

Geographical Load Forecasting

- The Tutorial -

Presenter: Monde Soni

Seminar: Domestic Electric Loads (consumption, demand & profiles)

Venue: John Maree Auditorium, Eskom Academy of Learning, Midrand

Date: 12 November 2014

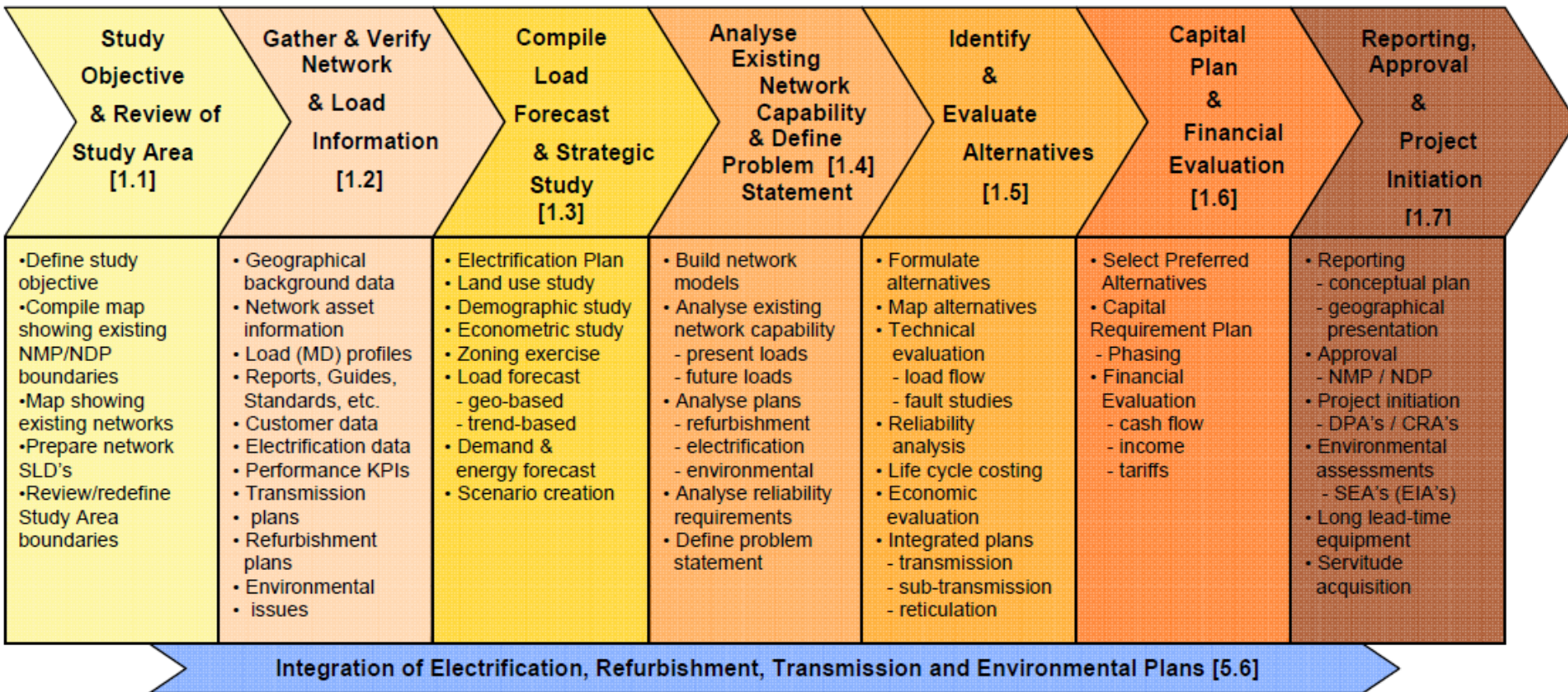
Powering your world



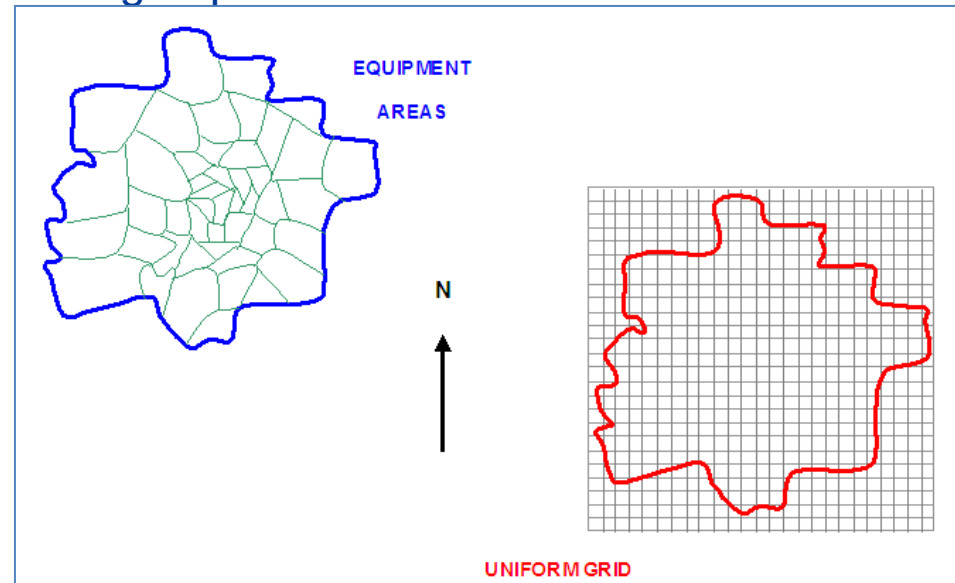
- This tutorial demonstrates how the domestic load (consumptions, demand and profiles) is used in Eskom Distribution (Dx) Planning, to forecast the load and plan the electrical infrastructure. The presentation will deal with the following aspects:
 - Planning Process/Methodology Overview;
 - Small Area Forecast;
 - Geographical Based Load Forecast Methodology;
 - Load Subclasses;
 - Load mix for capacity planning;
 - Potential Demand Modelling;
 - Conclusion; and
 - Areas of Improvement.



1. Background



- Small Area Forecasting concept dates back to the early 1950's.
- GLF: *Geo-based load forecasting can be defined as the approach to forecast the future electrical demand by splitting the study area into smaller subdivisions on the map, followed by assignment of electrical properties to the subdivisions using the load classes, forecasting the individual subdivisions on a coordinated or non-coordinated basis, and aggregating the sum of the forecasts to cover the bigger study area. The process involves defining load classification according to the economic class and electrical demand properties.*
- The load is forecasted to show the following aspects:
 - Where,
 - When,
 - How Much, and
 - What.



PowerGLF Tool

Forecast Explorer 2012

Load Hierarchy | Load List | Portion List

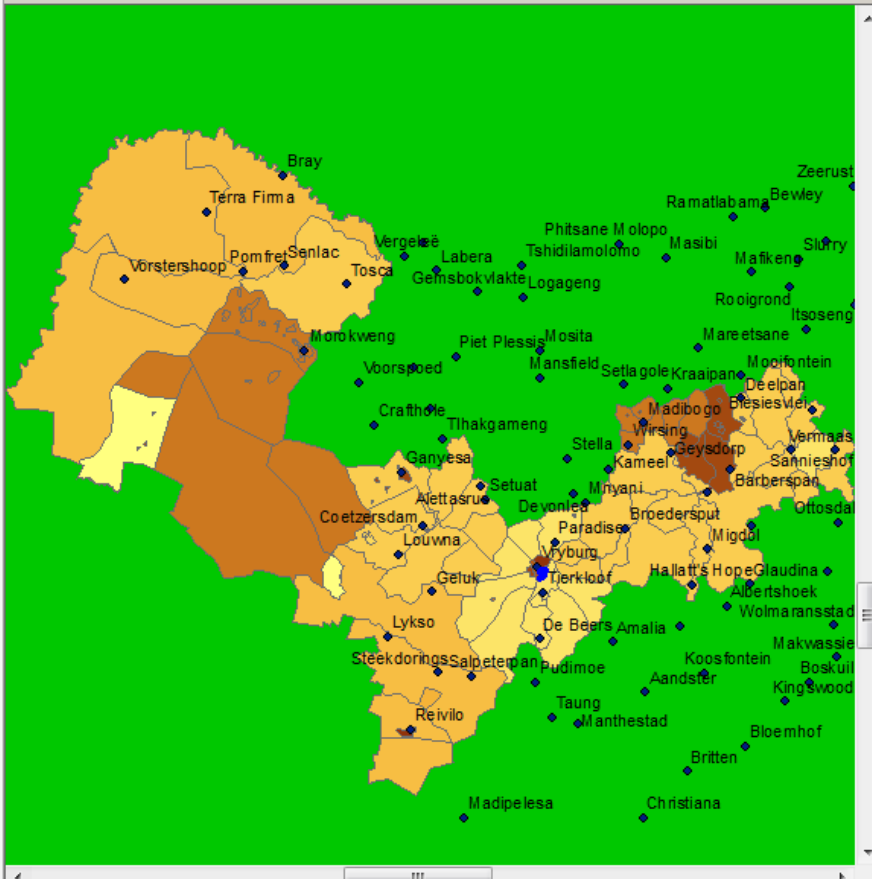
Bookmarks

ID

- Delareyville_Vryburg NDP
 - _Mookodi MTS 400/132kV
 - DELAREYVILLE MUN 88/22/11kV Substation
 - DELAREYVILLE MUN 2x 20MVA 88/22kV
 - _Botselo Mills (new)
 - _Rapule 22kV fdr
 - _Rooiwal fdr
 - DELAREYVILLE MUNIC / BARBERSPAN 1 22kV Feeder
 - DELAREYVILLE MUNIC / BOSCHRAND 1 22kV Feeder
 - DELAREYVILLE MUNIC / HARTSRIVIER 1 22kV Feeder
 - DELAREYVILLE MUNIC / MADIBOGO 1 22kV Feeder
 - DELAREYVILLE MUNIC / MIGDOL RURAL 1 22kV Feeder
 - DELAREYVILLE MUN 2x 5MVA 88/11kV
 - HEUNINGVLEI 132/22kV Substation
 - KAALPUT 88/22kV Substation
 - PERING 132/66kV Substation
 - SANNIESHOF MUN 88/22/11kV Substation
 - VESEL 132/22kV Substation
 - VRYBURG 88/11kV Substation
 - WOODHOUSE 88/22kV Substation

Graphs | **GIS Overview**

1:2 408 148



Display Options

General

Display Year	2012
Auto Zoom	False
Auto Create Node Polygons	False
Default Day Type	Total Max.
Default Scenario	Low

Load Hierarchy

Display text - position 1	Name
Display text - position 2	Description
Mouse hover hint field	<none>

Day Type

Total Max.	True
Summer Weekday	True
Winter weekday	True

Auto Zoom

Automatically zoom to selected item in GIS Overview

Attribute Editor

Load Portion Info

Portion Type	Load
Name	VB_VRYBURG MU
Description	New Load Object 1
Comment	
Base Load	967
SIC Code	0
Location	Not specified
Tariff	Not specified
Suggested Subclass	Not specified
Subclass	RurRes LD_1_2
Inherit from Subclass	True
Load Factor	0.6

Base Forecast Parameters

Low | Customer Based; F

Network (planning)

Where

What; How Much; When

- The subclass may be defined as the load categorisation according to economic class, energy consumption characteristics and location.
- It is used as means of converting input information (to PowerGLF) into electrical terms (kVA, MW, etc).
- PowerGLF consists of a Class Library, that hosts load classes and subclasses. The library has the following attributes:
 - Load Classes
 - Subclasses
 - Economic classification
 - 24-hour consumption profile
 - Growth Curves associated with the subclass
 - ADMD (kVA and kVA/ha)

Load Subclasses Library

Class Library

Name

Description

Administrator Classes

New Class

Open Space

Domestic

UrbTwn HD 7_8h

UrbRes MD 8_9l

UrbTwn LD 9_10h

UrbTwn MD 7_8h

UrbEst LD 10h+

RurRes LD 1_2

UrbRes LD 7_7h

UrbRes HD 8_9l

UrbRes LD 8_9l

Township 5_6

UrbRes MD 7_7h

UrbTwn HD 9_10h

UrbTwn LD 7_8h

UrbTwn MD 9_10h

New Class

Income 11600 - 19116. Normally high-density, in complexes that incorporate security or other shared facilities. Dwellings may be single or multi

Income 11600 - 24500. Built floor-area of main dwellings is around 190 m2, and none of the buildings are multistorey.

Income 26500 - 65500. Normally very highdensity in complexes that incorporate security. Dwellings may be single or multi-storey, with total (liv

Income 11600 - 19116. Normally high-density, in complexes that incorporate security or other shared facilities. Dwellings may be single or multi

Income 65000 - 100000. Dwellings are mostly multi-storey, brick or concrete, having floor areas in the region of 300-500m2 in regions with sor

Income 0 - 1800. Mixture of modern (matchbox and RDP) and traditional construction methods

Income 7800 - 11600. Typical dwellings range in size from 80-170m2. Most of such houses generally have some visible repair/maintenance n

Income 11600 - 24500. Built floor-area of main dwellings is around 190 m2, and none of the buildings are multistorey.

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Income 3200 - 7800. Consist of low-income flats at the bottom-end of the scale to old township houses and newer government schemes

Income 7800 - 11600. Typical dwellings range in size from 80-170m2. Most of such houses generally have some visible repair/maintenance n

Income 26500 - 65500. Normally very highdensity in complexes that incorporate security. Dwellings may be single or multi-storey, with total (liv

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General

Name

Description

Comments

Preferred forecast method

Subclass association

Spatial Forecast Enabled

Cust. No. Forecast Enabled

Custom % Growth Forecast Enabled

Fixed % Growth Enabled

Fixed Increment Forecast Enabled

RurRes LD 1_2

Income 0 - 1800. Mixture of modern

Customer Based

False

True

False

False

False

FEM

Tariff

Profiles

Low

Likely

High

RurRes 1_2

RurRes 1_2

RurRes 1_2

Customer number forecast parameters

Low

Likely

High

RurRes 1_2 (Customer); 0.41

RurRes 1_2 (Customer); 0.41

RurRes 1_2 (Customer); 0.41

Likely

Profile settings for scenario Likely

OK

RurRes 1_2, Summer Weekday

RurRes 1_2, Winter weekday

2.5

2.0

1.5

1.0

0.5

0

01:00

03:00

05:00

07:00

09:00

11:00

13:00

15:00

17:00

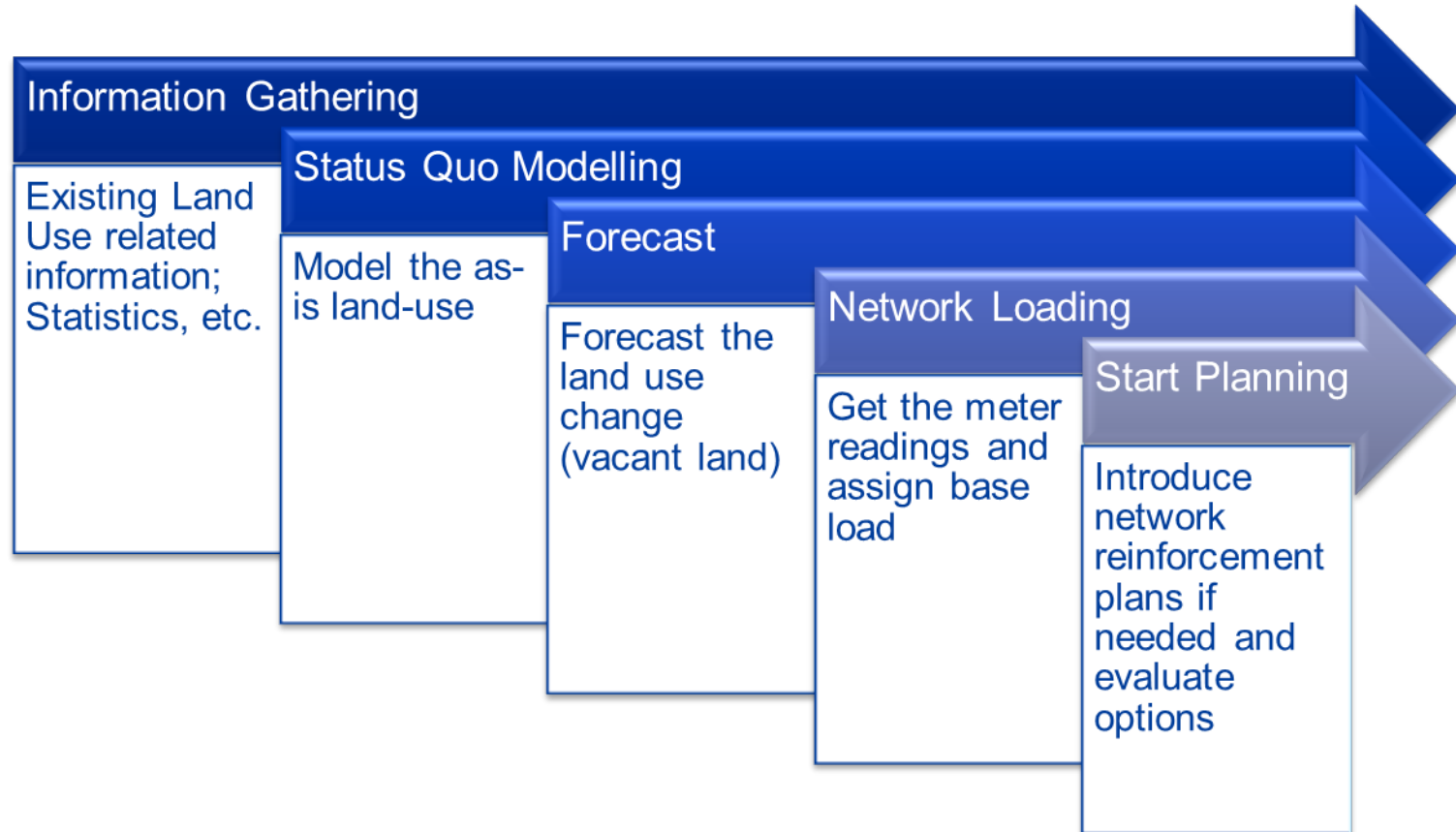
19:00

21:00

23:00



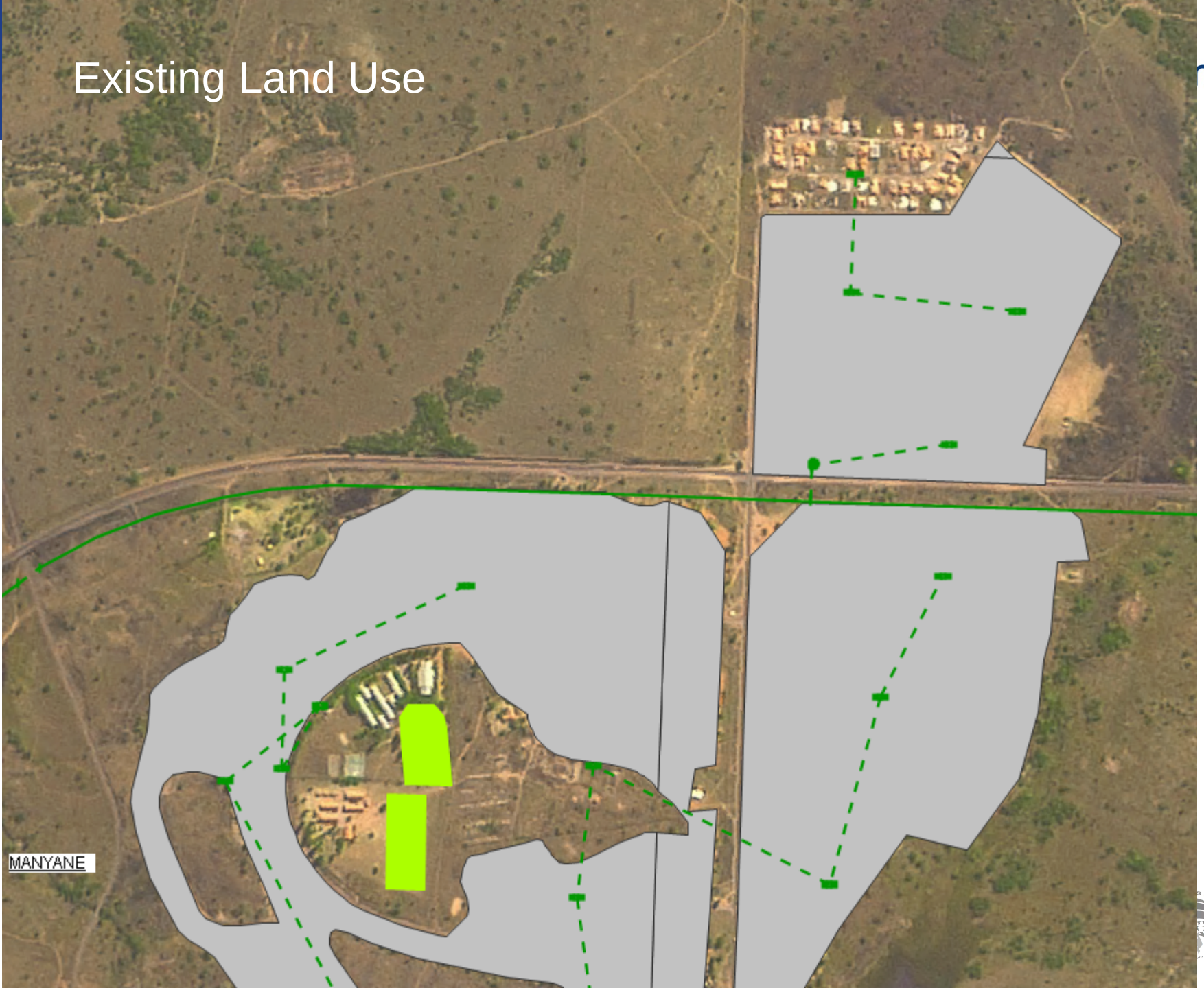
2. Forecasting Green Fields and Built Up Areas





MANYANE

Existing Land Use



MANYANE

Assigning The Subclass

UrbRes MD 8_9

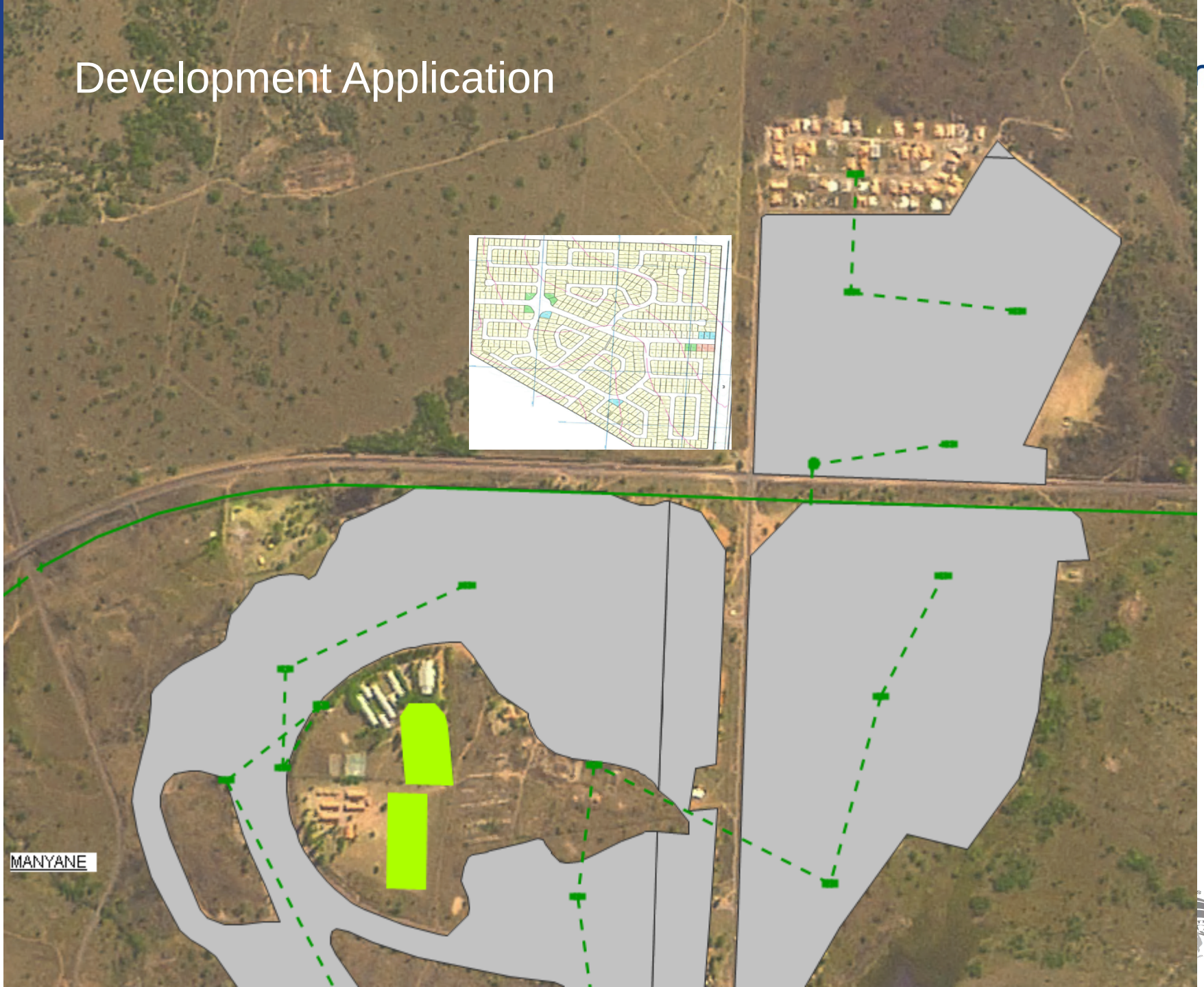
Urban residential dwellings (larger houses, “white collar”), at medium density.

Customer Characteristics	
AMPS LSM Class	LSM 8(low) – LSM9(Low)
Income Range	11,600 to 24,500
Derivation of Income	Derived from formal employment in cities, mostly in white-collar capacity.
Description of Dwellings	Built floor-area of main dwellings is around 190 m ² , and none of the buildings are multi-storey.
Type of Roads	All tarred.
Water Reticulation	Piped water is supplied into all houses, all of which have electric hot-water geysers.

Load Characteristics				
Load Profile	Load factor = 0.41 (Year 7)			
Load Growth	Growth-curve name	Curve type	Saturation	
			Admd	kWh
	UrbRes 8_9 (customer)	Per connection	2.88	864
	UrbRes 8_9 (S-curve Prj Yrs:3)	Per Ha	50.5	
	UrbRes 8_9 (S-curve Prj Yrs:7)	Per Ha	50.5	
	UrbRes 8_9 (S-curve Prj Yrs:10)	Per Ha	50.5	



Development Application



MANYANE

Local Development Overview

Mixed income residential uses

Future Residential Development

Unit 9 – Development of:

- 2 Business Stands (0,2%);
- 1 Place of worship &
- 1 Crèche (0,4%);
- 441 Middle income Residential stands (76,9%).

Unit 9

- Developed in phases – 60 units per phase;
- Phase 1 commissioned end 2014;
- Application approved;
- Request for extension of time about to lapse;

Unit 5

Manyane 11kV feeder

J M Ntsime HS

Unit 4

Unit 5

Future Industrial Development

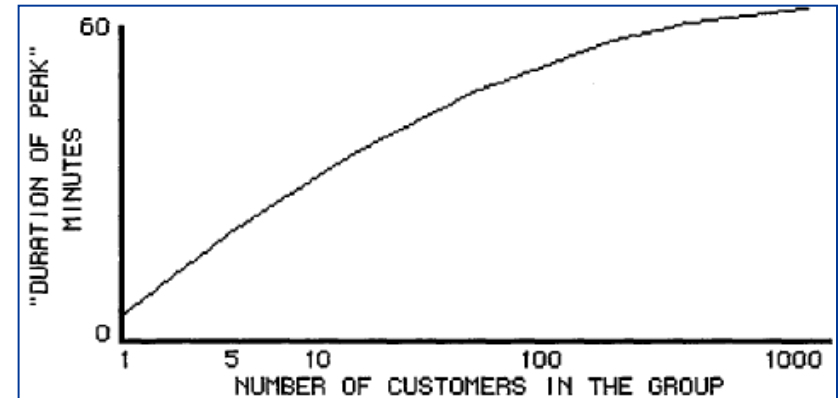
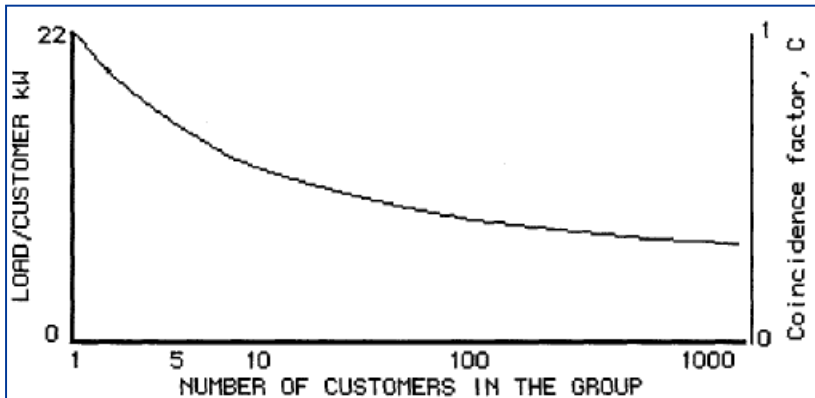
Millenium / Mogwase 88 kV feeder

Agri-processing Industries & Regional Market

Mogwase Ind / Sewerage 11kV feeder

- Feeder Load (recorded) = 5.2MVA
- Built up area = 111ha
- Load density = 47kVA/ha
- One can workout the feeder load provided that the load zone (subclass) is modelled accurately and the area size is known:
 - Area = 111ha;
 - Load Density = 50.8kVA/ha (from the subclass)
 - Maximum Demand = 5.6MVA (Area*Load Density)
- Factors affecting the difference between measured and calculated MD (“Max Ratio”):
 - Losses (kW) - need to be quantified.
 - The Area (111ha) represents the built up land. At high spatial resolution, this number will be reduced.
 - Data percentile: what was applied on the stats meter vs. subclass.

- Factors affecting the difference between measured and calculated MD (“Max Ratio”):
 - Ageing subclasses.
 - The ADMD is not a “fixed” value, in that, it decreases as the number of house holds increases.

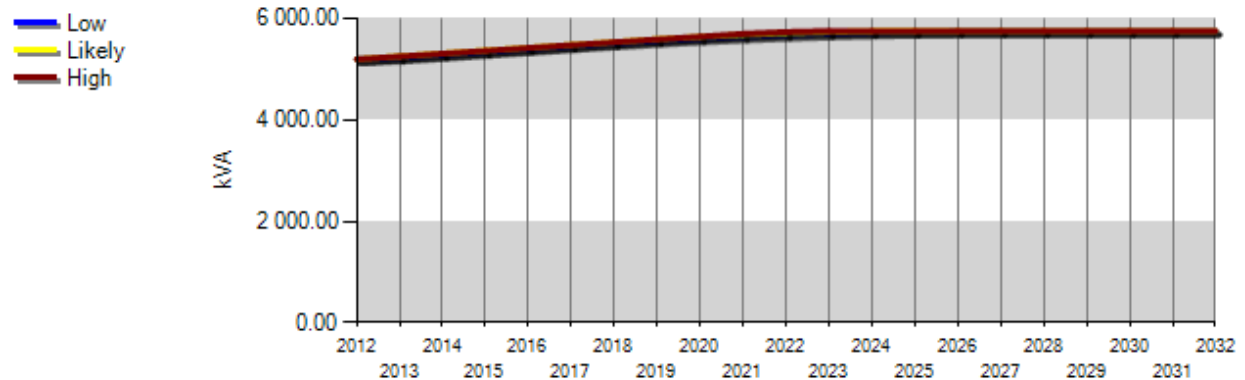


Forecast Results

The Built Up Area: Unit 4 and 5

Notes:

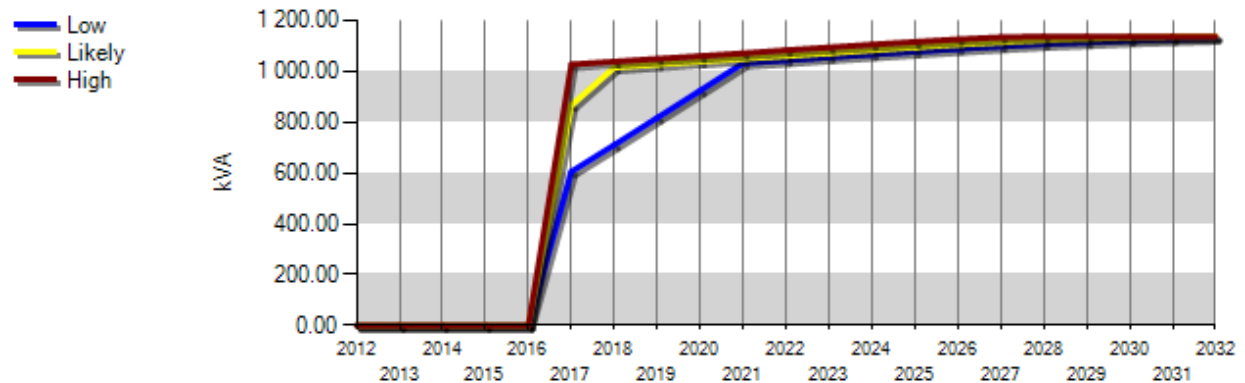
The area is built up and has been zoned for medium density and there is no further densification forecasted. The growth is based on possible increase in kW/capita



The Forecasted Area: Unit 9

Notes:

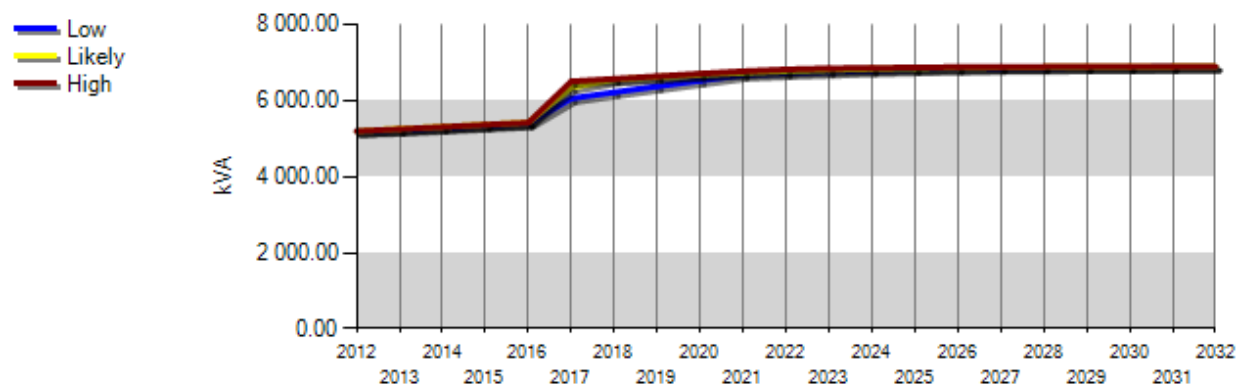
In nature, this forecasted area will be similar to the existing. The sharp growth is due to people moving in to this area.

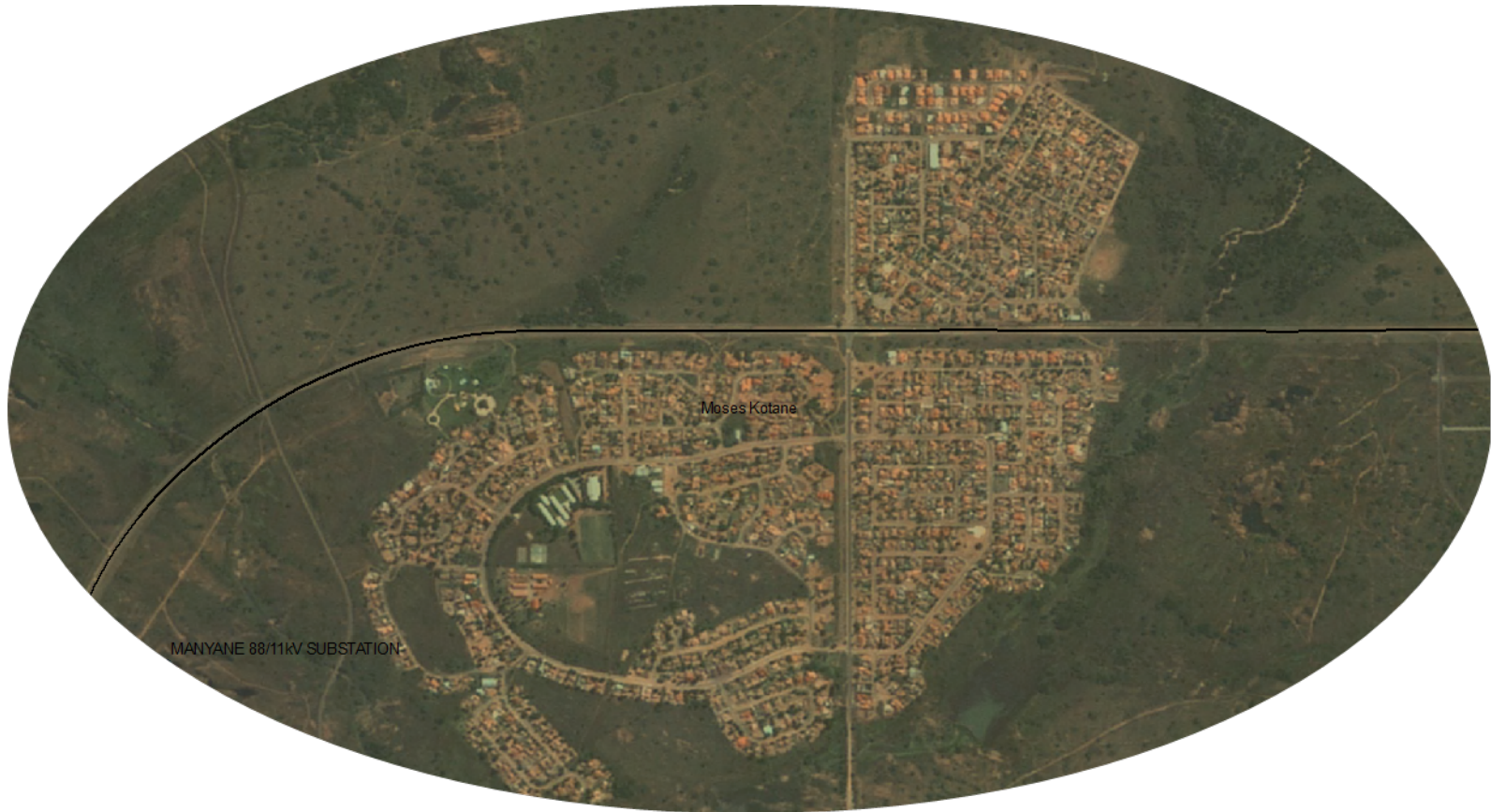


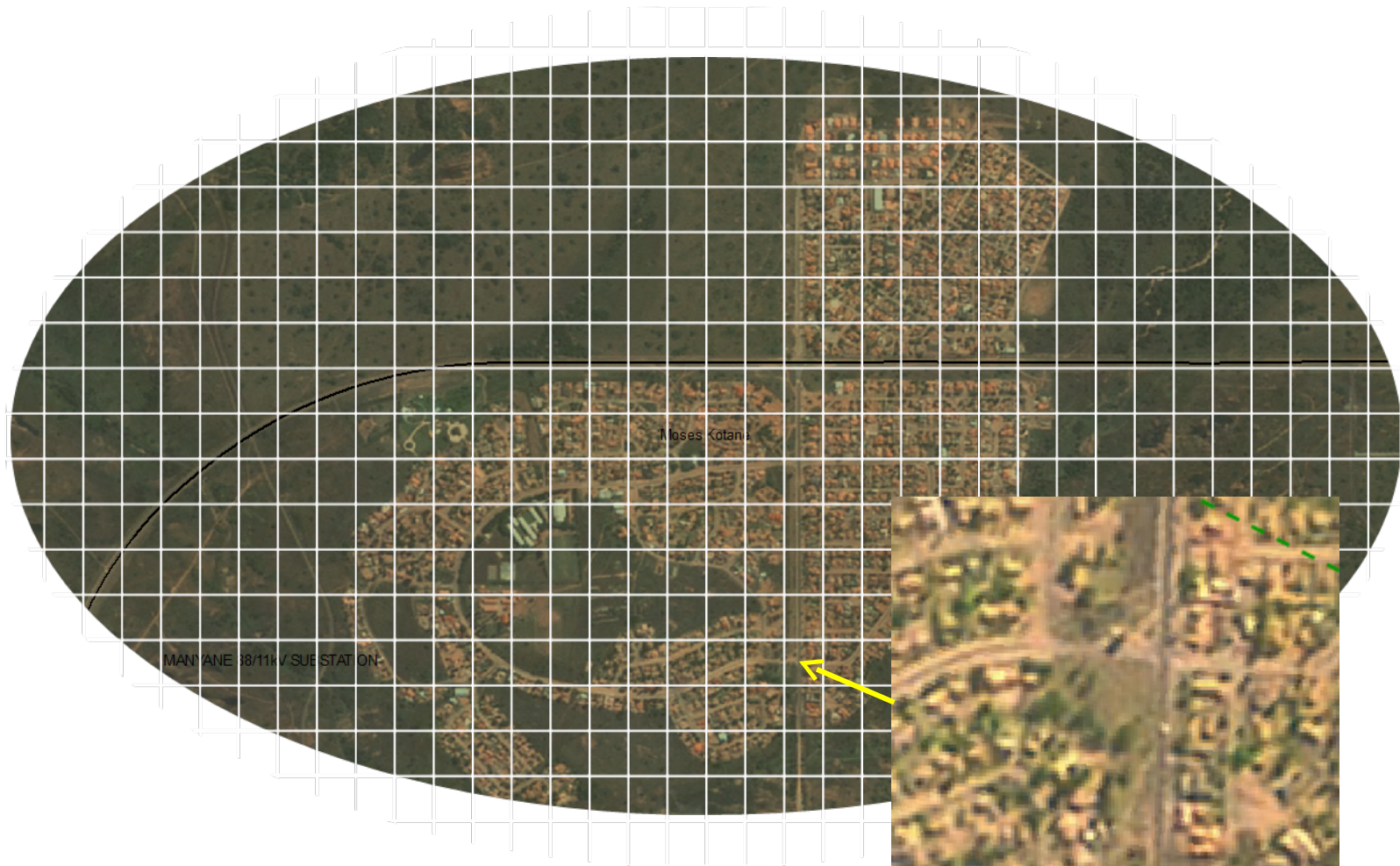
Total Feeder Area: Uni 4, 5 and 9

Notes:

Based on all that has been explained, the supply feeder is forecasted to grow as shown.

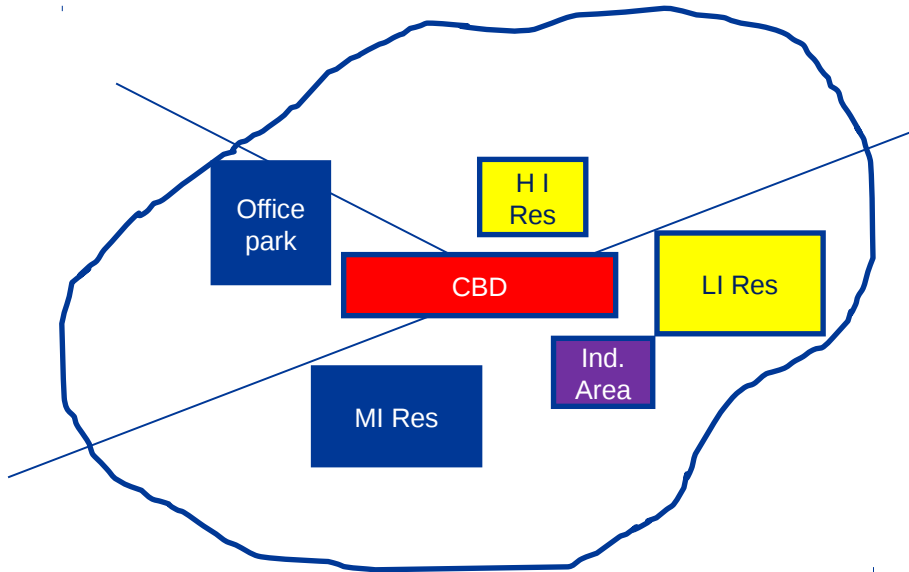








3. Mixing Load Profiles



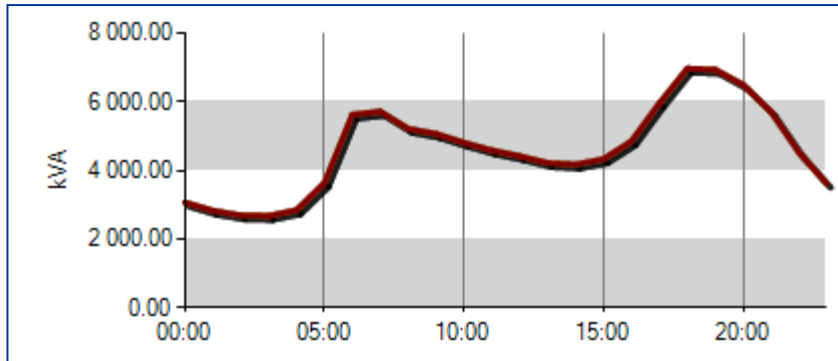
Development	Peak Load (MVA)
CBD	5
Industrial	5
Low Income Res	3
Med Income Res	3
Office Park	4
High Income Res	4
Total (undiversified)	24

Two transformers have been made available to supply the town and its surroundings. The apparatus are both rated 10MVA each.

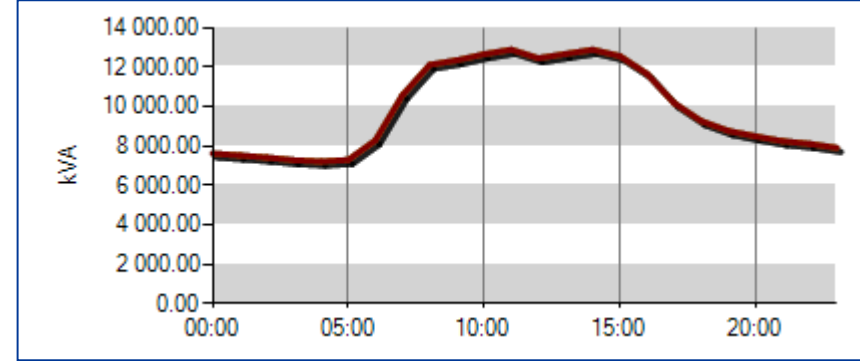
Supply Options and Resultant Profiles

Option 1

Transformer 1: HI Res, Low Income, Med Income

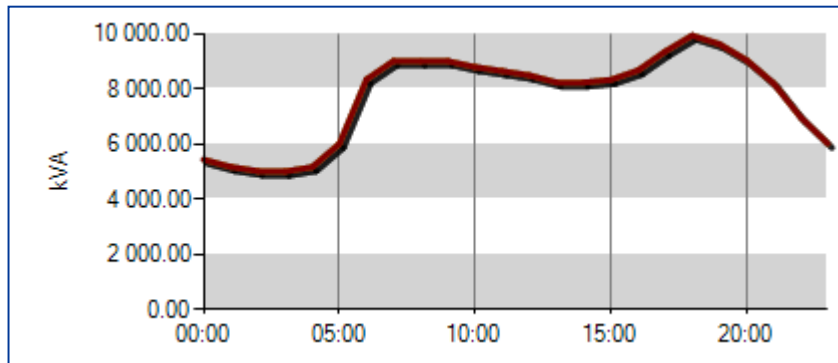


Transformer 2: Industrial, Office Park, CBD

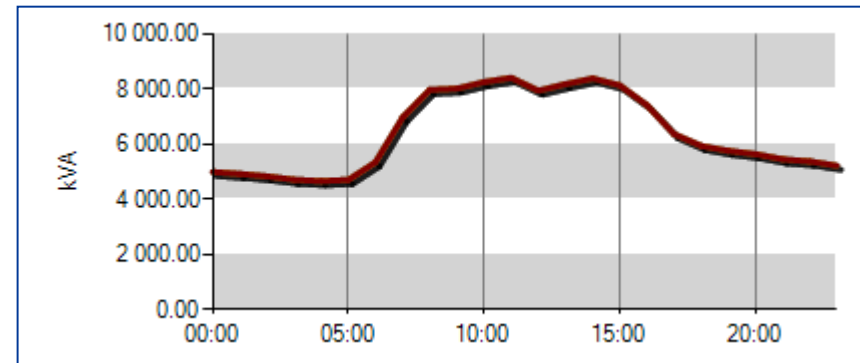


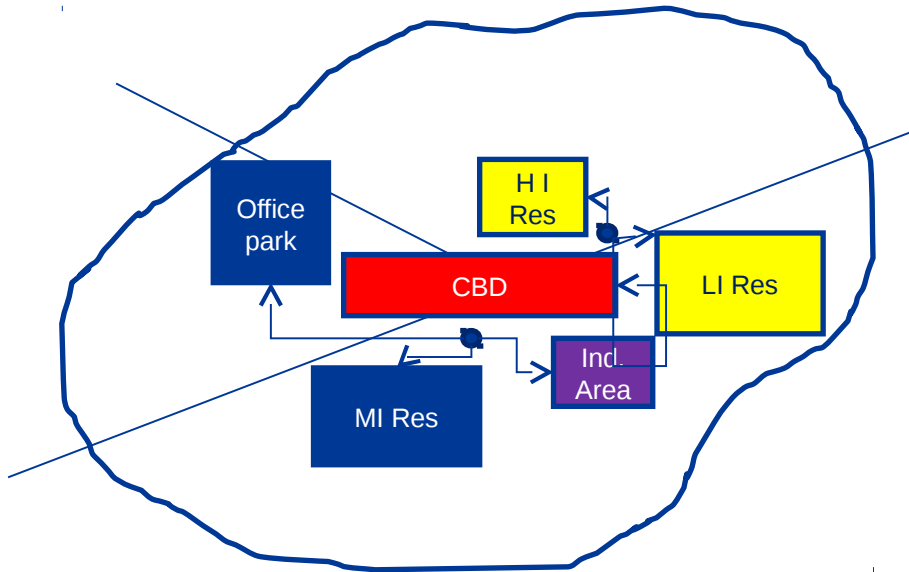
Option 2

Transformer 1: CBD, HI Res, Low Income



Transformer 2: Industrial, Office Park, Medium Income





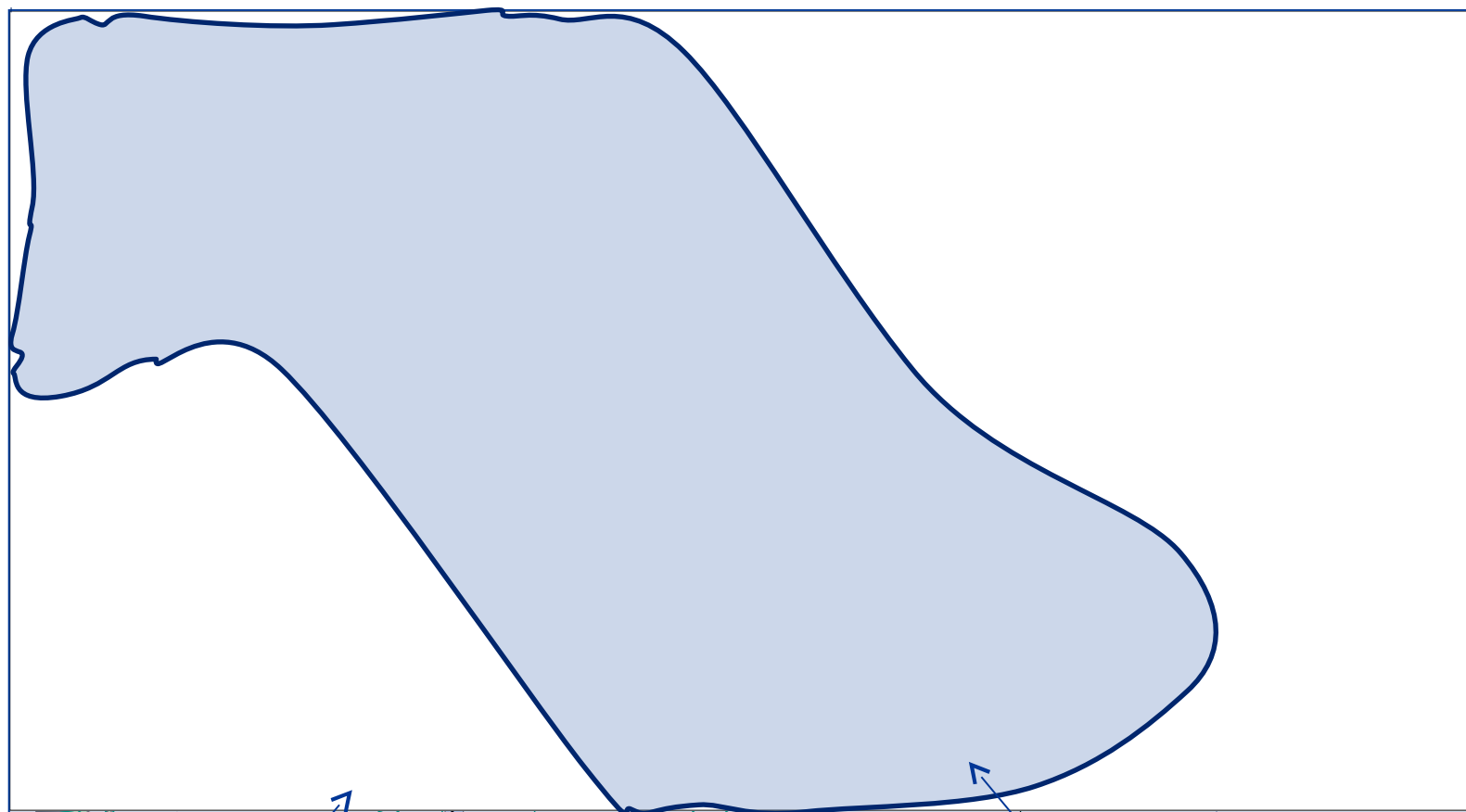
Development	Peak Load (MVA)
CBD	5
Industrial	5
Low Income Res	3
Med Income Res	3
Office Park	4
High Income Res	4
Total (undiversified)	24

DISCUSSION

- Option 2 combination provides adequate capacity but transformer Overrating chances are minimised due to high load factor.
- Other issues such as line route and substation site selection need to be considered when attempting the load mix exercise.
- The alternative of putting both transformers in one substation may also be evaluated (This would lead to a favourable high level of load diversity, and therefore more capacity). This scenario gives a total peak of **16MVA**.
- Reliability and power quality issues need to be understood before the plan is finalised.



4. Potential Demand Perspective



The feeder covers the above geographical area.

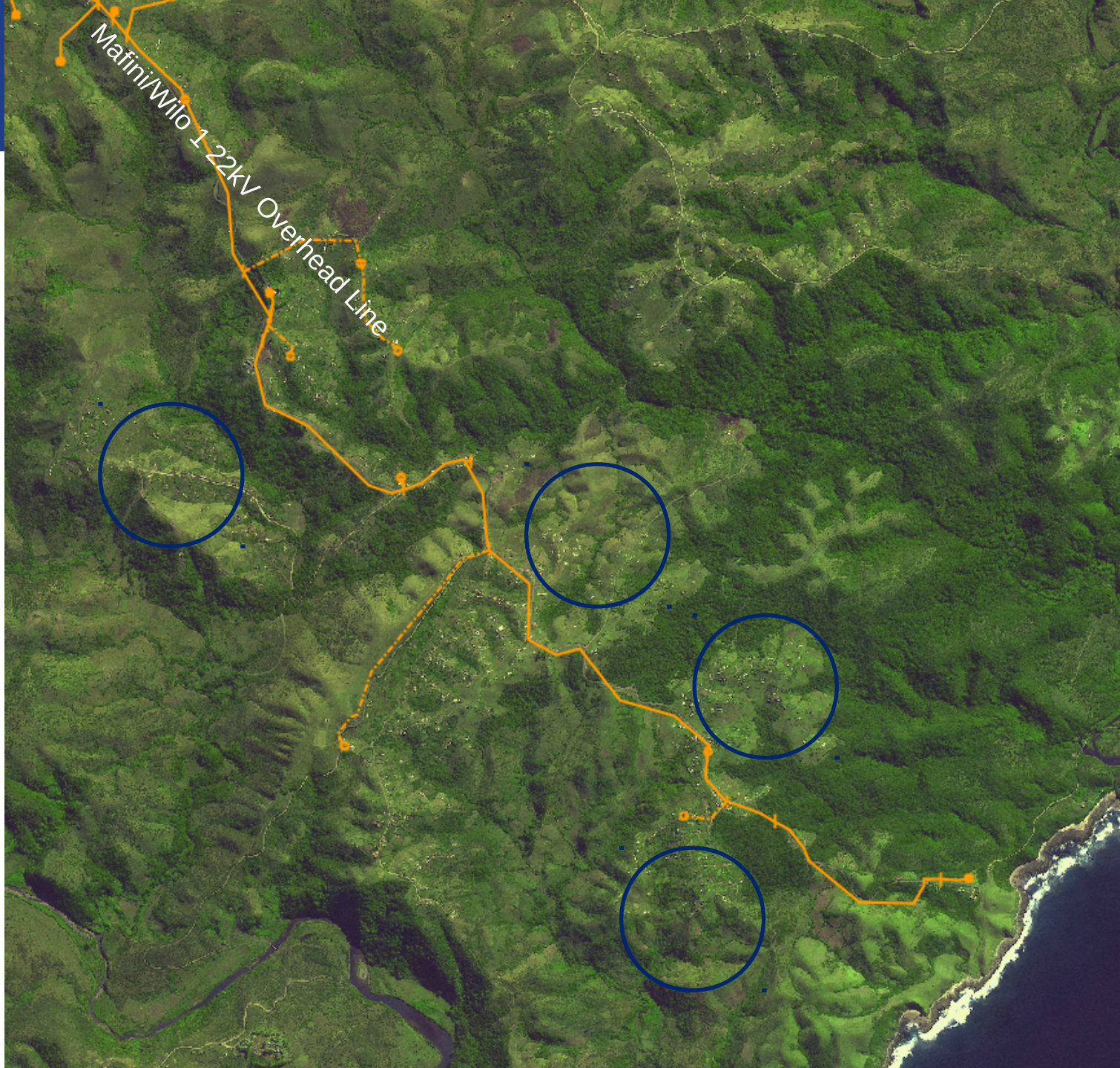
RurRes LD 1_2

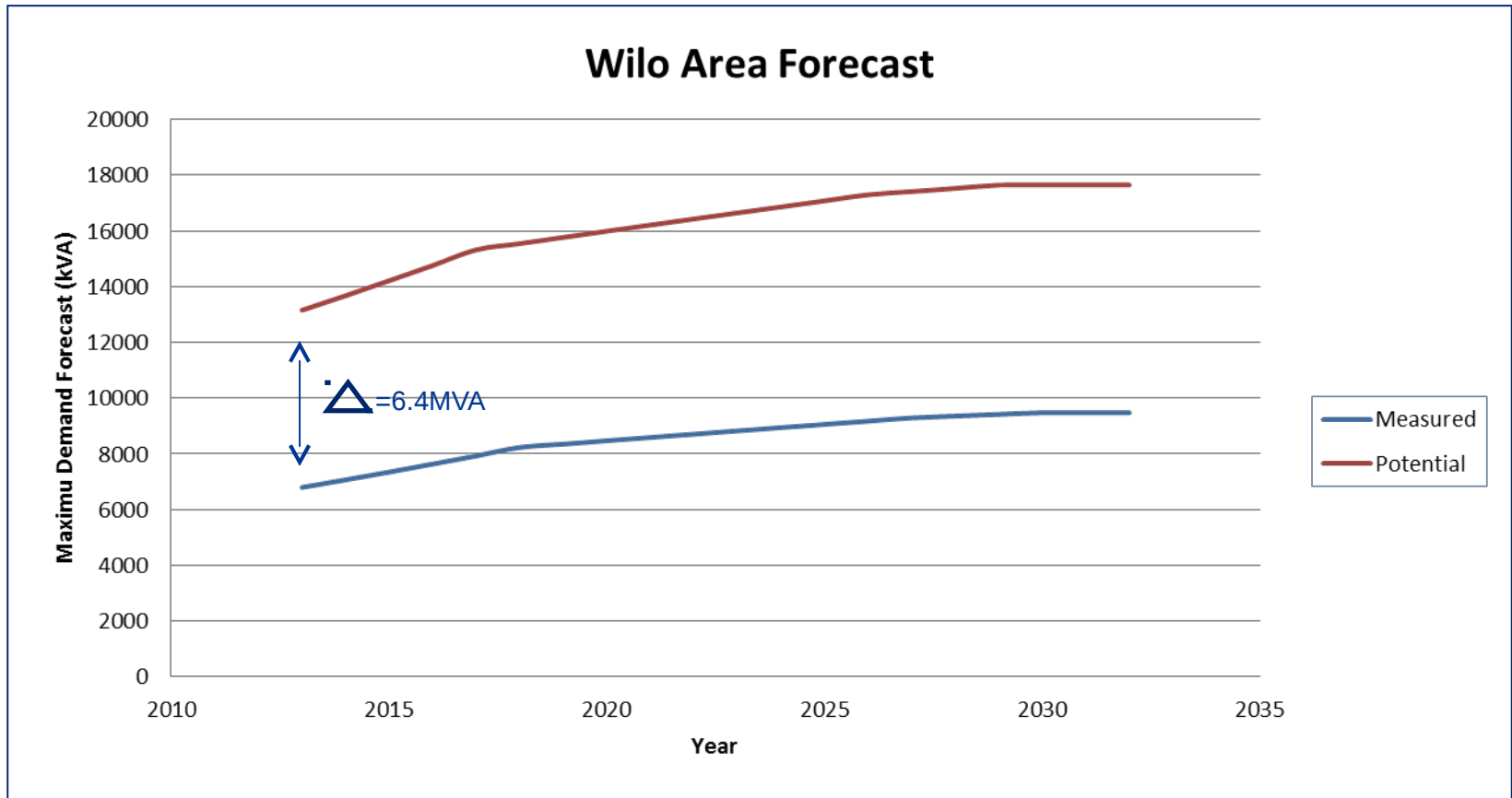
RurRes MD 1_2

DESCRIBING THE SITUATION

Areas
Not
Supplied

DESCRIBING THE SITUATION





Quantification of the Potential Load on the Ground.

- It shows the difference between what is supplied and what is not supplied.
- As soon as the infrastructure (feeder) is erected, this is the amount of load it will experience (Delta + Measured).
- During financial constraints, care must be taken to ensure that infrastructure rollout is prioritised. The size of the delta can be used as one of the indications/variables when performing prioritisation.
- The delta shows the MVA “backlog” of the area being studied.
- It can be used to calculate the “Energy Not Supplied” and the “Cost of Unsupplied Energy” that would be more significant to commercial/industrial customers.
- $\text{Cost to Customer} = f \{ \text{forecast, subclass} \}$



5. Conclusion

- Proper load sub-classification leads to optimum planning, and inaccurate modelling/assigning of subclass may lead to inaccurate infrastructure plan.
- Load subclasses do change with both time and location – hence subclass regionalization and time-based maintenance framework.
- Load types (load factors) can be mixed and manipulated to save on infrastructure expansion expenditure. This can be carried out on existing and/or future infrastructure by the planner.
- The Potential Demand can be used for project prioritisation.
- As it has been mentioned that the small area forecast dates back to the 1950's, in the current century (21st), researchers need to look at process automation, integration, processor speed and accuracy improvements.
- Load behaviour understanding is important for capacity planning, reliability planning, electrification planning, economic evaluation of infrastructure plans, and also operators and designers.
- The ADMD needs to be assigned according to the LSM and the number of customers – not a “blanket” value.

- Training of planners: Using subclasses can be a tricky exercise...
- Automated Subclass Identification Mechanism: One can easily get the subclass wrong, thereby modelling the load type incorrectly. This can compromise the forecast accuracy...
- Load profile mixing: there is a need to develop a script that will perform this task as it can be a long trial and error, when manually performed.
- Input information: like any other computer program, PowerGLF forecast is as good as the input information. Input information is important.

A decorative graphic on the left side of the slide. It consists of two overlapping circles. The larger, outer circle contains a photograph of a power plant with a large cooling tower and electrical infrastructure. The smaller, inner circle contains a photograph of two people, a man and a woman, sitting at a table and engaged in a discussion. The circles are outlined with multiple concentric lines.

Thank you