

Braak is supplied from Suidwal Substation with 2x 185 mm^2 Cu cables and has alternative supply from Stadsaal and Lower Dorp via Blakes Estates. The load forecast shows that the load increases from 2.7MVA to 5.34MVA over the planning period. The present network can supply this load for the planning period.

6.2.2.4.7 Braak secondary 11kV Ring

Blakes Estates

The load on the Braak/Blakes Estate/Lowerdorp 185 mm^2 Cu ring increases from 1.36MVA to 2.91MVA which is within the limit for the planning period.

6.2.2.5 Network Development and Strengthening

The following project is required to develop and strengthen the Markotter Substation networks.

- 2024: Brandwacht – Brandwacht 2 11kV Feeder.

6.2.2.5.1 Binnekring / Brandwaght Ring

The 25mm^2 Al cable between Brandwacht and Brandwacht 2 will not be able to supply the load under contingency conditions. This portion of feeder needs to be upgraded to 70mm^2 Cu cable (180m). This cable needs to be in operation in 2024.

6.2.3 New Golf Course 66/11 KV Substation

6.2.3.1 Introduction

This substation is situated next to the Stellenbosch Golf Course on the Stellenbosch – Somerset West road. The substation is equipped with 2 x 20 MVA 66/11 kV transformers. The supply area of this substation includes the areas adjacent to the substation and the areas alongside the main road to Somerset West. The main 11 kV substations supplied from this substation include Boord, Paradyskloof and Tegnopark. Various tie-feeders exist on the primary 11 kV network between Boord and Suidwal. No tie feeders exist for Paradyskloof and Tegnopark.

6.2.3.2 Load Forecast

The Load Forecast has shown that the maximum demand is expected to increase from 8.6MVA to 28MVA over the planning period. Most of this demand increase can be attributed to the new Golf Course development and hotel planned to the south of Stellenbosch, on the Eastern side of the Somerset West road. The load forecast results for the New Golf Course substation is shown in Figure 6-3.

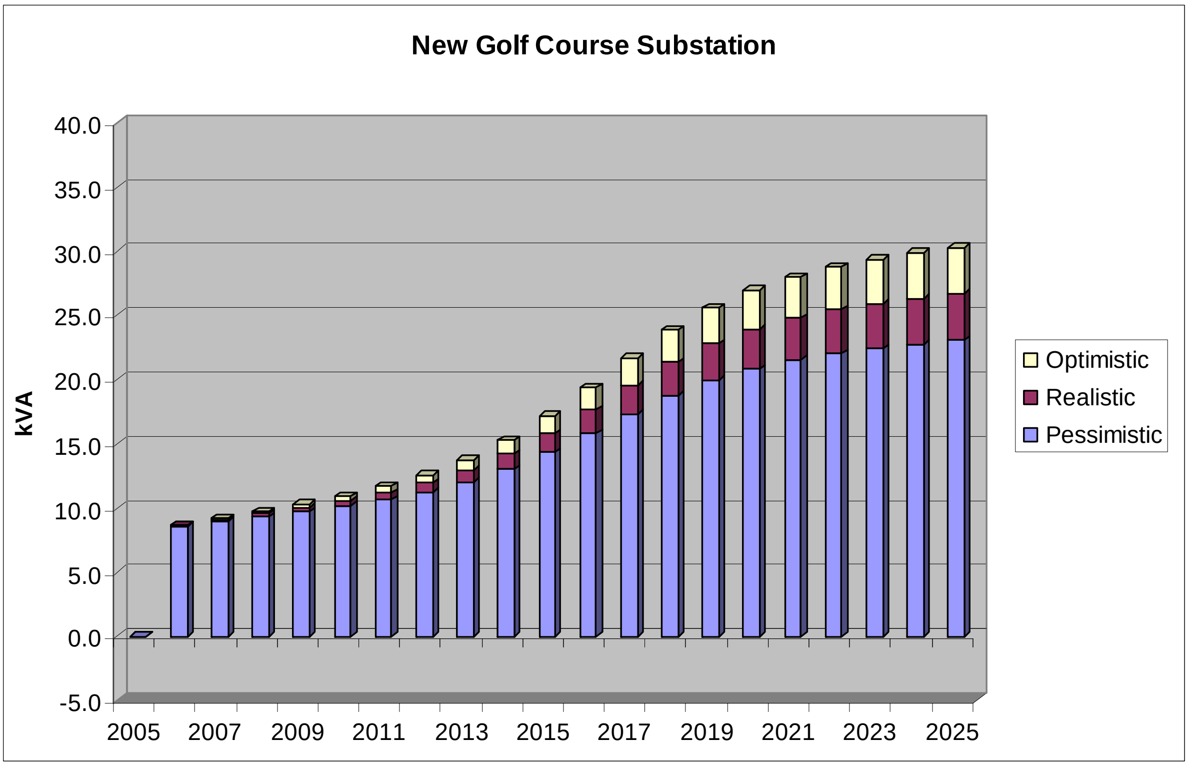


Figure 6-3: New Golf Course Substation Load Forecast Results

6.2.3.3 Open Points

Optimal open points were determined through load flow studies.

The following open points are proposed:

- New Golf Course bus-coupler,
- Boord bus-coupler,
- Tegnopark bus-coupler,
- Paradyskloof bus-coupler 2,

Boord - Suidwal (All 3 feeders),

- Dalsig – Boord,
- Die Werf – Wingerd,
- Lovell 1 – Lovell 2,
- Medi-Clinic – Culemburg,
- Tegnopark – Stellenpark Hotel,
- Termo – Elektron,
- Serruria – Padstal,
- Cyneroids – Repens, and

- MontBlanc – Paradyskloof RMU.

6.2.3.4 Network Analysis

6.2.3.4.1 New Golf Course 66/11 kV Substation

From the load forecast it was shown that the total load would increase to 28MVA, while firm capacity will be reached in 2020. It is proposed to install a 3rd 20MVA transformer in 2020.

6.2.3.4.2 Boord Sub-system

Boord is supplied from Golf Course Substation with 4x 90mm² Cu cables and has an alternative supply from Suidwal Substation via 3x 185mm² Cu cables. The load forecast shows that the load increases from 2.14MVA to 4.0MVA over the planning period. The present network can supply this load for the planning period. All 3 local ring feeders (Klein Geluk, Lovell, Rokewood) operate within their respective supply capacities for the planning period.

6.2.3.4.3 Tegnopark Sub-system

Tegnopark is supplied from Golf Course Substation with 2 x 70mm² Cu cables with a firm capacity of 3.4MVA. The load increases to 5.37MVA over the planning period. A third 70 mm^2 Cu feeder to Tegnopark is required by 2010 when firm capacity will be reached (2.25km). The Reutech / Tegnopark 2, 70 mm^2 Cu Ring will reach its firm capacity in 2012. A new 70mm^2 Cu feeder (550m) to Proton substation needs to be installed by then to create a 3-legged ring with normal open points at:

- Proton – Tegnopark Pump and
- Time Square – Electron House

6.2.3.4.4 Paradyskloof Sub-system

Paradyskloof is supplied from Golf Course Substation with 4x 90mm² Cu cables. The Paradyskloof load will increase from 3.8MVA to 19.56MVA. This demand increase is due to the new Golf Course residential development and Hotel. It is proposed to build a new substation (Golf Dorp substation) to cater for the new golf course residential development and Hotel. This substation should be supplied directly from Golf Course substation with initially 2x 185mm² Cu cables (2007, 2.2km), with a 3rd 185mm² Cu cable to be installed when the load on the new Golf Dorp substation increases beyond 6.4MVA (2018). With the new Golf Dorp substation the demand on Paradyskloof will only increase to 6.5MVA, which is within its supply capacity for the planning period. The demand on the Golf Dorp substation will increase to 12MVA.

6.2.3.5 Network Development and Strengthening

The following projects are required to develop and strengthen the Golf Course Substation networks. (The progressive development of these projects is shown geographically in Volume B of this report);

- 2007: Golf Dorp Substation,
- 2007: Golf Course Substation – Golf Dorp feeders,

- 2010: Golf Course Substation – Tegnopark 3rd feeder,
- 2012: Tegnopark – Proton 11kV feeder,
- 2018: Golf Course Substation – Golf Dorp 3rd feeder, and
- 2020: Golf Course Substation Transformer,

6.2.3.5.1 Golf Dorp Substation

Construct a new 11kV substation for the Golf Dorp Development. Substation to cater for 4x incomer panels, 1x buscoupler panel and 8x feeder panels. This substation dependant on the Golf Dorp development. Substation to be constructed 2007.

6.2.3.5.2 Golf Course Substation – Golf Dorp Feeders

Install 2x 185mm² Cu cables (2.2km) from Golf Course substation to the new Golf Dorp Substation. The feeder installation to coincide with the new Golf Dorp substation construction (2007).

6.2.3.5.3 Golf Course Substation Tegnopark 3rd Feeder

A 3rd Golf Course Substation – Tegnopark 70 mm² Cu cable (2.25km) needs to be installed to provide necessary supply capacity under contingency conditions. This cable needs to be in operation in 2010.

6.2.3.5.4 Tegnopark – Proton 11kV Feeder

The Reutech / Tegnopark 2, 70 mm^2 Cu ring will reached its firm capacity in 2012. A new 70mm^2 Cu feeder (550m) from Tegnopark to Proton substation needs to be installed, together with a RMU. This cable needs to be in operation by 2012.

6.2.3.5.5 Golf Course Substation – Golf Dorp 3rd Feeder

The initial 2x 185 mm^2 Cu cables from Golf Course substation to Golf Dorp substation will reach its firm capacity in 2018. A 3rd 185 mm^2 Cu cable (2.2km) needs to be installed by 2018.

6.2.3.5.6 Golf Course Substation Transformers

The existing 2 x 20 MVA 66/11 kV transformers will reach firm capacity in 2020. It is proposed to install a 3rd 20MVA 66/11 kV transformer in 2020.

6.2.4 Jan Marias 66/11 KV substation

6.2.4.1 Introduction

Jan Marais Substation is situated at the Jan Marais Park and supplies the Eastern areas of Stellenbosch, including Uniepark and Idasvallei. There are 2 x 10 MVA 66/11 kV transformers and the substation supplies the following main 11 kV substations: Uniepark, Tindal, Stone, Sonneblom, Karendal and Mariaspark.

Tie-feeders exist between Stone and Universiteit Substation, and between Denneoord and Maraispark Substations.

6.2.4.2 Load Forecast

The Load Forecast has shown that the maximum demand will increase from 9MVA to 16.7MVA over the planning period. The load forecast results for the Jan Marias substation is shown in Figure 6-4.

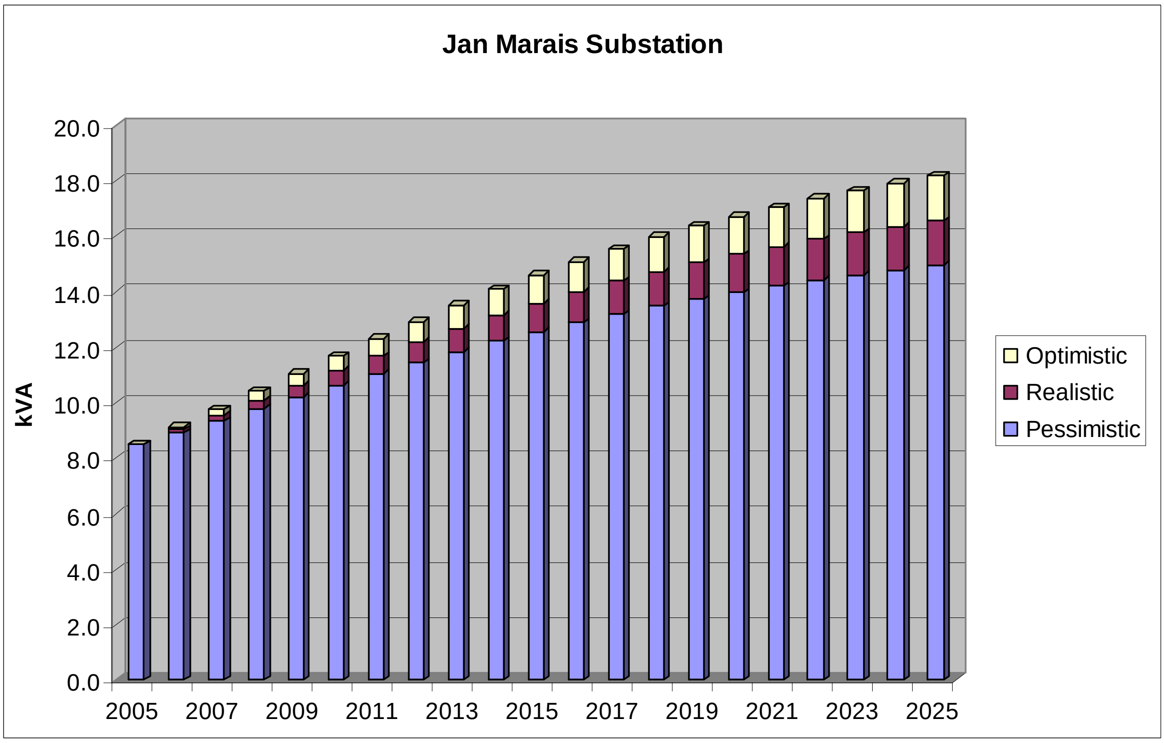


Figure 6-4: Jan Marais Substation Load Forecast Results

6.2.4.3 Open Points

Optimal open points were determined through load flow studies.

The following open points are proposed:

- Jan Marais – Bosman,
- Uniepark – Unielaan,
- 2Pieke – Karendal,
- Waterweg – Uitsig,
- Rowan – Jannasch,
- Karendal – Du Plessis,
- Merton – Packham,
- Stone – Stone MS,

- Idasvallei Sport – Bloekom/Adendorf,
- Stone – Sonnebloem,
- Tindal – MS 7-11,
- Tindal – Sonneblom,
- Lelie – Protea,
- Sonneblom – Eikenbosch,
- Droëbane – Cannery,
- Hospital – Morris,
- LaDauphine – Mcdonald, and
- Maraispark – Van Der Stel.

6.2.4.4 Network Analysis

6.2.4.4.1 Jan Marais 66/11 kV Substation

The substation has 2 x 10 MVA 66/11 kV transformers with a firm capacity of 12 MVA. It is expected that this load will be exceeded by 2012. The total load will increase to 16.3MVA. It is proposed to install a 3rd 10MVA 66/11kV transformer by 2012.

6.2.4.4.2 Uniepark Sub-system

Uniepark is supplied via a 185 mm² Cu cable with alternative supplies via secondary cable rings. There is also a 35 mm² Cu cable from Jan Marais to Uniepark, as well as a 70 mm² Cu cable from Stone. The load forecast shows that the load increases to 3.5 MVA over the planning period, which is more than the capacity of the 35 mm² Cu cable. (This is if the 185 mm² Cu cable is out of service.)

This load can however be supplied by the 70 mm² Cu cable from Stone.

6.2.4.4.3 Uniepark Secondary 11kV Networks

Venter/Provinsie

The load on the Venter/Provinsie ring is within the capacity of the 35 mm² Cu cable.

Endler

The Endler feeder forms a ring with Karendal through Huis du Preez to Jan Marais. The load on this ring increases to 2.2 MVA over the planning period. This ring is limited by the capacity of the 35 mm² Cu cable, i.e. 2.1 MVA. This load is reached by 2025.

6.2.4.4.4 Maraispark Sub-system

Marais Park forms part of the Jan Marais/Marais Park/Denneoord/Bosman ring. It is supplied with a 70 mm² Cu cable. The load on the ring increases to 2.1 MVA over the planning period, which is within the capacity of the ring. The Bosman ring can supply the Marais Park load for the planning period. The Marais Park/Denneoord ring is therefore firm for the planning period.

6.2.4.4.5 Tindal / Stone Sub-System

The Tindal sub-system consists of the Jan Marais/Tindal/Stone/Universiteit 185 mm² Cu ring. The load forecast shows that the load on this ring increases from 2.3 MVA to 4.5 MVA over the planning period, which is within the capacity of the ring of 6.4 MVA.

6.2.4.4.6 Tindal Secondary 11 kV Networks

Sonneblom

Sonneblom is supplied from Jan Marais via Cluver with a 70mm² Cu cable. The load forecast shows that the present load of 1.85 MVA increase to 2.2 MVA over the planning period. The alternative supply for Sonneblom is either from Tindal or Merriman Z. The Tindal ring can only supply the Sonneblom load up to 2020, when the 185 mm² Cu cable will be overloaded. Merriman Z can supply the Sonneblom load for the planning period.

Tindal/Simonswyk/Jan Marais

The Tindal/Simonswyk/Jan Marais feeder has a capacity of 2.1 MVA. The load forecast shows that the load increases from 1 MVA to 1.65 MVA over the planning period, which is within the capacity of the feeder.

Tindal/Khaler/Sonneblom

The Tindal/Khaler/Sonneblom ring is limited by the 16 mm² Cu cable between Sonneblom and Glen Elley. The load forecast shows that the load on this ring increases from 1.18 MVA to 1.77 MVA over the planning period. The thermal limit will therefore be reached at the end of the planning period.

Tindal/Bloekom/Stone

The Tindal/Bloekom/Stone ring has a 2.1 MVA capacity due to the 35 mm² Cu cable between Idasvallei Sport and Stone. The load of this ring increases to 0.95 MVA over the planning period.

6.2.4.4.7 Stone Secondary 11 kV Networks

Hector/Gorridon

The load on the Hector/Gorridon ring increases to 1.5 MVA over the planning period, which is within the 2.1 MVA capacity of the 35 mm² Cu cable ring.

Assegaai

The Assegaai radial feeder load increase to 0.66 MVA, which is within the 2.1 MVA capacity of the 35 mm² Cu cable ring.

6.2.4.4.8 Soeteweide 11kV Ring

Soeteweide forms part of the Jan Marais/Soeteweide/JC Smuts/Merriman Z 70 mm² Cu cable ring. The load forecast indicates that the load on the ring increases from 2.56 MVA to 3.65 MVA over the planning period. The 3.4MVA capacity of the ring will be exceeded by 2021. It is proposed to install a 2nd 70 mm² Cu cable parallel to the existing one from Merriman Z to JC Smuts (290m, 2021).

6.2.4.5 Network Development and Strengthening

The following project is required to develop and strengthen the Jan Marais Substation networks.

- 2012: Jan Marais Substation Transformer,
- 2021: Merriman Z – JC Smuts 2nd Feeder.

6.2.4.5.1 Jan Marais Substation Transformer

The Jan Marais substation will reach its firm capacity of 12 MVA in 2012. At this point in time the 3rd 10 MVA 66/11kV transformer and transformer bay needs to be installed at Jan Marais substation.

6.2.4.5.2 Merriman Z – JC Smuts 2nd Feeder

The Soeteweide 11kV ring will reach its firm capacity in 2021. A 2nd 70 mm² Cu cable needs to be installed parallel to the existing cable from Merriman Z to JC Smuts (290m, 2021).

6.2.5 University 66/11 KV Sub-system

6.2.5.1 Introduction

Universiteit Substation is situated next to the Stellenbosch University Engineering Faculty and it supplies most of the town centre of Stellenbosch. The substation has 3 x 15 MVA 66/11 kV transformers and supplies a number of 11 kV substations, which include Bosman, Stadsaal and Merriman Z. The larger part of the Central Business District is supplied from this substation. Many tie-feeders exist between the 11 kV substations, making it possible to transfer loads between many substations.

6.2.5.2 Load Forecast

The Load Forecast reveals that the maximum demand will increase from 23 MVA to 37 MVA over the planning period. The load forecast results for the University substation is shown in Figure 6-5.

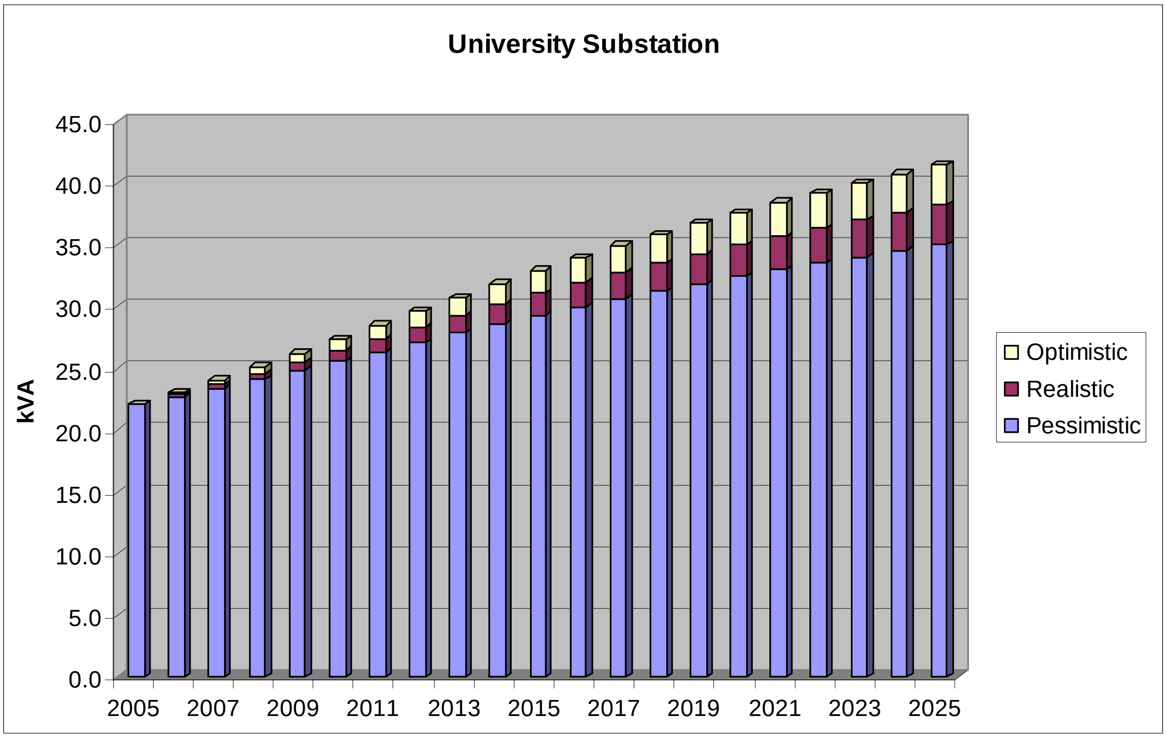


Figure 6-5: University Substation Load Forecast Results

6.2.5.3 Open Points

Optimal open points were determined through load flow studies.

The following open points are proposed:

- University – Tennant (All 3 feeders),
- Merriman Z – Langenhoven 2,
- Drosdy – Coetzenburg Gallery,
- Bergville – Drama,
- SDR Kliniek – Cascade,
- Hofman – Latski,
- Lavanda – Kromrivier,
- Vergesicht – Kromrivier RM,
- La Coline – Die Rand RM,
- Bergendal – Dr Malan,
- Stadsaal – Braak,
- Kerk – Bosman,
- Kerk – Nyasa,

- Andmar – Ou Kollege,
- Trust Bank – 1st National,
- Stadsaal – Rembrandt,
- Stadsaal – SA Perm,
- Bosman – Coetzenburg (Both Feeders),
- Bosman – Jan Marais,
- Bosman – NH Kerk,
- La Dauphine – Mcdonald,
- Rattray – Die Laan,
- Van Der Stel – Marais,
- Hoffman – Blakes Estate (Both Feeders),
- Hoffman – Latski,
- Pagegaaipark 2 – Pagegaaipark 3,
- Papegaairand – Lubbe,
- Papegaairand – Tennant,
- Papgaairand – Randstraat,
- Cascade – Rembrandt/Bird,
- Papegaairand – Vrugtepakkers,
- Zambezi – Lombelia, and
- Dag hospital – Taylor.

6.2.5.4 Network Analysis

6.2.5.4.1 University 66 / 11 kV Substation

This substation has 3 x 15 MVA 66/11 kV transformers. The load forecast indicates that the load increases from 23 MVA to 37 MVA over the planning period. The 66/11 kV Transformers are unevenly loaded, especially Transformer 2, which will overload in 2009. It is suggested to operate Transformer 2 and 3 in parallel under these circumstances.

6.2.5.4.2 Bosman Sub-system

Bosman forms part of the Universiteit/Bosman/Jan Marais 185 mm² Cu cable ring. Bosman is presently supplied from University Substation. The load forecast indicates that the load increases from 4.1 MVA to 5.88 MVA over the planning period and the ring is therefore firm.

6.2.5.4.3 Bosman Secondary 11 kV Networks

Denneoord

Denneoord forms part of the Denneoord/Marais Park ring, as discussed in paragraph 6.2.4.4.4. This ring can supply the total load of 2.1 MVA for the planning period.

Kerk

Kerk forms part of the Bosman/Kerk/Stadsaal ring. There are two cable rings between Kerk and Stadsaal: the one a 35 mm² Cu ring through UBS/Stadsaal and the other also a 35 mm² Cu ring through Andmar/Edgars.

The load on this ring increases to 2.17 kVA over the planning period, which is within the capacity of the ring.

6.2.5.4.4 Hofman Sub-system

Hofman Substation is supplied from Universiteit with a 185 mm² Cu cable and has an alternative supply through Blakes Estate, SDR Kliniek and Papegaairand Substations. The load forecast shows that the present load of 2.3 MVA increases to 6.13 MVA over the planning period. This load includes the loads of SDR Kliniek and Papegaairand Subsations. Alternative supplies are available by supplying Papegaairand from Tennant, SDR Kliniek from Cascade and Hofman from Blakes Estate. The Hoffman/Aklkerhof/Papegaairand feeder load increase to 1.4MVA which is within the limit of the 35 mm² Cu cable.

6.2.5.4.5 SDR Kliniek Sub-system

SDR Kliniek forms part of the Hofman/SDR Kliniek/Cascade/Tennant 11 kV ring. The load forecast shows that the present load of 0.7 MVA increases to 1.21 MVA over the planning period. This load can alternatively be supplied from Tennant 2 / Curry for the planning period. This means that Cascade can also alternatively be supplied from Tennant 2 / Curry for the planning period in the event of loosing the SDR Kliniek-Cascade feeder. There is only one secondary ring on SDR Kliniek, namely the Langenhoven/Nouveau ring. This ring has a 2.1 MVA capacity, with the load increasing from 700 kVA to 1.21 MVA over the planning period.

6.2.5.4.6 Papegaairand Sub-system

Papegaairand forms part of the Hofman/Papegaairand/Tennant 185 mm² Cu cable ring. The load on Papegaairand will increase to 3.3 MVA over the planning period. This load can be supplied from Hofman or Tennant. The load on the Papegaai Park secondary ring increases to 1.9 MVA over the planning period, which is within the capacity of the 70 mm² Cu cable.

6.2.5.4.7 Engineering Faculty Sub-system

The Engineering Faculty is supplied by 2 x 150 mm² Cu cables, with a firm capacity of 4.3 MVA. The load forecast indicates that the load will increase to 2.0 MVA over the planning period, which is within the capacity of the ring.

6.2.5.4.8 Merriman Z Sub-system

Merriman Z is supplied from Universiteit Substation with 4 x 150 mm² Al cables, with cables paralleled in two pairs of two each. The ring has a firm capacity of 9 MVA. The load forecast shows that the load of 8.6 MVA increases to 12.3 MVA over the planning period. The cable ring will become non-firm by the year 2007, when the total load will be more than 9 MVA. No primary 11 kV tie-feeder exists to any other substation.

It is proposed to create four feeders, by splitting the parallel cables (2007). This will increase the firm capacity to 13.4 MVA, which is adequate for the planning period.

6.2.5.4.9 Merriman Z Secondary 11kV Networks

Het Begijnhof

The Het Begijnhof feeder forms a ring to Tennant via Kromrivier Substation, as well as a ring to Merriman/Bird through Kromrivier Substation. The ring to Kromrivier has a 70 mm² Cu cable, but is limited to 2.4 MVA by sections of 35 mm² Cu cable. The load through the Merriman/Bird ring increases to 4.3 MVA over the planning period. Firm capacity will be reached by 2009. The load through the Tennant/Kromrivier ring increases to 3.0 MVA over the planning period. Firm capacity will be reached by 2015.

It is proposed to install a new 70 mm² Cu cable from Merriman Z directly to Kromrivier (800m) to solve the overload under contingency conditions for both the Merriman/Bird ring and the Tennant/Kromrivierrivier. This cable needs to be installed by 2009 and will be operated normal open.

BJ Vorster

The BJ Vorster feeder forms a ring with Hofman through Merriman/Bird and a ring with Tennant through Kromrivier, as discussed in the previous paragraph. Both rings are limited by sections of 35 mm² Cu cable. The load on the feeder increases to 1.8 MVA over the planning period. The alternative supplies are limited by the 35 mm^2 Cu cable sections. The B J Vorster load cannot be supplied from Kromrivier, as the loading exceeds the capacity of the Banghoek / Kromrivier cable (2015). The supply from Het Begijnhof is also limited (2009). The solution provided under Het Begijnhof resolves the above overloads.

Langenhoven

Langenhoven is supplied with 2 x 70 mm² Cu cables, with a firm capacity of 3.4 MVA. The loading on this ring will increase to 3.7MVA over the planning period, with firm capacity that will be reached by 2016. A 3rd 70 mm² Cu cable (230m) needs to be installed by 2016 to provide adequate supply under a feeder contingency.

Eikenbosch

Eikenbosch is supplied on the Merriman Z/Sonneblom ring. The loading on this ring will increase to 400 kVA over the planning period. This load can be supplied from Sonneblom / Cluver as an alternative for the planning period.

Bergzicht

Bergzicht forms part of the Merriman Z/Bergzicht/Beyershof/Stadsaal ring, with a 70 mm² Cu cable. The load forecast shows that the load on this feeder increases from 1.4 MVA to 2.2 MVA over the planning period, which is within the capacity of the ring.

J C Smuts

JC Smuts forms part of the Merriman Z/JC Smuts/Soeteweide/Jan Marais ring, with a 70 mm² Cu cable. The load forecast indicates that the load on the ring increases from 2.56 MVA to 3.65 MVA over the planning period. The 3.4MVA capacity of the ring will be exceeded by 2021. See paragraph 6.2.4.4.8 for the proposed upgrading of the feeder.

Cyrus

Cyrus forms a ring to Stadsaal through De Waal. The Merriman/Drama portion of the feeder has a 70 mm^2 Cu cable and the Drama/Stadsaal section a 35 mm^2 Cu cable.

The load forecast shows the load increases from 680 kVA to 1.0 MVA over the planning period, which is within the capacity of the 35 mm^2 Cu cable of 2.1 MVA

Schuman

The Schuman feeder forms a ring to Bosman, with a 70 mm^2 Cu cable. The load forecast shows that the load increases from 1 MVA to 1.31 MVA over the planning period. Bosman can also supply this load for the planning period.

6.2.5.4.10 Stadsaal Sub-system

Stadsaal is supplied from Universiteit with a 185 mm^2 Cu cable and forms part of the Stadsaal/Braak/Suidwal 11 kV ring. The load forecast shows that the load increases from 2.5 MVA to 4.05 MVA over the planning period. An alternative infeed is from Suidwal/Krige/Braak, with the load on this ring increasing from 5.0 MVA to 8.4 MVA. When the load exceeds 6.4 MVA (2017), a direct link needs to be provided from Suidwal to Stadsaal. (950m, 185 mm^2 Cu cable, 2017)

6.2.5.4.11 Stadsaal Secondary 11 kV networks

Beyershof

Beyershof is supplied on the Merriman Z/Bergzicht/Beyershof/Stadsaal ring, with a 70 mm^2 Cu cable. The load forecast shows that the load on this feeder increases from 1.4 MVA to 2.2 MVA over the planning period, which is within the capacity of the ring.

De Waal

De Waal forms part of the De Waal/Cyrus/Merriman Z ring, with a 35 mm^2 Cu cable up to Drama. The load forecast shows the load increases from 680 kVA to 1.0 MVA over the planning period, which is within the capacity of the 35 mm^2 Cu cable of 2.1 MVA.

Neethlinghuis

Neethlinghuis forms part of the Stadsaal/Kerk/Bosman ring, with a 35 mm^2 Cu cable. The load on this ring increases to 2.1 MVA and can be supplied from both ends for the planning period.

Edgars

Edgars forms part of the Andmar/Kerk/Bosman ring, with a 35 mm^2 Cu cable. This ring can supply the anticipated load of 1.10 kVA for the planning period.

Trust Bank

Trust Bank forms part of the Helderberg/Suidwal ring, with a 70 mm^2 Cu cable.

The load on this ring increases from 2.1 MVA to 3.3 MVA over the planning period, which is within the capacity of the ring.

SA Perm

SA Perm forms part of the SA Perm/Saambou/Braak 11 kV ring, with a 35 mm^2 Cu cable. The load on this ring increases from 0.92 MVA to 1.62 MVA over the planning period, which is within the capacity of the ring.

6.2.5.5 Network Development and Strengthening

The following project is required to develop and strengthen the University Substation networks.

- 2007: University – Merriman Z feeder split,
- 2009: Merriman Z – Kromrivier feeder,
- 2016: Merriman Z – Langenhoven 3rd feeder,
- 2017: Suidwal – Stadsaal feeder.

6.2.5.5.1 University – Merriman Z Feeder Split

When the Universiteit/Merriman Z 150 mm² Al cables reach there firm capacity in 2007, the parallel cables should be split to form four feeders, increasing the firm capacity from 9 MVA to 13.5 MVA.

6.2.5.5.2 Merriman Z – Kromrivier Feeder

It is proposed to install a new 70 mm² Cu cable from Merriman Z directly to Kromrivier (800m) to solve the overload under contingency conditions for both the Merriman/Bird ring and the Tennant/Kromrivierrivier ring. This cable needs to be installed by 2009 and will be operated normal open.

6.2.5.5.3 Merriman Z – Langenhoven 3rd Feeder

A 3rd 70 mm² Cu cable (230m) from Merriman Z to Langenhoven needs to be installed by 2016 to provide adequate supply under a feeder contingency.

6.2.5.5.4 Suidwal – Stadsaal Feeder

In 2017, when the Suidwal – Stadsaal feeder load is expected to exceed its firm capacity of 6.4 MVA, a direct link needs to be provided from Suidwal substation to Stadsaal substation (950m, 185 mm² Cu cable).

6.2.6 Cloetesville 66/11 KV Sub-system

6.2.6.1 Introduction

Cloetesville Substation is situated next to the R304 main road into Stellenbosch and it supplies the northern areas of Stellenbosch, including Cloetesville, Kayamandi and Welgevonden. The substation has 2 x 20 MVA 66/11 kV transformers and supplies a number of 11 kV substations, which include Curry, Tennant, Welgevonden and Kayamandi. Various tie-feeders exist between the 11 kV substations, making it possible to transfer loads between many substations.

6.2.6.2 Load Forecast

The Load Forecast reveals that the maximum demand will increase from 8.7 MVA to 22.0 MVA over the planning period. The load forecast results for the Cloetesville substation is shown in Figure 6-6.

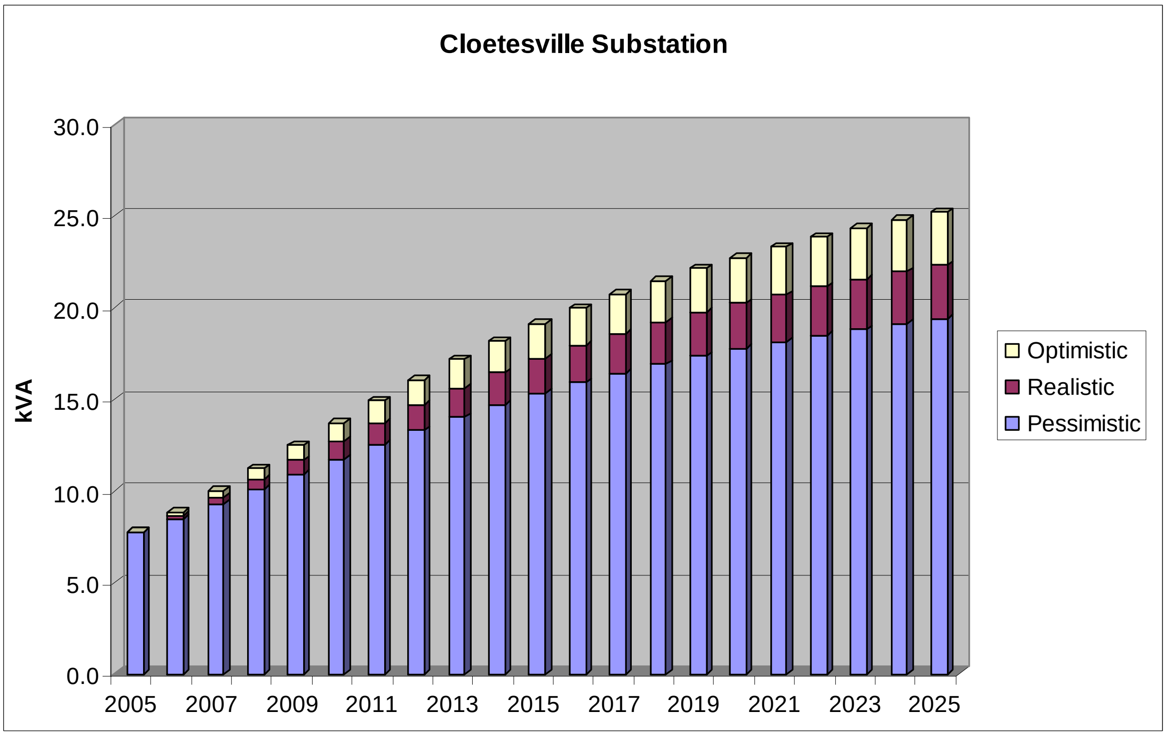


Figure 6-6: Cloetesville Substation Load Forecast Results

6.2.6.3 Open Points

Optimal open points were determined through load flow studies.

The following open points are proposed:

- Welgevonden – Boulevard (C9),
- Perdevy – Protea,
- Gabriel – Rode,
- Mountain Silver – Waterboom,
- Tennant – University (All 3 feeders),
- Alley – Lappan1,
- Tennant – Papegaairand,
- Lakay 1 – Lakay 2,
- Fir - Lang Williams,
- Du Toit – Kayamandi,
- Kayamandi – Bassi 4,
- Snake Valley – Long 6,

- Mondi Crescent – Kayamandi,
- Anthony – Davidse,
- Vrugtepakkers – Papegaairand,
- Rembrandt – Cascade,
- SDR Kliniek – Cascade,
- Randstraat, and
- Papegaairand.

6.2.6.4 Network Analysis

6.2.6.4.1 Cloetesville 66 / 11 kV Substation

This substation has 2 x 20 MVA 66/11 kV transformers. The load forecast indicates that the load on Cloetesville Substation increases from 8.7 MVA to 22 MVA over the planning period, which is within the firm capacity of the substation.

6.2.6.4.2 Curry Subsystem

Curry is supplied from Cloetesville with 4 x 95 mm² Cu cables with a total capacity of 16.7 MVA and firm capacity of 12.5 MVA. The load forecast indicates that the load increases from 7.6 MVA to 20 MVA over the planning period. Installed capacity will be reached in 2020, while firm capacity will be reached in 2016. It is proposed to install another 2 x 95 mm² Cu cables from Cloetesville substation to Curry (1060m). These cables need to be in operation by 2016.

6.2.6.4.3 Tennant Subsystem

Tennant is fed from curry with 3 x 185 mm² Cu cables with a total capacity of 19.2 MVA and firm capacity of 12.8 MVA. Tennant can also be supplied from University via 3 x 185 mm² Cu cables as an alternative supply. The load forecast indicates that the load increases from 5.5 MVA to 12.9 MVA over the planning period. The installed cables will reach there firm capacity at the end of the planning period. With the Tennant bus-coupler operated normally open, the Tennant load will be distributed unevenly, resulting in the Tennant – Curry 1 feeder overloading in 2011. It is proposed to close both the Tennant and Curry bus-couplers in 2011, and to operate them in these positions under stead-state conditions.

6.2.6.4.4 Welgevonden Sub-system

Welgevonden is fed directly from Cloetesville substation on 2 x 185 mm² Cu cables with a total capacity of 12.8 MVA and firm capacity of 6.4 MVA. No tie feeders exist to Welgevonden substation. The load forecast indicates that the load increases from 420 kVA to 2 MVA over the planning period. The supply to Welgevonden is firm over the planning period. The two 2 x 70 mm² Cu secondary rings is also firm over the planning period.

6.2.6.4.5 Kayamandi Sub-system

Kayamandi is fed with 1 x 70 mm² Cu cable from Tennant and 2 x 70 mm² Cu cables from Curry. The load forecast indicates that the load increases from 4 MVA to 10 MVA over the planning period. The Watergang planned development contributes significantly to this load increase. As part of the Watergang development a new substation is being built in the centre of the development, behind the church grounds. This substation will cut into one of the Costa – Curry 70 mm² Cu cables by installing 2 x 70 mm² Cu cables from Watergang substation to the Costa – Curry feeder. This new Curry/Watergang/Costa ring will reach firm capacity in 2010. The 6th Avenue 5 - Mdala 2 35 mm² Cu ring will also reach its capacity in 2012.

To resolve the supply problems in and around Kayamandi the following is proposed:

i) Change the supply to the new Watergang substation from Curry substation to Cloetesville substation. This can be done by disconnecting the Curry – Watergang supply cable from Watergang substation. This cable need to be shortened by connecting it to Costa substation where it passes the substation. Install 2x 70 mm² Cu cables from Cloetesville substation to Watergang substation (2500m, 2010). Keep the Watergang – Costa 70 mm² feeder to support the network for either a Curry- Costa or Cloetesville – Watergang cable contingency, but operate normal open,

ii) Install a new tie in 35 mm² Cu cable from Watergang substation to Vinyard 7 minisub (480m, 2011).

6.2.6.5 Network Development and Strengthening

The following project is required to develop and strengthen the Cloetesville Substation networks.

- 2006: New Watergang substation and supply feeders (current project),
- 2010: Watergang supply cables,
- 2011: Watergang – Vinyard 7 tie feeder,
- 2011: Tennant, Curry bus couplers,
- 2016: Cloetesville – Curry 5th and 6th feeders.

6.2.6.5.1 Watergang Supply Cables

Change the supply to the new Watergang substation from Curry substation to Cloetesville substation. This is done by disconnecting the Curry – Watergang supply cable from Watergang substation. This cable need to be shortened by connecting it to Costa substation where it passes the substation.

Install 2x 70 mm² Cu cables from Cloetesville substation to Watergang substation (2500m, 2010).Operate the Watergang – Costa 70 mm² feeder normal open.

6.2.6.5.2 Watergang – Vinyard 7 Tie Feeder

Install a new tie in 35 mm² Cu cable from Watergang substation to Vinyard 7 minisub (480m) to release the load on the Holly Oak – Melkhout ring.

6.2.6.5.3 Tennant, Curry Bus couplers

Close both the Tennant and Curry bus couplers, and operate in this position under steady state conditions.

6.2.6.5.4 Cloetesville – Curry 5th and 6th Feeders

Another 2 x 95 mm^2 Cu cables needs to be installed from Cloetesville substation to Curry (1060m) to increase the supply capacity to Curry substation. These cables need to be in operation by 2016.

6.2.7 Franschhoek 66 / 11 kV substation

6.2.7.1 Background

This substation supplies the entire Franschhoek area, and is equipped with 2x 20 MVA 66/11 kV transformers. The 11 kV substations supplied by this substation include Groendal, Hugenote and Monument substations.

6.2.7.2 Load Forecast

The Load Forecast Model was balanced with the latest telemetry data, as well as inputs from the Structure plan and future developments. The present maximum demand is nearly 7MVA and is expected to increase to 19.5MVA over the planning period. The load forecast results for Franschhoek substation is shown in Figure 6-7.

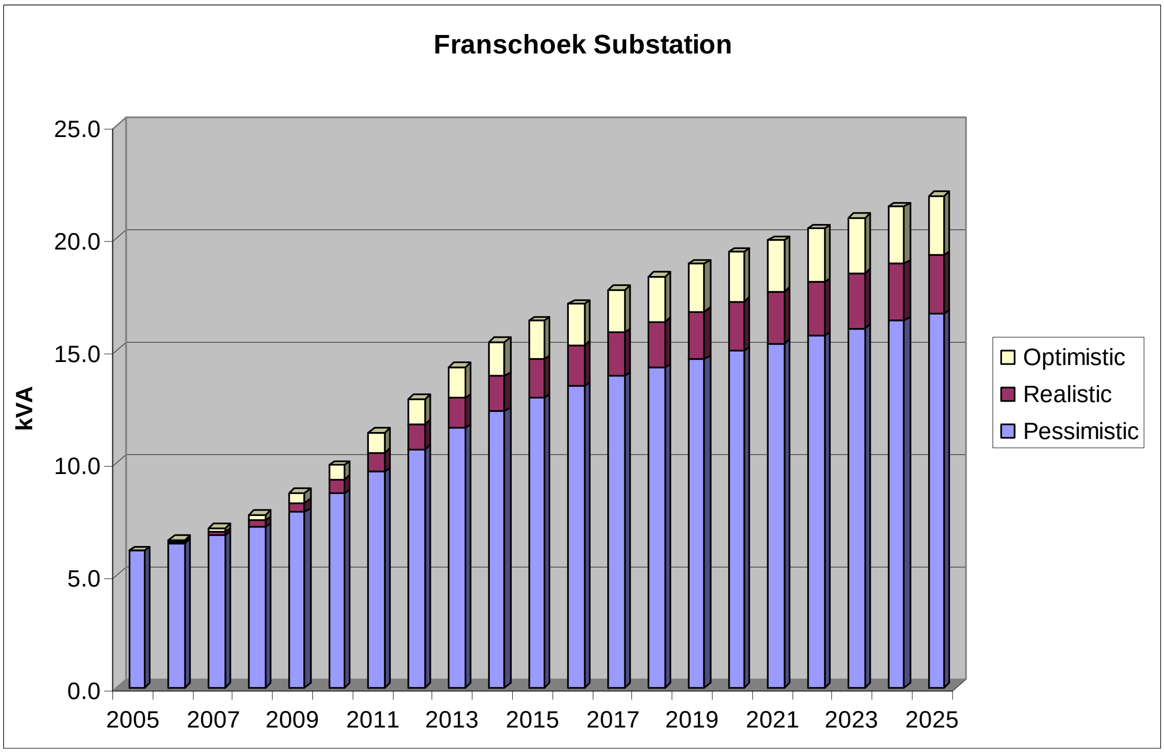


Figure 6-7: Franschhoek Substation Load Forecast Results

6.2.7.3 Open Points

Optimal open points were determined through load flow studies.

The following open points are proposed:

- Airbreaker L4 – Ring Isolated Switch RIS1,
- Monument Bus B – Drop Out Fuse OR-411,
- Hampton Square RMU – Hampton Square,
- Hampton Square RMU – Le Avenue De Franschhoek,

- RMU003 – WPK,
- RMU5 (Dirkie Uys) – RMU6 (Hugenote m/s), and
- Village Art – SS-005 Ground Mounted Transformer.

6.2.7.4 Network Analysis

6.2.7.4.1 Franschhoek 66/11 kV Substation

This substation has 2 x 20 MVA 66/11 kV transformers. The load forecast indicates that the load on Franschhoek Substation increases from 7 MVA to 19.5 MVA over the planning period, which is within the firm capacity of the substation.

6.2.7.4.2 Groendal Subsystem

Groendal is supplied from Franschhoek substation with 2x 185 mm² Cu cables with a total capacity of 12.8 MVA and firm capacity of 6.4 MVA. The load forecast indicates that the load increases from 2.8 MVA to 8.7 MVA over the planning period. The installed cables will reach there firm capacity by 2019. It is proposed to install a 3rd, 185 mm² Cu cable from Franschhoek substation to Groendal at this time (560m).

6.2.7.4.3 Groendal Secondary 11kV Networks

<u>Le Rouxweg and La Provance feeders</u>

Le Rouxweg and La Provence feeders are two 70 mm² Cu radial feeders whose respective loads will increase to 1.5 MVA and 3.3 MVA. It is proposed to close the ring by installing a 70 mm² Cu cable between Langrug and Upper Lea Smith (300m, 2007).

This total load on the Le Rouxweg /La Provance ring (with the network open between RMU 3 and RMU 4 under contingency) will increase to 3.4 MVA which is within the capacity of the ring.

<u>Groendal/Le Rouxweg/Louis Botha/Hugenote ring</u>

The Groendal/Le Rouxweg/Louis Botha/Hugenote ring is limited to 1.7 MVA by portions of 25 mm² Cu cable on the ring. The load on the ring already exceeds 1.7 MVA and the ring is operated non-firm.

By closing the Le Roughweg/La Provance ring as proposed in the previous paragraph and by opening the network at RMU 3 – GP Sport under a feeder contingency, the overload of the 25 mm² Cu cable can be postponed until the year 2010, when it will be necessary to upgrade the 25 mm² Cu cable from RMU6 to Hugenote to 70 mm² Cu cable (720m).

<u>La Provance radial feeder</u>

The load on the La Provance feeder is expected to grow to 0.8 MVA over then planning period, which is within the capacity of the 16 mm² Cu cable.

It is however proposed to provide an alternative feed by creating a ring by installing 35 mm² Cu cable between La Provance and SS-208 (400m, 2007). This new portion of cable should be run normal open under steady-state conditions.

<u>Groendal/SS-111/SS-137/Monument ring</u>

The load on the Groendal/SS-111/SS-137/Monument ring is expected to grow to 1.2 MVA over then planning period, which is within the capacity of the feeder.

Groendal/SS-201/ABSA/Hugenote ring

The load on the Groendal/SS-201/ABSA/Hugenote ring is expected to grow to 2.3 MVA over the planning period, which is within the capacity of the feeder.

6.2.7.4.4 Hugenote Subsystem

Hugenote is supplied from Franschhoek substation with 2x 185 mm² Cu cables with a total capacity of 12.8 MVA and firm capacity of 6.4 MVA.

The load forecast indicates that the load increases from 4.3 MVA to 11 MVA over the planning period. The installed cables will reach their firm capacity in 2011.

It is proposed to relief load from Hugenote substation by supplying Monument directly from Franschhoek substation, and operating the Hugenote-Monument feeder open. This will entail the installation of a new 120 mm² Cu cable from Franschhoek substation to Monument Substation (4.3km, 2011).

6.2.7.4.5 Hugenote Secondary 11kV Networks

Hugenote/Fabriek/Village Art/Hugenote ring

The capacity of the Hugenote/Fabriek/Village Art/Hugenote ring is limited to 2.6 MVA by the portions of 50 mm² Cu cable. The load on the ring is expected to grow to 2.6 MVA, and firm capacity is reached at the end of the planning period.

Hugenote/Kerk/Monument ring

The load on the Hugenote/Kerk/Monument ring is expected to grow to 2.0MVA, which is within the capacity of the 70 mm² Cu cable of the ring.

6.2.7.4.6 Monument Subsystem

Monument supplies the new Franschhoek Estate development, and is supplied from Hugenote substation with 1x 120 mm² Cu cable with a total capacity of 4.3 MVA.

The load forecast indicates that the load increases from 0.4 MVA to 4.2 MVA over the planning period. An alternative supply is available through the Hugenote/Kerk/WPK/Monument 70 mm² Cu cable ring. The capacity of this supply is however limited to 3.4MVA, which will be reached in 2011.

The proposed solution under 6.2.7.4.4 will also solve the above contingency.

6.2.7.5 Network Development and Strengthening

The following projects are required to develop and strengthen the Franschhoek Substation networks. (The progressive development of these projects is shown geographically in Volume B of this report);

- 2006: Langrug – Upper Lea Smith 11kV feeder (current project),
- 2006: La Provance – SS-208 11kV feeder (current project),
- 2007: Le Quntere – M/S upgrade,
- 2007: SS Cabri – WR L2 11kV feeder,
- 2008: Hugenote – SS Kruger 11kV feeder,
- 2008: Oaklodge – Akademie RMU,

- 2008: Oaklodge / Akademie RMU – SS2 B9 11kV feeder,
- 2008: SS2 B9 - SS2 B4H 11kV feeder,
- 2008: SS2 B2 M/S,
- 2008: SS2 C6 M/S upgrade,
- 2010: Hugenote – RMU 6 feeder upgrade,
- 2011: Franschhoek – Monument 11kV feeder,
- 2019: Franschhoek Substation – Groendal 3rd feeder.

6.2.7.5.1 Le Quntere – M/S upgrade

The Le Quntere (SS2-D4) 315kVA mini-substation will reach firm capacity and needs to be upgraded to 500kVA.

6.2.7.5.2 SS Cabri – WR L2 11kV feeder

It is proposed to install a 70 mm² Cu cable from SS Cabri to WR L2 to close the radial feeder and increase firm capacity (400m, 2007).

6.2.7.5.3 Hugenote – SS Kruger 11kV feeder

It is proposed to install a 95 mm² Cu cable from Hugenote to the new 500kVA SS Kruger M/S (200m, 2008).

6.2.7.5.4 Oaklodge – Akademie RMU

Install a new RMU (Oaklodge – Akademie).

6.2.7.5.5 Oaklodge / Akademie RMU – SS2 B9 11kV feeder

It is proposed to install a 70 mm² Cu cable from Oaklodge / Akademie RMU to the new 500kVA SS2 B9 M/S (400m, 2008).

6.2.7.5.6 SS2 B9 - SS2 B4H 11kV feeder

It is proposed to install a 70 mm² Cu cable from SS2 B9 to the new 500kVA SS2 B4H M/S (400m, 2008).

6.2.7.5.7 SS2 B2 M/S

It is proposed to install a new 500kVA M/S, SS2 B2.

6.2.7.5.8 SS2 C6 M/S upgrade

The SS2 C6 315kVA mini-substation will reach firm capacity and needs to be upgraded to 500kVA.

6.2.7.5.9 Hugenote – RMU 6 feeder upgrade

The Groendal/Le Rouxweg/Louis Botha/Hugenote ring is limited to 1.7 MVA by portions of 25 mm^2 Cu cable on the ring. These portions of 25 mm^2 Cu cable between RMU6 and Hugenote needs to be upgraded to 70 mm^2 Cu (720m, 2010).

6.2.7.5.10 Franschhoek – Monument 11kV feeder

Hugenote substation supply will be non-firm in 2011 due to the load increase on Monument substation, currently fed from Hugenote substation via 1x 120 mm^2 Cu cable. The supply to Monument substation is also non-firm in 2011.

It is proposed to relief load from Hugenote substation by supplying Monument directly from Franschhoek substation, and operating the Hugenote-Monument feeder open. This will also solve the Monument supply. This will entail the installation of a new 120 mm^2 Cu cable from Franschhoek substation to Monument Substation (4.3km, 2011).

6.2.7.5.11 Franschhoek Substation – Groendal 3rd feeder

The supply cables to Groendal substation will reach there firm capacity in 2019.

It is proposed to install a 3rd, 185 mm^2 Cu cable from Franschhoek substation to Groendal at this time to increase firm capacity (560m, 2019).

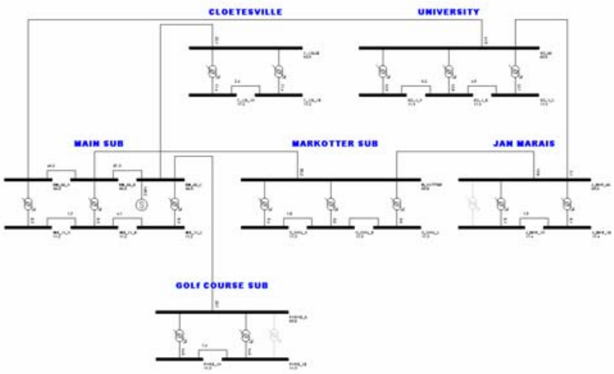
6.3 HV System Contingency Analysis

This section provides a summary of supply feeder and transformer contingency analysis and solutions for the Stellenbosch 66kV network. Each contingency is tested followed by the evaluation of possible solutions. The capital requirements to provide infrastructure to support contingencies are Section 7 of this report.

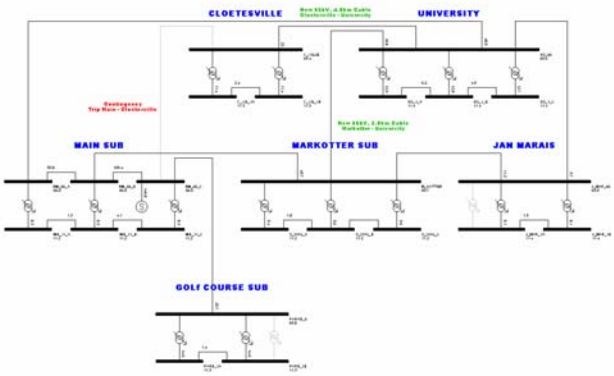
6.3.1 Cable / Line Contingency Requirements

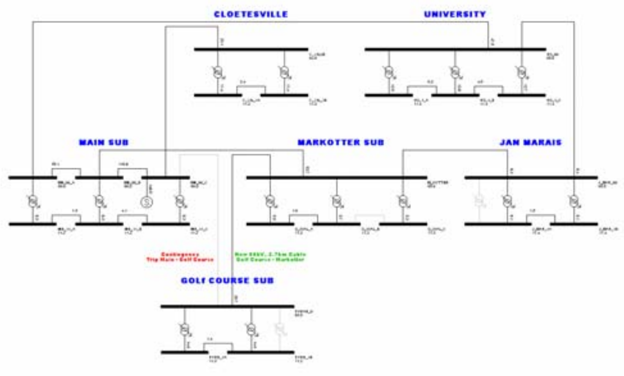
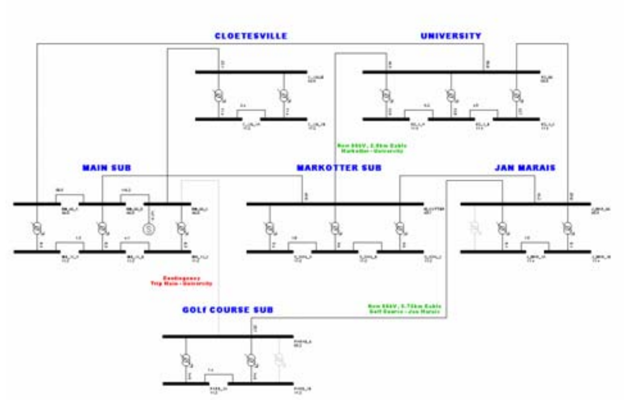
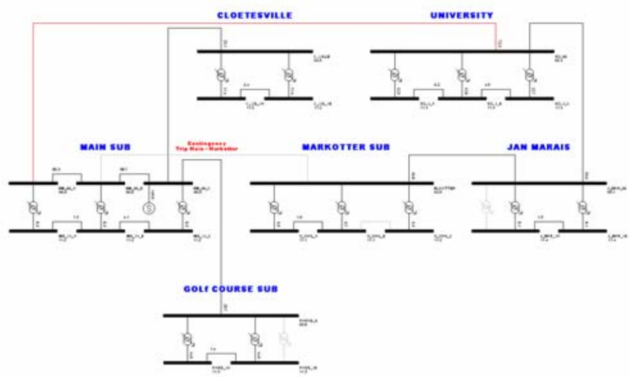
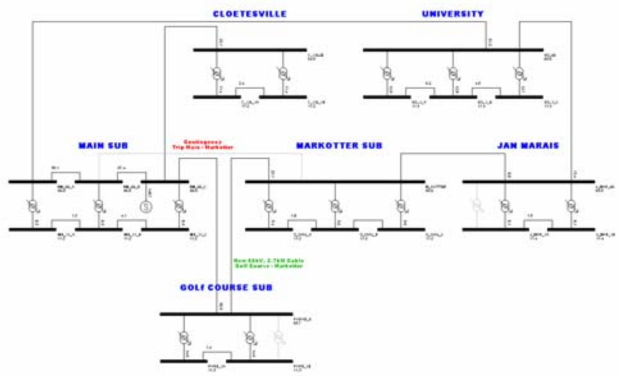
This section provides a summary of the impact and solutions to line and cable contingencies on the 66kV network. Lines and cables are manually taken out of commission and the impact thereof is tested through load flow analysis. Subsequent corrective actions are then identified and tested through load flow analysis. The results are shown in more detail in Addendum C to this report.

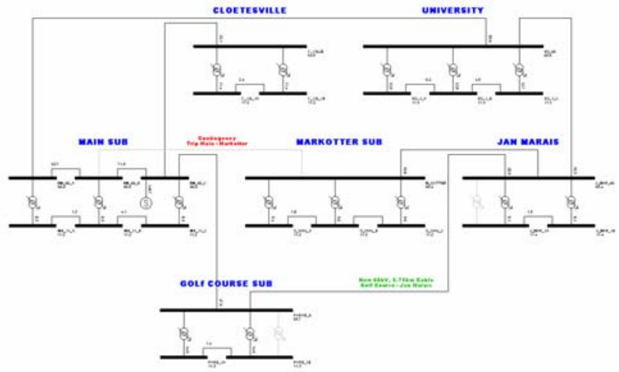
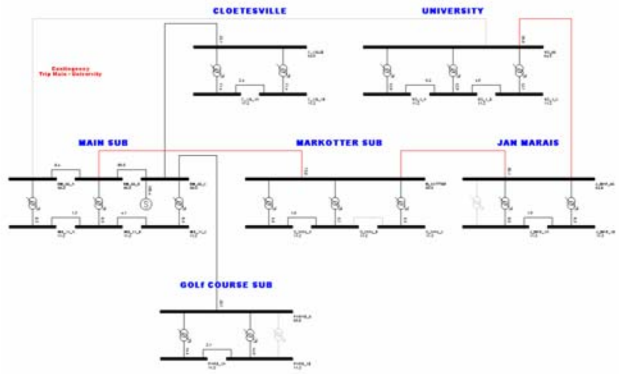
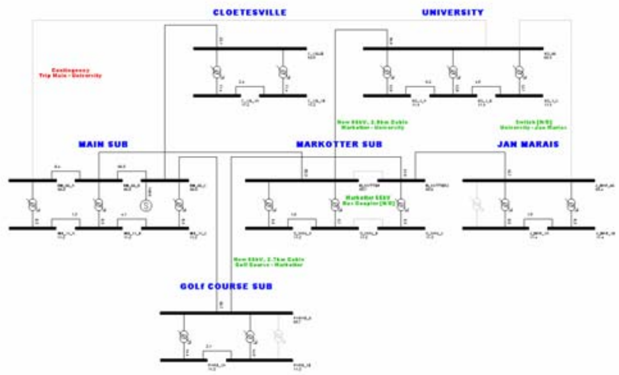
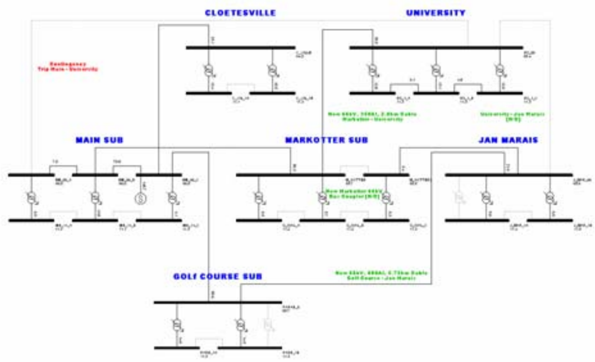
<table>
<tr><th>Cable / Line Contingencies</th><th>Results / Solutions</th></tr>
<tr><td>Normal conditions, 2025 Load

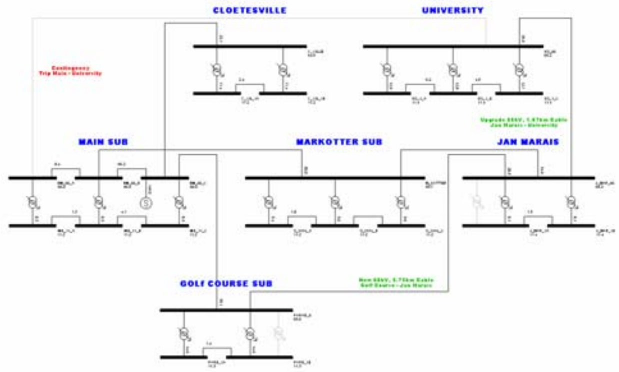
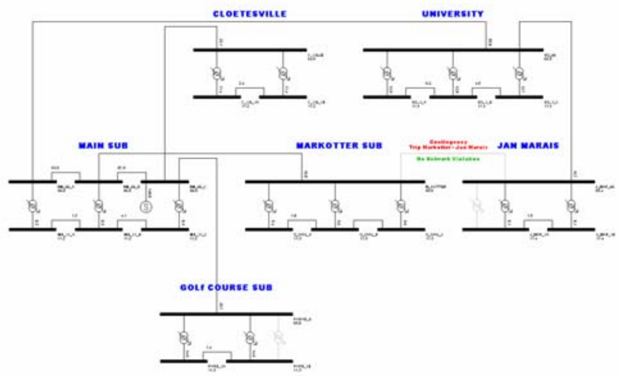
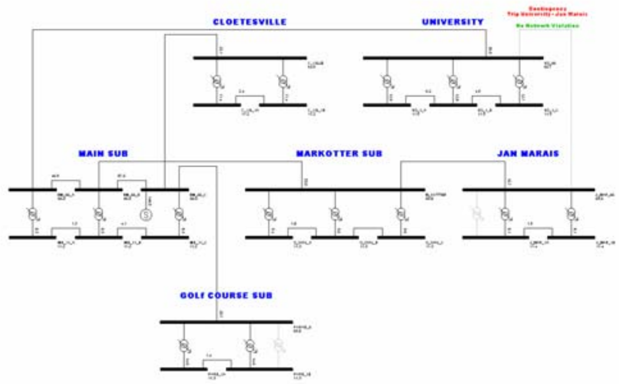
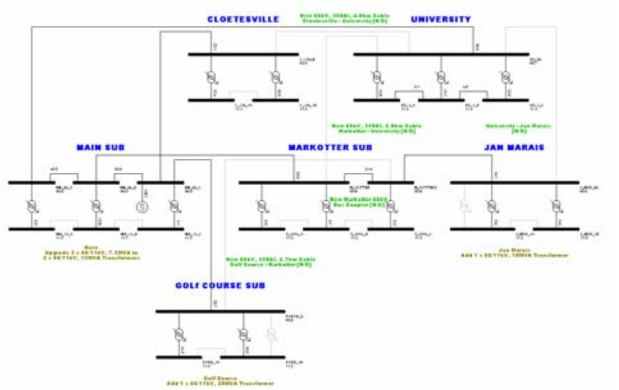
No network overloads are experience during this condition.</td><td>
</td></tr>
<tr><td>Main – Cloetesville, 2025 Load

Result: Cloetesville substation is fed from a radial feeder from Main substation thus has no firm supply.

Solution: Add a new 66kV, 4.0km cable from Cloetesville – University (Main – University 66kV cable overload) and new 66kV, 2.8km cable from Markotter – University.</td><td>
</td></tr>
</table>

Cable / Line Contingencies	Results / Solutions
Main – Golf Course, 2025 Load Result: Golf Course substation is fed from a radial feeder from Main substation thus has no firm supply. Solution 1: Add a new 66kV, 2.7km cable from Golf Course – Markotter.	
Solution 2: Add a new 66kV, 5.75km cable from Golf Course – Jan Marais (Main – University 66kV cable overload) and new 66kV, 2.8km cable from Markotter – University.	
Main – Markotter, 2025 Load Result: Overload 66kV cable from Main – University.	
Solution 1: Add a new 66kV, 2.7km cable from Golf Course – Markotter.	

Cable / Line Contingencies	Results / Solutions
Solution 2: Add a new 66kV, 5.75km cable from Golf Course – Markotter.	
Main – University, 2025 Load Result: Overload 66kV cables from Main – Markotter, Markotter – Jan Marais and Jan Marais – University.	
Solution 1: Add a new 66kV, 2.7km cable from Golf Course – Markotter, new 66kV, 2.8km cable from Markotter – University and Split the Markotter 66kV busbar. During this contingency, Jan Marais – University cable need to be switched out.	
Solution 2: Add a new 66kV, 5.75km cable from Golf Course – Jan Marais, new 66kV, 2.8km cable from Markotter – University and Split the Markotter 66kV busbar. During this contingency, Jan Marais – University cable need to be switched out.	

Cable / Line Contingencies	Results / Solutions
Solution 3: Add a new 66kV, 5.75km cable from Golf Course – Jan Marais (Jan Marais – University 66kV Overload) and upgrade the 66kV, 1.675km cable from Jan Marais – University.	
Markotter – Jan Marais, 2025 Load Result: No network overloads are experience during this contingency.	
University – Jan Marais, 2025 Load Result: No network overloads are experience during this contingency.	
Cable Network Recommendation 1 New 66kV, 4.0km cable from Cloetesville – University, New 66kV, 2.8km cable from Markotter – University, New 66kV, 2.7km cable from Golf Course – Markotter, and Split the Markotter 66kV busbar.	

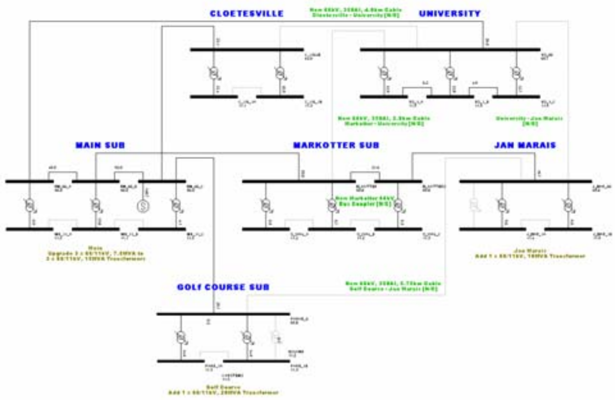
NETGroup

<table>
<tr><th>Cable / Line Contingencies</th><th>Results / Solutions</th></tr>
<tr><td>Cable Network Recommendation 2

New 66kV, 4.0km cable from Cloetesville – University,

New 66kV, 2.8km cable from Markotter – University,

New 66kV, 5.75km cable from Golf Course – Jan Marais, and

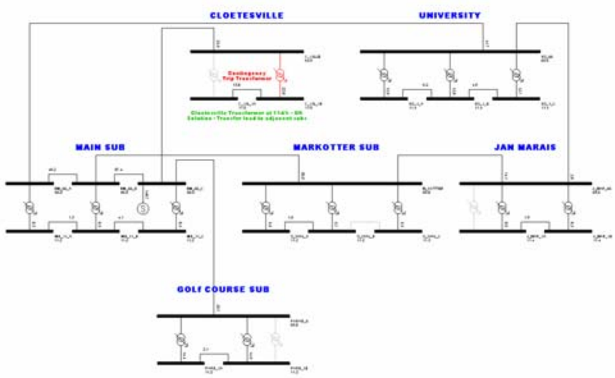
Split the Markotter 66kV busbar.</td><td>
</td></tr>
</table>

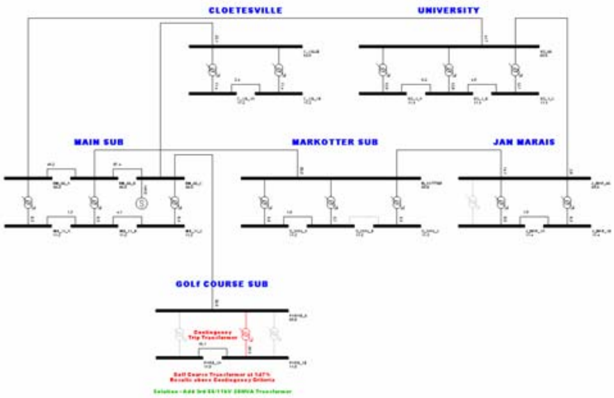
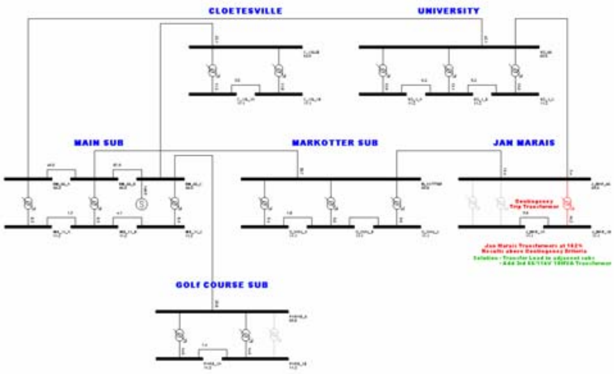
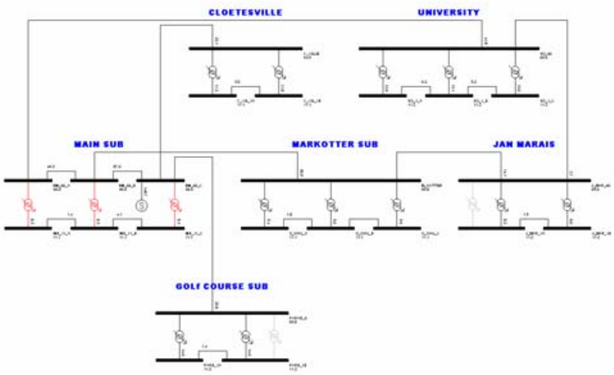
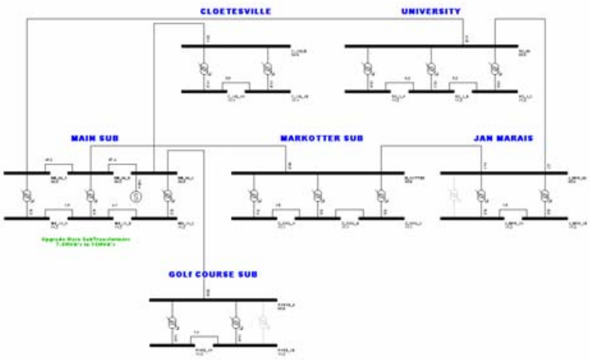
6.3.2 Substation Transformer Contingencies Requirements

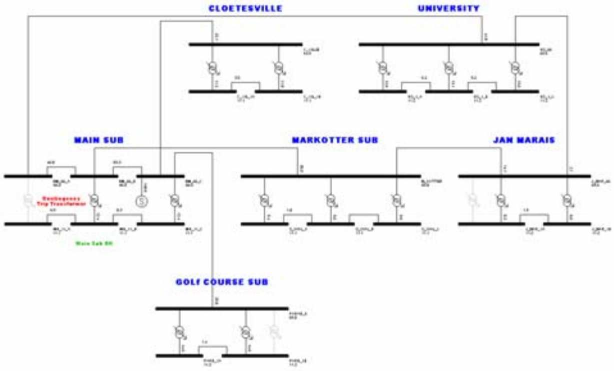
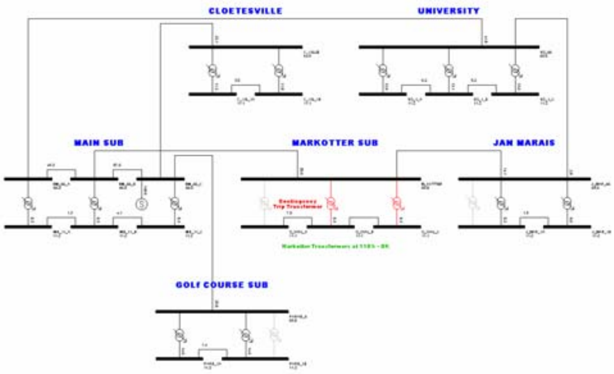
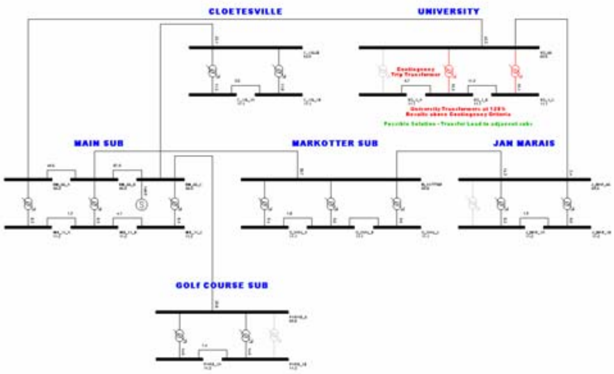
This section provides a summary of the impact and solutions to transformer contingencies on the 66kV network. Substation transformers are manually taken out of commission and the impact thereof is tested through load flow analysis. Subsequent corrective actions are then identified and tested through load flow analysis. The results are shown in more detail in Addendum C to this report.

<table>
<tr><th>Transformer Contingencies</th><th>Results / Solutions</th></tr>
<tr><td>Cloetesville, 2025 Load

Result: Cloetesville Transformer loaded at 114%. The Transformer loading is less then the specified contingency criteria of 120%.

Solution: No action and / or Transformer upgrades are needed. Load can be transfer to adjacent substations.</td><td>
</td></tr>
</table>

Transformer Contingencies	Results / Solutions
Golf Course, 2025 Load Result: Golf Course Transformer loaded at 147%. The Transformer loading is higher then the specified contingency criteria of 120%. Solution: Add a 3rd 66/11kV, 20MVA Transformer at Golf Course.	
Jan Marais, 2025 Load Result: Jan Marais Transformer loaded at 162%. The Transformer loading is higher then the specified contingency criteria of 120%. Solution: Add a 3rd 66/11kV, 10MVA Transformer at Jan Marais and / or transfer load to adjacent substations.	
Main – Existing, 2025 Load Result: Main Transformers are loaded at 110%. The Transformer loading is higher then the specified normal operation criteria of 100%.	
Main – Upgrade, 2025 Load Solution: Upgrade Main Transformers from 66/11kV, 7.5MVA to 66/11kV, 15MVA Transformers.	

Transformer Contingencies	Results / Solutions
Main, 2025 Load Solution: No action and / or Transformer upgrades are needed.	
Markotter, 2025 Load Result: Markotter Transformers loaded at 110%. The Transformer loading is less then the specified contingency criteria of 120%. Solution: No action and / or Transformer upgrades are needed. Load can be transfer to adjacent substations.	
University, 2025 Load Result: University Transformers loaded at 128%. The Transformer loading is higher then the specified contingency criteria of 120%. Solution: No action and / or Transformer upgrades are needed. Load can be transfer to adjacent substations.	

7 Capital and Financial Evaluation

7.1 Background

One of the main criteria in evaluating system alternatives is the extent of capital outlay. Not only must the solutions to network problems be technically viable, but they must also be financially sound. The capital and financial analysis conducted on the Stellenbosch network aims to set-up a Short- and Long-term capital program which offers Stellenbosch Municipality an acceptable return on investment. The following aspects apply:

- In order to perform a financial analysis, a basic capital program is compiled containing capital requirements for each proposed project ,
- Financial analysis tests the viability of the capital expenditure in terms of:
    - The impact on future cash flows,
    - Net present worth of the investments, and
    - The Internal Rate of Return (IRR).

The financial analysis should ensure that the envisaged capital expenditure program is affordable to Stellenbosch Municipality.

7.2 Costing of Capital Projects

Capital projects were identified through analysis and assessment of the following aspects:

- Expansion requirements, and
- Refurbishment requirements.

The costing of capital projects were done by using standard equipment cost, contained in an equipment library. The output from the various evaluation systems was used to set-up two program scenarios.

These scenarios evaluate:

- The Capital requirements according to planning criteria (taking into consideration firm supply criteria), and
- A phased approach to implementing the development requirements.

This was one for both expansion and refurbishment projects. A geographic presentation of each project is provided in Volume B to this report. The project number (Pr Nr.) within the CAPEX correspond to the project number in Volume B.

Stellenbosch Municipality - Network Development [Criteria]						
Year	Pr Nr.	Project Name	Project Type	Project Description	Project Cost	
2006		New Watergang substation	Strengthening	[current project]		
2006		New Watergang sub supply feeders	Strengthening	[current project]		
2006		Langrug - Upper Lea Smith 11kV Feeder	Contingency	[current project]		
2006		La Provance - SS-208 11kV Feeder	Contingency	[current project]		
2007	1	Markotter 66kV Upgrade	Contingency	Markotter Busbar reconfiguration - Split Single Busbar, Add 1 x 66kV BusCoupler.	R	876,000
2007	2	Golf Course 66kV Expansion	Contingency	Expand Golf Course 66kV - 1 x 66kV Feeder Bay [Cable Circuit from Markotter Substation].	R	1,468,500
2007	3	Markotter 66kV Expansion	Contingency	Expand Markotter 66kV - 1 x 66kV Feeder Bay [Cable Circuit from Golf Course Substation].	R	1,468,500
2007	4	Golf Course - Markotter 66kV Cable	Contingency	New 1 x 66kV, 350Al/1C/Oil [500Al/1C/XLPE], 2.7km Cable from Golf Course to Markotter Substation.	R	6,480,000
2007	5	Cloetesville 66kV Expansion	Contingency	Expand Cloetesville 66kV - 1 x 66kV Feeder Bay [Cable Circuit from University Substation].	R	1,468,500
2007	6	University 66kV Expansion	Contingency	Expand University 66kV - 1 x 66kV Feeder Bay [Cable Circuit from Cloetesville Substation].	R	1,468,500
2007	7	Cloetesville - University 66kV Cable	Contingency	New 1 x 66kV, 350Al/1C/Oil [500Al/1C/XLPE], 4.0km Cable from Cloetesville to University Substation.	R	9,600,000
2007	8	Golf Dorp Substation	Development	New 11kV Substation for Golf Dorp Development.	R	2,601,000
2007	9	Golf Course Substation - Golf Dorp Feeders	Development	Add 2 x 11kV, 185Cu/3C, 2.2km Cables from Golf Course to New Golf Dorp Substation.	R	3,300,000
2007	10	University - Merriman Z Feeder Split	Contingency	Split 2 x parallel cables from University to Merriman Z to form 4 x 11kV, 150Al/3C Cables.	R	751,600
2007	31	Le Quntere – M/S upgrade	Contingency	Upgrade 1 x 11kV, 315kVA M/S to 500kVA.	R	300,000
2007	32	SS Cabri – WR L2 11kV feeder	Contingency	New 1 x 11kV, 70Cu/3C, 0.4km Cable from SS Cabri to WR L2.	R	222,400
2008	11	Devon Valley - RMU 11kV Feeder	Strengthening	Add 1 x 11kV, 70Cu/3C, 0.5km Cable from Devon Valley to New RMU between Hagen and Riool.	R	358,000
2008	33	Hugenote – SS Kruger 11kV feeder	Contingency	New 1 x 11kV, 95Cu/3C, 0.2km Cable from Hugenote to new 500kVA M/S, SS Kruger.	R	430,000
2008	34	Oaklodge – Akademie RMU	Contingency	New 1 x 11kV, RMU - Oaklodge / Akademie.	R	101,600
2008	35	Oaklodge / Akademie RMU – SS2 B9 11kV feeder	Contingency	New 1 x 11kV, 70Cu/3C, 0.4km Cable from Oaklodge / Akademie RMU to new 500kVA M/S, SS2 B9.	R	522,400
2008	36	SS2 B9 - SS2 B4H 11kV feeder	Contingency	New 1 x 11kV, 70Cu/3C, 0.4km Cable from SS2 B9 to new 500kVA M/S, SS2 B4H.	R	522,400
2008	37	SS2 B2 M/S	Contingency	New 1 x 11kV, 500kVA M/S, SS2 B2.	R	300,000
2008	38	SS2 C6 M/S upgrade	Contingency	Upgrade 1 x 11kV, 315kVA M/S to 500kVA.	R	300,000
2009	12	Markotter 66kV Expansion	Contingency	Expand Markotter 66kV - 1 x 66kV Feeder Bay [Cable Circuit from University Substation].	R	1,468,500
2009	13	University 66kV Expansion	Contingency	Expand University 66kV - 1 x 66kV Feeder Bay [Cable Circuit from Markotter Substation].	R	1,662,900
2009	14	Markotter - University 66kV Cable	Contingency	New 1 x 66kV, 350Al/1C/Oil [500Al/1C/XLPE], 2.8km Cable from Markotter to University Substation.	R	6,720,000
2009	15	Merriman Z - Kromrivier Feeder	Contingency	Add 1 x 11kV, 70Cu/3C, 0.8km Cable from Merriman Z to Kromrivier.	R	774,800
2010	16	Golf Course Substation - Tegnopark 3rd Feeder	Contingency	Add 1 x 11kV, 70Cu/3C, 2.25km Cable from Golf Course toTegnopark.	R	1,581,000
2010	17	Watergang Supply Cables	Strengthening	New 2 x 11kV, 70Cu/3C, 2.5km Cable from Cloetesville to Watergang.	R	2,780,000
2010	39	Hugenote - RMU 6 Feeder upgrade	Contingency	Upgrade 1 x 11kV, 70Cu/3C, 0.72km Cable from Hugenote to RMU 6.	R	500,320
2011	18	Watergang - Vinyard 7 Tie Feeder	Strengthening	Add 1 x 11kV, 35Cu/3C, 0.48km from Watergang to Vinyard 7 minisub.	R	209,760
2011	19	Tennant, Curry Bus Couplers	Operational	Close both the Tennant and Curry bus couplers, and operate in this position under steady state conditions.	R	50,000
2011	40	Franshoek - Monument 11kV Feeder	Contingency	New 1 x 11kV, 120Cu/3C, 4.3km Cable from Franschhoek to Monument Substation.	R	3,340,000
2012	20	Jan Marais Expansion [Transformer]	Expansion	Add 1 x 66/11kV, 10MVA Transformer. Expand 1 x 66kV Bay and 1 x 11kV Switchgear.	R	3,849,500
2012	21	Tegnopark - Proton 11kV Feeder	Strengthening	Add 1 x 11kV, 70Cu/3C, 0.55km Cable & RMU from Tegnopark to Proton.	R	420,800
2014	22	Main 66kV Upgrade [Transformers]	Expansion	Replace 3 x 66/11kV, 7.5MVA with 3 x 66/11kV, 15MVA Transformers.	R	10,842,000
2014	23	Main Substation - Polkadraai 11kV Feeder	Strengthening	Add 1 x 11kV, 150Al/3C, 0.5km Cable from Main to Polkadraai Substation.	R	690,000
2016	24	Merriman Z - Langenhoven 3rd Feeder	Contingency	Add 1 x 11kV, 70Cu/3C, 0.23km Cable from Merriman Z to Langenhoven.	R	457,880
2016	25	Cloetesville - Curry 5th and 6th Feeders	Strengthening	Add 2 x 11kV, 95Cu/3C, 1.06km Cables from Cloetesville to Curry Substation.	R	1,938,000
2017	26	Suidwal - Stadsaal Feeder	Contingency	Add 1 x 11kV, 185Cu/3C, 0.95km Cable from Suidwal - Stadsaal Substation.	R	1,042,500
2018	27	Golf Course Substation - Golf Dorp 3rd Feeder	Contingency	Add 1 x 11kV, 185Cu/3C, 2.2km Cable from Golf Course to Golf Dorp.	R	1,980,000
2019	41	Franshoek - Groendal 3rd Feeder	Contingency	New 1 x 11kV, 185Cu/3C, 0.56km Cable from Franschhoek to Groendal Substation.	R	750,000
2020	28	Golf Course Expansion [Transformer]	Expansion	Add 1 x 66/11kV, 20MVA Transformer. Expand 1 x 66kV Bay and 1 x 11kV Switchgear.	R	4,349,500
2021	29	Merriman Z - JC Smuts 2nd Feeder	Contingency	Add 1 x 11kV, 70Cu/3C, 0.29km Cable from Merriman Z to JC Smuts.	R	491,240
2024	30	Brandwacht - Brandwacht 2 11kV Feeder	Contingency	Upgrade 1 x 11kV, 70Cu/3C, 0.18km Cable from Brandwacht to Brandwacht 2 Substation.	R	430,080
				Excluding to this project cost are all Sites and Servitudes.		
					R	**78,868,180**

Table 7-1: Stellenbosch Municipality Expansion CAPEX – According to Criteria

Stellenbosch Municipality - Network Development [Phased]						
Year	**Pr Nr.**	**Project Name**	**Project Type**	**Project Description**	**Project Cost**	
2006		New Watergang substation	Strengthening	[current project]		
2006		New Watergang sub supply feeders	Strengthening	[current project]		
2006		Langrug - Upper Lea Smith 11kV Feeder	Contingency	[current project]		
2006		La Provance - SS-208 11kV Feeder	Contingency	[current project]		
2007	8	Golf Dorp Substation	Development	New 11kV Substation for Golf Dorp Development.	R	2,601,000
2007	9	Golf Course Substation - Golf Dorp Feeders	Development	Add 2 x 11kV, 185Cu/3C, 2.2km Cables from Golf Course to New Golf Dorp Substation.	R	3,300,000
2007	10	University - Merriman Z Feeder Split	Contingency	Split 2 x parallel cables from University to Merriman Z to form 4 x 11kV, 150Al/3C Cables.	R	751,600
2007	31	Le Quntere – M/S upgrade	Contingency	Upgrade 1 x 11kV, 315kVA M/S to 500kVA.	R	300,000
2007	32	SS Cabri – WR L2 11kV feeder	Contingency	New 1 x 11kV, 70Cu/3C, 0.4km Cable from SS Cabri to WR L2.	R	222,400
2008	11	Devon Valley - RMU 11kV Feeder	Strengthening	Add 1 x 11kV, 70Cu/3C, 0.5km Cable from Devon Valley to New RMU between Hagen and Riool.	R	358,000
2008	33	Hugenote – SS Kruger 11kV feeder	Contingency	New 1 x 11kV, 95Cu/3C, 0.2km Cable from Hugenote to new 500kVA M/S, SS Kruger.	R	430,000
2008	34	Oaklodge – Akademie RMU	Contingency	New 1 x 11kV, RMU - Oaklodge / Akademie.	R	101,600
2008	35	Oaklodge / Akademie RMU – SS2 B9 11kV feeder	Contingency	New 1 x 11kV, 70Cu/3C, 0.4km Cable from Oaklodge / Akademie RMU to new 500kVA M/S, SS2 B9.	R	522,400
2008	36	SS2 B9 - SS2 B4H 11kV feeder	Contingency	New 1 x 11kV, 70Cu/3C, 0.4km Cable from SS2 B9 to new 500kVA M/S, SS2 B4H.	R	522,400
2008	37	SS2 B2 M/S	Contingency	New 1 x 11kV, 500kVA M/S, SS2 B2.	R	300,000
2008	38	SS2 C6 M/S upgrade	Contingency	Upgrade 1 x 11kV, 315kVA M/S to 500kVA.	R	300,000
2009	1	Markotter 66kV Upgrade	Contingency	Markotter Busbar reconfiguration - Split Single Busbar, Add 1 x 66kV BusCoupler.	R	876,000
2009	12	Markotter 66kV Expansion	Contingency	Expand Markotter 66kV - 1 x 66kV Feeder Bay [Cable Circuit from University Substation].	R	1,468,500
2009	13	University 66kV Expansion	Contingency	Expand University 66kV - 1 x 66kV Feeder Bay [Cable Circuit from Markotter Substation].	R	1,662,900
2009	14	Markotter - University 66kV Cable	Contingency	New 1 x 66kV, 350Al/1C/Oil [500Al/1C/XLPE], 2.8km Cable from Markotter to University Substation.	R	6,720,000
2009	15	Merriman Z - Kromrivier Feeder	Contingency	Add 1 x 11kV, 70Cu/3C, 0.8km Cable from Merriman Z to Kromrivier.	R	774,800
2010	16	Golf Course Substation - Tegnopark 3rd Feeder	Contingency	Add 1 x 11kV, 70Cu/3C, 2.25km Cable from Golf Course toTegnopark.	R	1,581,000
2010	17	Watergang Supply Cables	Strengthening	New 2 x 11kV, 70Cu/3C, 2.5km Cable from Cloetesville to Watergang.	R	2,780,000
2010	39	Hugenote - RMU 6 Feeder upgrade	Contingency	Upgrade 1 x 11kV, 70Cu/3C, 0.72km Cable from Hugenote to RMU 6.	R	500,320
2011	18	Watergang - Vinyard 7 Tie Feeder	Strengthening	Add 1 x 11kV, 35Cu/3C, 0.48km from Watergang to Vinyard 7 minisub.	R	209,760
2011	19	Tennant, Curry Bus Couplers	Operational	Close both the Tennant and Curry bus couplers, and operate in this position under steady state conditions.	R	50,000
2011	40	Franshoek - Monument 11kV Feeder	Contingency	New 1 x 11kV, 120Cu/3C, 4.3km Cable from Franschhoek to Monument Substation.	R	3,340,000
2012	20	Jan Marais Expansion [Transformer]	Expansion	Add 1 x 66/11kV, 10MVA Transformer. Expand 1 x 66kV Bay and 1 x 11kV Switchgear.	R	3,849,500
2012	21	Tegnopark - Proton 11kV Feeder	Strengthening	Add 1 x 11kV, 70Cu/3C, 0.55km Cable & RMU from Tegnopark to Proton.	R	420,800
2013	2	Golf Course 66kV Expansion	Contingency	Expand Golf Course 66kV - 1 x 66kV Feeder Bay [Cable Circuit from Markotter Substation].	R	1,468,500
2013	3	Markotter 66kV Expansion	Contingency	Expand Markotter 66kV - 1 x 66kV Feeder Bay [Cable Circuit from Golf Course Substation].	R	1,468,500
2013	4	Golf Course - Markotter 66kV Cable	Contingency	New 1 x 66kV, 350Al/1C/Oil [500Al/1C/XLPE], 2.7km Cable from Golf Course to Markotter Substation.	R	6,480,000
2014	22	Main 66kV Upgrade [Transformers]	Expansion	Replace 3 x 66/11kV, 7.5MVA with 3 x 66/11kV, 15MVA Transformers.	R	10,842,000
2014	23	Main Substation - Polkadraai 11kV Feeder	Strengthening	Add 1 x 11kV, 150Al/3C, 0.5km Cable from Main to Polkadraai Substation.	R	690,000
2016	24	Merriman Z - Langenhoven 3rd Feeder	Contingency	Add 1 x 11kV, 70Cu/3C, 0.23km Cable from Merriman Z to Langenhoven.	R	457,880
2016	25	Cloetesville - Curry 5th and 6th Feeders	Strengthening	Add 2 x 11kV, 95Cu/3C, 1.06km Cables from Cloetesville to Curry Substation.	R	1,938,000
2017	26	Suidwal - Stadsaal Feeder	Contingency	Add 1 x 11kV, 185Cu/3C, 0.95km Cable from Suidwal - Stadsaal Substation.	R	1,042,500
2018	27	Golf Course Substation - Golf Dorp 3rd Feeder	Contingency	Add 1 x 11kV, 185Cu/3C, 2.2km Cable from Golf Course to Golf Dorp.	R	1,980,000
2019	41	Franshoek - Groendal 3rd Feeder	Contingency	New 1 x 11kV, 185Cu/3C, 0.56km Cable from Franschhoek to Groendal Substation.	R	750,000
2020	28	Golf Course Expansion [Transformer]	Expansion	Add 1 x 66/11kV, 20MVA Transformer. Expand 1 x 66kV Bay and 1 x 11kV Switchgear.	R	4,349,500
2021	29	Merriman Z - JC Smuts 2nd Feeder	Contingency	Add 1 x 11kV, 70Cu/3C, 0.29km Cable from Merriman Z to JC Smuts.	R	491,240
2024	30	Brandwacht - Brandwacht 2 11kV Feeder	Contingency	Upgrade 1 x 11kV, 70Cu/3C, 0.18km Cable from Brandwacht to Brandwacht 2 Substation.	R	430,080
2025	5	Cloetesville 66kV Expansion	Contingency	Expand Cloetesville 66kV - 1 x 66kV Feeder Bay [Cable Circuit from University Substation].	R	1,468,500
2025	6	University 66kV Expansion	Contingency	Expand University 66kV - 1 x 66kV Feeder Bay [Cable Circuit from Cloetesville Substation].	R	1,468,500
2025	7	Cloetesville - University 66kV Cable	Contingency	New 1 x 66kV, 350Al/1C/Oil [500Al/1C/XLPE], 4.0km Cable from Cloetesville to University Substation.	R	9,600,000
				Excluding to this project cost are all Sites and Servitudes.		
					R	**78,868,180**

Table 7-2: Stellenbosch Municipality Expansion CAPEX – Phased

Stellenbosch Municipality - Network Refurbishment [Criteria]					
Year	Pr Nr.	Project Name	Project Type	Project Description	Project Cost
2007	1	Main - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-10 [1970] AEI circuit breakers [10].	R 1,200,000
2007	2	Main - Surge Arrestors [66kV]	Refurbishment	Add 66kV Surge Arrestors to the Transformers, 3 Transformers - 66kV Surge Arrestors [9].	R 58,500
2007	3	Suidwal - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-22 [1970] AEI circuit breakers [22].	R 2,640,000
2007	4	Markotter - Surge Arrestors [66kV]	Refurbishment	Add 66kV Surge Arrestors to the Transformers, 3 Transformers - 66kV Surge Arrestors [9].	R 58,500
2007	5	Jan Marais - Surge Arrestors [66kV]	Refurbishment	Add 66kV Surge Arrestors to the Transformers, 2 Transformers - 66kV Surge Arrestors [6].	R 39,000
2007	6	Polkadraai - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-6 [1948-1977] Reyrolle [6].	R 720,000
2007	7	Tindal - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-7 [1950-1967] Reyrolle [7].	R 840,000
2007	8	Distell - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 9-11 [1960] [3].	R 360,000
2007	9	Papagaairand - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 4-11 [1952-1967] Reyrolle [8].	R 960,000
2007	10	Devon Valley - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1961-1967] Reyrolle [5].	R 600,000
2007	11	Bosman - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2, 6-12 [1948-1971] Reyrolle [8].	R 960,000
2007	12	Begraafplaas - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 8-12 [1946-1961] Reyrolle [5].	R 600,000
2007	13	SDR Kliniek - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1948-1967] Reyrolle [5].	R 600,000
2007	14	La Colline - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1961-1967] Reyrolle [5].	R 600,000
2007	15	Tortelduif - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1948-1967] Reyrolle [5].	R 600,000
2007	16	Dalsig Oos - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 4-9 [1948-1964] Reyrolle [6].	R 720,000
2007	17	Blakes Estate - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-8 [1961-1967] Reyrolle [8].	R 960,000
2007	18	Sonneblom - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-6 [1961-1967] Reyrolle [6].	R 720,000
2007	19	Krige - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-6 [1961] Long and Crawford [6].	R 720,000
2007	20	Marais Park - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1961-1967] Long and Crawford [6].	R 720,000
2007	21	Kromrivier - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-7 [1961-1982] Reyrolle [7].	R 840,000
2007	22	Langstr Suid - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2-6 [1948-1968] Reyrolle [5].	R 600,000
2007	23	Coetzenburg - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 3-8 [1960-1967] Reyrolle [6].	R 720,000
2007	24	Lower Dorp - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1961-1964] Reyrolle [5].	R 600,000
2007	25	Karendal - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1961-1975] Reyrolle [5].	R 600,000
2007	26	Uniepark - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-8 [1948-1967] Reyrolle / Long and Crawford [8].	R 960,000
2007	27	Hoffman - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 3-4, 6-8 [1960-1961] Reyrolle [5].	R 600,000
2008	28	Universiteit - Outdoor Breakers [66kV]	Refurbishment	Replace the Tx1, Tx2 and Tx3, 66kV Outdoor Circuit breakers [3].	R 1,095,000
2008	29	Jan Marais - Outdoor Breakers [66kV]	Refurbishment	Replace the University, Markotter, Tx1 and Tx2, 66kV Outdoor Circuit breakers [4].	R 1,460,000
2008	30	Jan Marais - Isolators [66kV]	Refurbishment	Replace the University, Markotter, Tx1 and Tx2, 66kV Isolators [4].	R 312,000
2008	31	MerrimanZ - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5, 7-12 [1960-1974] Reyrolle [12].	R 1,440,000
2008	32	Denneoord - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1961-1974] Reyrolle [5].	R 600,000
2010	33	Boord - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 10-11, 13-15 [1973-1978] Reyrolle [5].	R 600,000
2013	34	Jan Marais - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 4-11 [1978] Reyrolle [8].	R 960,000
2013	35	Dalsig Oos - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-3 [1978-1982] Reyrolle [3].	R 360,000
2013	36	Lower Dorp - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 6-8, 10-11 [1978-1982] Reyrolle [5].	R 600,000
2014	37	Begraafplaas - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 4-7 [1978-1983] Reyrolle [4].	R 480,000
2015	38	Coetzenburg - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-2 [1980] Reyrolle [2].	R 240,000
2015	39	Hoffman - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-2, 5, 9 [1973-1985] Reyrolle [4].	R 480,000
2020	40	Jan Marais - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2, 12-13 [1981-1985] Reyrolle [3].	R 360,000
2020	41	Braak - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2-13 [1984-1989] Reyrolle [12].	R 1,440,000
2020	42	Boord - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2-9, 12, 16 [1982-1990] Reyrolle [10].	R 1,200,000
2020	43	Kerk - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-6 [1984-1986] Reyrolle [6].	R 720,000
2021	44	Markotter - 66/11kV, 7.5MVA Transformers	Refurbishment	Replace the 66/11kV, 7.5MVA [Tx1, Tx2] with new 66/11kV, 7.5MVA Transformers [1971 - 50 years].	R 4,000,000
2022	45	Universiteit - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 7-19 [1980 - 1989] Reyrolle circuit breakers [13].	R 1,560,000
2022	46	Tegno Park - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-2, 4-7 [1987] Reyrolle [6].	R 720,000
2023	47	Markotter - 66/11kV, 7.5MVA Transformer	Refurbishment	Replace the 66/11kV, 7.5MVA [Tx3] with new 66/11kV, 7.5MVA Transformer [1973 - 50 years].	R 2,000,000
2024	48	Markotter - Isolators [66kV]	Refurbishment	Replace the Tx1 and Bus Section, 66kV Isolators [2].	R 156,000
2024	49	Universiteit - Outdoor Breaker [66kV]	Refurbishment	Replace the Main Feeder, 66kV Outdoor Circuit breakers [1].	R 365,000
2024	50	Universiteit - Isolators [66kV]	Refurbishment	Replace the Tx1, Tx2, Main, Jan Marais and Bus Section, 66kV Isolators [5].	R 390,000
2024	51	Universiteit - Surge Arrestors [66kV]	Refurbishment	Replace the 66kV Surge Arrestors to the Transformers, 3 Transformers - 66kV Surge Arrestors [9].	R 58,500
2025	52	Tennant - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2-18 [1985-1992] Reyrolle [17].	R 2,040,000
2025	53	Paradyskloof - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2-3, 6, 8-15 [1984-1990] Reyrolle [11].	R 1,320,000
					R 44,552,500

Table 7-3: Stellenbosch Municipality Refurbishment CAPEX – According to Criteria

Stellenbosch Municipality - Network Refurbishment [Phased]

Year	Pr Nr.	Project Name	Project Type	Project Description	Project Cost
2007	1	Main - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-10 [1970] AEI circuit breakers [10].	R 1,200,000
2007	2	Main - Surge Arrestors [66kV]	Refurbishment	Add 66kV Surge Arrestors to the Transformers, 3 Transformers - 66kV Surge Arrestors [9].	R 58,500
2007	3	Suidwal - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-22 [1970] AEI circuit breakers [22].	R 2,640,000
2007	4	Markotter - Surge Arrestors [66kV]	Refurbishment	Add 66kV Surge Arrestors to the Transformers, 3 Transformers - 66kV Surge Arrestors [9].	R 58,500
2007	5	Jan Marais - Surge Arrestors [66kV]	Refurbishment	Add 66kV Surge Arrestors to the Transformers, 2 Transformers - 66kV Surge Arrestors [6].	R 39,000
2007	6	Polkadraai - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-6 [1948-1977] Reyrolle [6].	R 720,000
2007	7	Tindal - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-7 [1950-1967] Reyrolle [7].	R 840,000
2007	8	Distell - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 9-11 [1960] [3].	R 360,000
2008	9	Papagaairand - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 4-11 [1952-1967] Reyrolle [8].	R 960,000
2008	10	Devon Valley - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1961-1967] Reyrolle [5].	R 600,000
2008	11	Bosman - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2, 6-12 [1948-1971] Reyrolle [8].	R 960,000
2008	12	Begraafplaas - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 8-12 [1946-1961] Reyrolle [5].	R 600,000
2008	13	SDR Kliniek - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1948-1967] Reyrolle [5].	R 600,000
2008	14	La Colline - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1961-1967] Reyrolle [5].	R 600,000
2008	15	Tortelduif - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1948-1967] Reyrolle [5].	R 600,000
2008	16	Dalsig Oos - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 4-9 [1948-1964] Reyrolle [6].	R 720,000
2009	17	Blakes Estate - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-8 [1961-1967] Reyrolle [8].	R 960,000
2009	18	Sonneblom - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-6 [1961-1967] Reyrolle [6].	R 720,000
2009	19	Krige - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-6 [1961] Long and Crawford [6].	R 720,000
2009	20	Marais Park - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1961-1967] Long and Crawford [6].	R 720,000
2009	21	Kromrivier - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-7 [1961-1982] Reyrolle [7].	R 840,000
2009	22	Langstr Suid - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2-6 [1948-1968] Reyrolle [5].	R 600,000
2009	23	Coetzenburg - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 3-8 [1960-1967] Reyrolle [6].	R 720,000
2009	24	Lower Dorp - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1961-1964] Reyrolle [5].	R 600,000
2010	25	Karendal - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1961-1975] Reyrolle [5].	R 600,000
2010	26	Uniepark - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-8 [1948-1967] Reyrolle / Long and Crawford [8].	R 960,000
2010	27	Hoffman - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 3-4, 6-8 [1960-1961] Reyrolle [5].	R 600,000
2010	28	Universiteit - Outdoor Breakers [66kV]	Refurbishment	Replace the Tx1, Tx2 and Tx3, 66kV Outdoor Circuit breakers [3].	R 1,095,000
2010	29	Jan Marais - Outdoor Breakers [66kV]	Refurbishment	Replace the University, Markotter, Tx1 and Tx2, 66kV Outdoor Circuit breakers [4].	R 1,460,000
2010	30	Jan Marais - Isolators [66kV]	Refurbishment	Replace the University, Markotter, Tx1 and Tx2, 66kV Isolators [4].	R 312,000
2010	31	MerrimanZ - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5, 7-12 [1960-1974] Reyrolle [12].	R 1,440,000
2011	32	Denneoord - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-5 [1961-1974] Reyrolle [5].	R 600,000
2011	33	Boord - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 10-11, 13-15 [1973-1978] Reyrolle [5].	R 600,000
2013	34	Jan Marais - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 4-11 [1978] Reyrolle [8].	R 960,000
2013	35	Dalsig Oos - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-3 [1978-1982] Reyrolle [3].	R 360,000
2013	36	Lower Dorp - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 6-8, 10-11 [1978-1982] Reyrolle [5].	R 600,000
2014	37	Begraafplaas - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 4-7 [1978-1983] Reyrolle [4].	R 480,000
2015	38	Coetzenburg - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-2 [1980] Reyrolle [2].	R 240,000
2015	39	Hoffman - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-2, 5, 9 [1973-1985] Reyrolle [4].	R 480,000
2020	40	Jan Marais - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2, 12-13 [1981-1985] Reyrolle [3].	R 360,000
2020	41	Braak - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2-13 [1984-1989] Reyrolle [12].	R 1,440,000
2020	42	Boord - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2-9, 12, 16 [1982-1990] Reyrolle [10].	R 1,200,000
2020	43	Kerk - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-6 [1984-1986] Reyrolle [6].	R 720,000
2021	44	Markotter - 66/11kV, 7.5MVA Transformers	Refurbishment	Replace the 66/11kV, 7.5MVA [Tx1, Tx2] with new 66/11kV, 7.5MVA Transformers [1971 - 50 years].	R 4,000,000
2022	45	Universiteit - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 7-19 [1980 - 1989] Reyrolle circuit breakers [13].	R 1,560,000
2022	46	Tegno Park - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 1-2, 4-7 [1987] Reyrolle [6].	R 720,000
2023	47	Markotter - 66/11kV, 7.5MVA Transformer	Refurbishment	Replace the 66/11kV, 7.5MVA [Tx3] with new 66/11kV, 7.5MVA Transformer [1973 - 50 years].	R 2,000,000
2024	48	Markotter - Isolators [66kV]	Refurbishment	Replace the Tx1 and Bus Section, 66kV Isolators [2].	R 156,000
2024	49	Universiteit - Outdoor Breaker [66kV]	Refurbishment	Replace the Main Feeder, 66kV Outdoor Circuit breakers [1].	R 365,000
2024	50	Universiteit - Isolators [66kV]	Refurbishment	Replace the Tx1, Tx2, Main, Jan Marais and Bus Section, 66kV Isolators [5].	R 390,000
2024	51	Universiteit - Surge Arrestors [66kV]	Refurbishment	Replace the 66kV Surge Arrestors to the Transformers, 3 Transformers - 66kV Surge Arrestors [9].	R 58,500
2025	52	Tennant - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2-18 [1985-1992] Reyrolle [17].	R 2,040,000
2025	53	Paradyskloof - Switchgear [11kV]	Refurbishment	Replace the 11kV switchgear: Panel 2-3, 6, 8-15 [1984-1990] Reyrolle [11].	R 1,320,000
					R 44,552,500

Table 7-4: Stellenbosch Municipality Refurbishment CAPEX – Phased

NETGroup

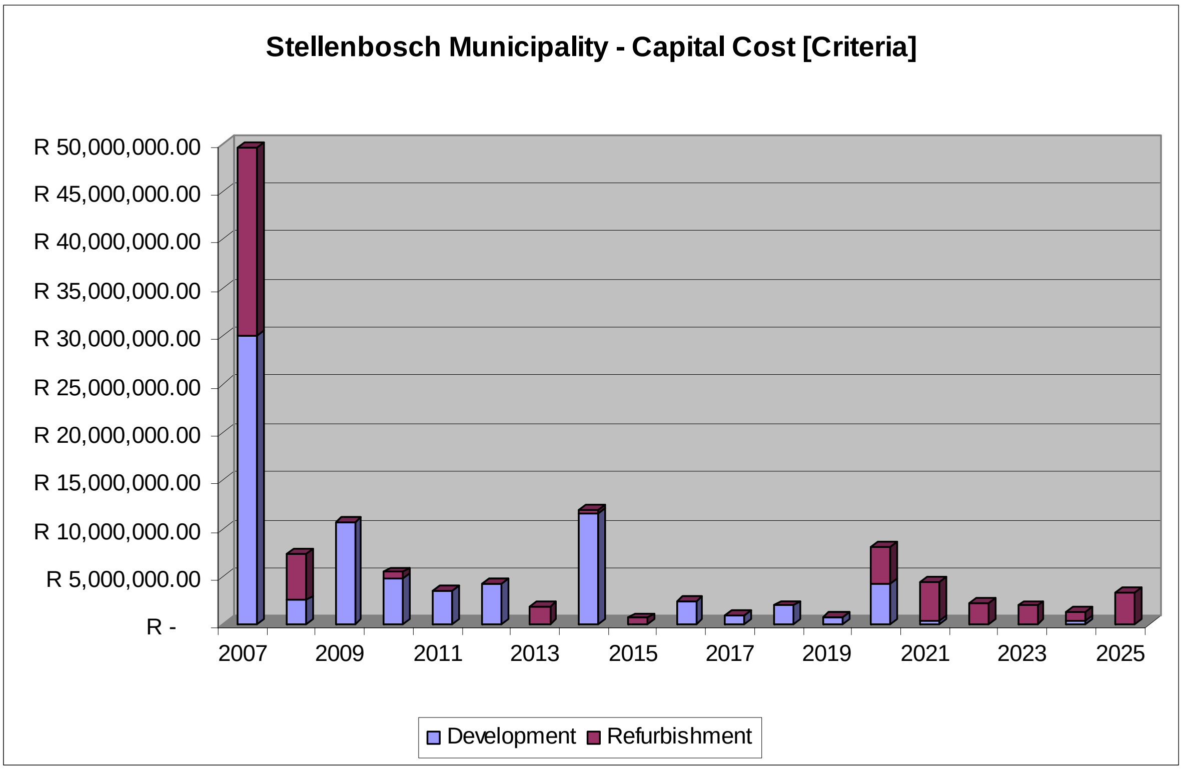


Figure 7-1: Stellenbosch Municipality Combined CAPEX – According to Criteria

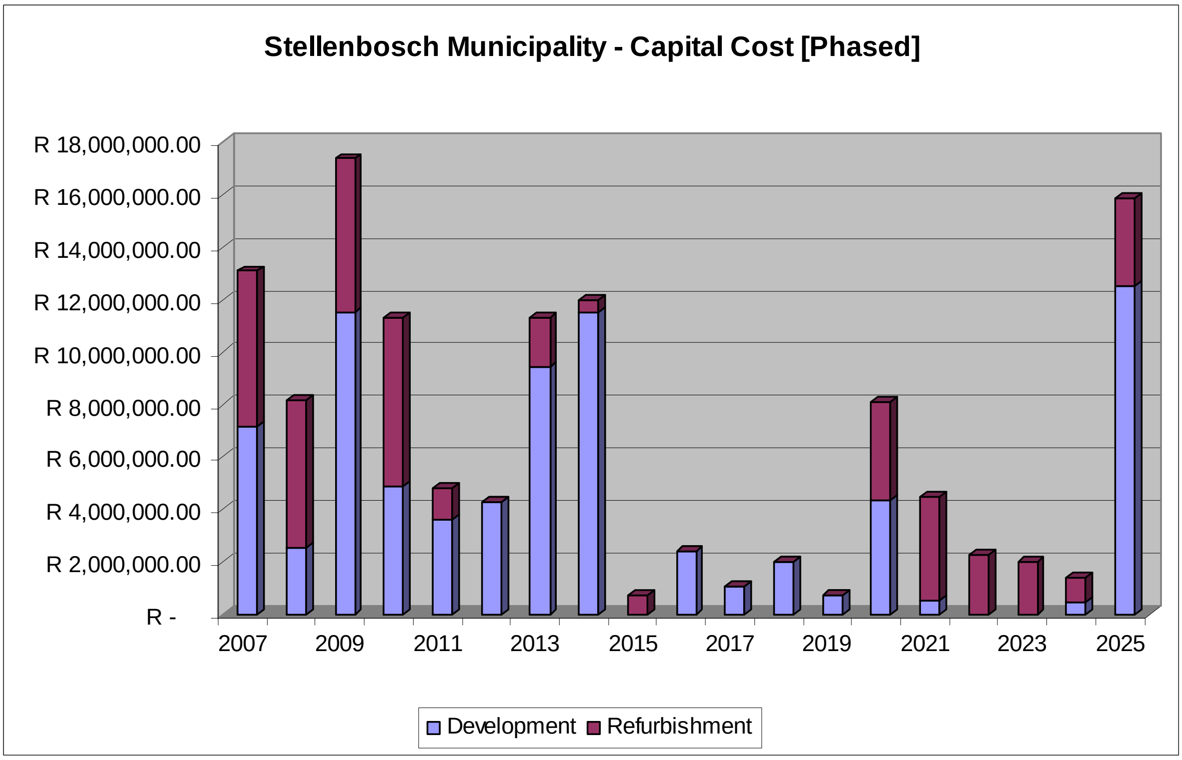


Figure 7-2: Stellenbosch Municipality Combined CAPEX - Phased

7.3 Linking with Load Forecast Model

The load forecast model developed during this study provides vital input for the financial evaluation. Per unit purchase and selling rates are calculated and extrapolated according to the load growth of the study area. The load zones and their corresponding load parameters as defined in the Load Forecast model are used to calculate expected energy consumption and subsequent revenue.

7.4 Financial Evaluation

For the financial evaluation, the costs of the formulated scenarios are compared to determine the most viable financial solutions. Discounted Cash Flow (DCF) methods are used in which the expected capital requirements for the proposed technical solutions are evaluated over the normal expected life of the assets.

The results of DCF calculations over extended periods can be sensitive to variations in certain input parameters. Literature has shown that the financial evaluation results are most sensitive to changes in load growth and real discount rate. The real discount rate is defined as;

$$R(\%) = [1 - (1 + \frac{I}{100}) + (1 + \frac{E}{100})] \times 100 \qquad (7.1)$$

Where I = nominal interest rate in % per annum (10% for the study)

E = inflation or escalation rate in % per annum (6% for the study)

The representation of results in the form of Net Present Value (NPV), enables one to determine the robustness of the preferred solution to variations in the input parameters chosen for the sensitivity analysis. The Present Value (PV) of the future cash flows can be determined by means of the following equation:

$$PV_n = \frac{Cash\_Flow_n}{(1 + \frac{R}{100})^n} \qquad (7.2)$$

Where PV_n = Present Value of Cash Flown

n = number of years

R = real discount rate in %

The present value must then be applied to all future cash flows that stem from the proposed investment:

$$NPV_n = PV_{incremental\_revenue} - PV_{incremental\_cost} \qquad (7.3)$$

Where

Incremental revenue = incremental sales X tariff

Incremental costs = capital + cost of purchase incremental sales + incremental operating and maintenance costs

An Internal Rate of Return (IRR) will be calculated based on the difference in systems present value (PV) for no load growth and no capital expenditure compared to load growth with the capital expenditure. The IRR is therefore an indication of how profitable the capital investment will be over and above the present network.

7.4.1 Financial Parameters

The financial parameters used for the financial analysis are shown below. Average purchase and selling rates where determined from account information.

Table 7-5: Financial Parameters

Parameter	Value
Escalation Rate (%)	6.0 %
Interest rate on Capital (Discount Rate) %	10 %
% Distribution Losses	7 %
% Operation & Maintenance Cost	5 %
Average Power Factor	0.92
System Load Factor	0.65
Purchase Rate c/kWh	13
Selling Rate c/kWh	26
% Non Payment	10%

7.4.1.1 Escalation Rate

The escalation rate has been chosen as 6% that is comparable to the current inflation rate. This parameter is highly dependent on economic prosperity and the South African exchange rate to stronger currencies.

7.4.1.2 Interest Rate

This parameter has been fixed at the current interest rate but in real terms is dependent on economic factors.

7.4.1.3 % Losses

Losses for Distribution have been set at 7%. This value is representative of similar networks and can be modified should better information become available.

7.5 Capital and Financial Evaluation

Both capital programs scenarios were found to be viable.

8 Addendums:

Addendum A: Planning Criteria,

Addendum B: Refurbishment Audit Methodology,

Addendum C: Network Assessment under Contingency,

ADDENDUM A: PLANNING CRITERIA

ADDENDUM B: REFUBISHMENT AUDIT METHODOLOGY

ADDENDUM C: NETWORK ASSESSMENT UNDER CONTINGENCY