ESKOM UNIVERSAL ACCESS TO ELECTRICITY BUSINESS PLAN

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1 Abstract

This paper addresses the business plan prepared by Eskom for the program required to support the Government's vision of Universal Access to Electricity by 2012.

It describes the methodology followed to compile the universal access plan (UAP) through a desk top analysis based on the best available geospatial information as well as the knowledge and experience of both demand side and supply side planners. It also provides main results emanating from the plan and insight to backlog, network expansion, load, costs and resource requirements for such an initiative on a national basis.

The UAP shows that although great strides have already been made, much work still lies ahead to provide universal access to electricity for all.

2 Introduction

Universal Access was recognised when our President Thabo Mbeki stated "Through our integrated system of government, with the strengthened local government working with our State Enterprise, Eskom, we will, within the next eight years, ensure that each household has access to electricity" during the State of the Nation Address on the 21 May 2004.

Universal Access is not a new concept in government departments. It was always a topical issue on government's agenda. However, only in 2004 was a committed timetable officially extended to the nation.

Government had stated a clear desire to provide affordable access to energy services including electricity since the 1990's. National leadership recognised that household access to energy services is a basic need. A lack of access to electricity means that basic needs will not be met.

The production and distribution of energy must be sustainable and any plans developed, must be long term solutions. The Deputy Minister of Minerals and Energy stated that an integrated programme that utilises both grid and non-grid technologies will allow for electrification to be sustained.

In broader statements government also highlighted the need for electrification for minority groupings as a matter of urgency. These minority groups include: disadvantaged households, small businesses, small farms and community services. It is necessary for the electricity supply industry to contribute towards social equity by addressing the electrification needs of the poor.

Electrification has not only been mentioned in national addresses and white papers, but also serves as a central component of the Reconstruction and Development Plan's (RDP's) infrastructure delivery programme.

3 UAP Project Context

The Department of Minerals and Energy (DME) contracted Eskom through ESI-GIS to provide a Universal Access Planning approach for electrification.

In February 2006 ESI-GIS presented statistics to Eskom, DME & AMEU which indicated a current backlog of electrification connections of approximately 3 million households, with an estimated requirement of 5 million connections by 2012.

The workshop agreed that a plan to manage "Universal Access" is required and Eskom offered to prepare a proposed project charter on how the plan might be prepared.

Eskom through ESI-GIS has contracted with DME to undertake this work, and has structured the work into three phases with support from various project teams. The three phases are:

- Phase 1 - (Short term): To formulate a high level planning proposal to achieve universal access in line with Government objectives;
- Phase 2 - (Medium term): Formulate a planning proposal per municipality for the current Medium Term

Expenditure Framework (MTEF) 3 year cycle and refine the planning proposal as provided in Phase 1; and

- Phase 3 - (Long term): To establish and recommend a Long Term approach for the development of the Universal Access Plan (UAP).

ESI-GIS completed a combined Phase 1 and 2 report in 2005. This report has provided indicative estimates of Government funding required to meet electrification backlogs, based on various scenarios and assumptions for the quantity and cost of connections.

The objective of Phase 3 was a detailed approach to the development of a Universal Access Plan. Due to the magnitude of the programme, Phase 3 was split into two stages namely:

- Stage 1: Electrification;
- Stage 2: Integrated Network Plan.

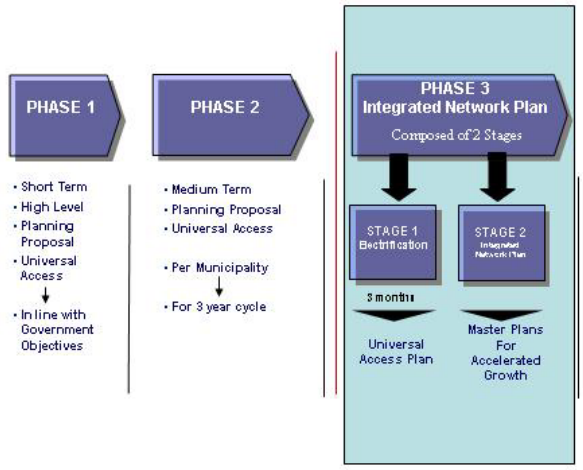


Fig.1 Programme Phase & Stages

Typical deliverables from Phase 3 include the electrification plans, network development plans and master plans required to achieve universal access while considering operation and commercial functions to ensure the business can support the programme.

The following workstreams were identified to ensure a comprehensive plan.

- Electrification Planning;
- Master Planning;
- Strategic Studies;
- Data Management;
- Geo Based Load Forecasting;
- Refurbishment;
- Operations;
- Commercial; and
- Programme and Journey Management.

3.1 Phase 3 Stage 1: Electrification

Objectives

Stage 1 allowed Eskom to gain a better understanding of the extent of the programme and provided for better Stage 2 estimates. The objectives of Stage 1 were to develop a Universal Access Plan, to identify enhancements that would improve planning in future iterations as well as develop a business case. In order to achieve these objectives the following streams were mobilised:

- Data Management;
- Strategic studies;
- Electrification and Network Planning;
- The Integrated Planning System (TIPS) Enhancements
- Master Planning Methodology and,
- Programme and Journey Management.

Scope

The following scope was agreed with regards to the development of the Universal Access Plan:

- Only Eskom Areas of Supply are considered for the development of the connection schedule;
- Eskom as well as municipal electrification loads are considered with regards to the national sub-transmission infrastructure plan. This was considered for funding purposes but municipal electrification was not incorporated in the geospatial expansion plan;
- The current electricity industry structure is assumed to remain during the timeframe of the project. Plans will have to be assessed and updated in the event of industry restructuring; and
- Strategic studies to provide a high level view regarding the household growth as input to the Universal Access Plan and the business case that can be refined in Stage 2.

Deliverables

- A 6-year Universal Access Plan;
    - Concept Release Approval (CRA) forms for projects identified in the 1st three years;
    - Geospatial representation of the projects;
    - Costing and resourcing for the projects;
    - Sub-transmission plan; and
    - Generation and Transmission inputs.
- Evaluation of commercially off the shelf applications to replace TIPS;

- Design specifications to enhance TIPS for future planning iterations;
- Enhancement of the current Eskom master planning methodology; and
- Business Case.

Approach

Settlement data was required in order for the electrification and network planning stream to develop geospatial plans. The data management stream investigated the available Eskom data and obtained settlement data from institutions including the Department of Water Affairs and Forestry (DWAF).

The regions were also requested to provide their three year rolling plans as input. This data was analysed in workshops with the respective regions in order to resolve gaps. The data was then handed to the electrification and network planning team for further analysis. The electrification and network planning team conducted several workshops per region in which they:

- Filled in data gaps and pologonised the projects geospatially;
- Prepared Integrated Development Plans (IDP's) aligned 6 year connection plans;
- Identified network constraints; and
- Iteratively planned network expansion and electrification projects over the 6 year period.

At the same time, the strategic studies team prepared a best estimate for the growth and provided the information in the required format to the electrification and network planning stream, as input to the plans.

3.2 Phase 3 Stage 2: Integrated Network Planning

The primary objective of integrated network planning is to develop master plans for a 20 year horizon for all regions across the country. Master plans will be developed according to the master planning methodology developed in Stage 1. Master plans will enable network development planning and associated projects over a 5 year horizon. These plans will provide planning input for infrastructure projects required to support electrification projects in both Eskom and municipal areas.

3.3 Status of Phase 3

- Stage 1: Completed in January 2007. Accepted and approved
- Stage 2: Approved and initiated in February 2007

This paper focuses on the methodology and results for Phase 3 – Stage 1.

4 Methodology

4.1 Definition of Universal Access

The definition that has been submitted to DME during Phases 1 and 2 of the programme was as follows:

To provide all previously disadvantaged South African households with access to basic electricity by 2012, under the following conditions:

- Grid electrification will be utilised, as an option of choice while other technologies will be considered as a means of an interim solution;
- Within the constraints of access to resources and time, these alternative solutions will be replaced through a process of continuous improvement in line with the expected asset lifecycle of the alternatives, even if the process continues beyond 2012;
- In remote areas where grid electrification is inaccessible, technologies can include:
    - Solar;
    - Gas;
    - Liquid fuels;
    - Mini-grid;
    - Renewables; or
    - A combination of the above.
- Households to be electrified will be restricted to authorised settlements (proclaimed and tribal land), but exclude the following:
    - Un-proclaimed areas, and
    - Settlements on unsafe ground formations and areas in the flood lines;
- A basic supply refers to the following:
    - Grid : <10A, 0.6 kVA ADMD
    - Non-grid : 50 W peak solar system,

4.2 Backlog

The Census 2001 information is generally accepted as the formal and most accurate source with regards to determining the electricity backlog. The Census question from which the electricity backlog is derived seeks to determine the energy source mainly used by the household for lighting purposes.

Census information therefore does not measure electricity grid connections explicitly but that it measures a household's access to electricity for lighting purposes.

Eskom is ultimately interested in the actual number of connections that need to be made in order to provide Universal Access to electricity. However, there is a conceptual difference between a physical electricity

connection or supply and the demographic concept of a household

Backlog is defined as all existing housing units which do not have access to electricity and includes:

- "Brown fields" or Infills – Potential connections that are within a range of 300-550m of existing pre-paid distribution transformers;
- "Green fields" – Potential connections that are outside these respective boundaries;
- Known formal housing projects as provided by regional planners.

The generic approach to determine backlog was:

- Exclude non-Eskom supply areas (all Municipalities licensed to distribute);
- Establish a buffer of up to 550m around all electrification transformers;
- Count all households from 2001 HELP Database inside and outside this buffer;
- Brown fields (Infills) determined from the count inside the buffer less existing prepaid customers;
- Green fields determined as the count outside the buffer less existing land rate customers; and
- Results adjusted by Strategic Studies Team delta data to provide for growth during the period 2001 to 2006.

4.3 Planning Process

A classical planning approach could not be applied to this assignment due to the short time frame. A high level qualitative approach was taken which relied on the knowledge and experience of Eskom electrification and network planners of what, how and when projects need to be completed to achieve universal access to electricity.

Three workshops were conducted per region of which the objectives were the following:

- Workshop 1: Demand Side Planning;
- Workshop 2: Supply Side Planning;
- Workshop 3: Finalisation

Planning decisions taken in the workshops with the regional and network planning managers were recorded spatially in an ARCVIEW Geospatial Information System (GIS) platform. The GIS is not a model with built in functionality to evaluate scenarios but enables the geospatial representation of the plan and facilitate costing.

The DME Regional Energisation Managers were invited to these sessions to ensure as close as possible IDP alignment given network capacity constraints.

Eskom Electrification planners were requested to define project polygons for the backlog identified in the workshops. These polygons represent projects that have been identified in the current Eskom three year rolling plan as well as the remaining known backlog.

Projects in the current three year rolling plan were reviewed against network capacity. Projects which were not possible due to network capacity constraints were moved out of the three year plan and replaced with suitable alternatives.

The remainder of projects were then allocated a new project year, to achieve the electrification in the 6 year period according to:

- Preference (6-Year wish list & IDP Alignment):
- Network Capacity,
- Logical Network Expansion.

4.4 Load & Energy Estimate

Load forecasts were determined through a process of determining an estimated After Diversity Maximum Demand (ADMD) loading per 20A connection as a function of the settlement density as tabled below.

Category	Density	Saturation ADMD (kVA)
Urban	Proclaimed	1.90
Peri-Urban	>150	1.25
Rural1	110 to 150	0.85
Rural2	70 to 110	0.80
Rural3	0 to 70	0.65

Table 2: Backlog Estimates

Load growth curves, based on past research, were then applied for each settlement category to establish the change in ADMD values over a twenty year period from initial to saturation values. These ADMD values were then multiplied with the number of connections per year, including growth, to establish a load forecast.

Energy consumption was related to the ADMD values using the NRS 034 Load Research data. The results from the load forecast exercise were then used to profile the additional Generation Energy Required.

4.5 Network Constraints

The existing network constraints per network breaker were evaluated following discussions with the Area Network Planners and categorised as follows:

Green	No constraint on networks, electrification can proceed and all backlog in this supply area can be supplied.
Orange	Slightly constrained networks, electrification

	can proceed with caution but not all backlog in the supply area can be cleared strengthening has taken place.
Red	Constrained networks, no electrification can proceed without network strengthening first taking place.

Table 3: Network Breaker Constraint Categorisation

Existing Eskom projects affecting these constrained networks were captured to determine the status of the networks from FY 07/08 onwards. This exercise highlighted networks that had a status of orange or red but which did not have strengthening/capacity projects in place as yet.

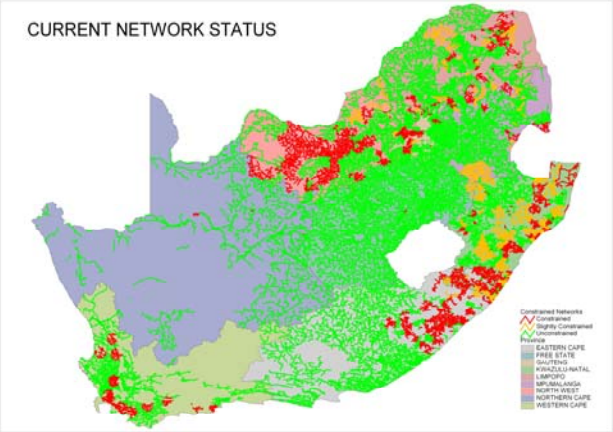


Fig.2 Network Constraints

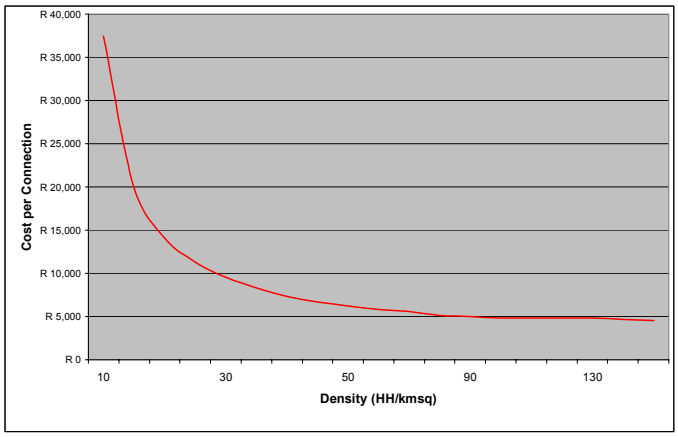
Additional sub-transmission expansion projects were then identified with the Area Network Planers to address these constraints taking into account project lead times. The final list of expansion projects contains both current NDP (Eskom initiated projects) as well as projects that are necessitated by the Universal Access requirements. The result is a change in status of networks from orange or red to green over the implementation period (2006 – 2012).

4.6 Reliability

Reliability criteria, as per regional preferences, were applied into the expansion planning process.

4.7 Costing and Material Estimation

An electrification cost curve and associated material ratios were developed from a sample of recently completed projects with different settlement densities for the planning model.



Graph1: Cost per connection based on density

Sub transmission cost modules and ratios were also derived from recently completed projects for the planning model.

4.8 Resource Requirements

Resource estimates both at electrification and sub-transmission level were made for:

- Consultants;
- Surveyors;
- Contractors (Small, medium & Large).

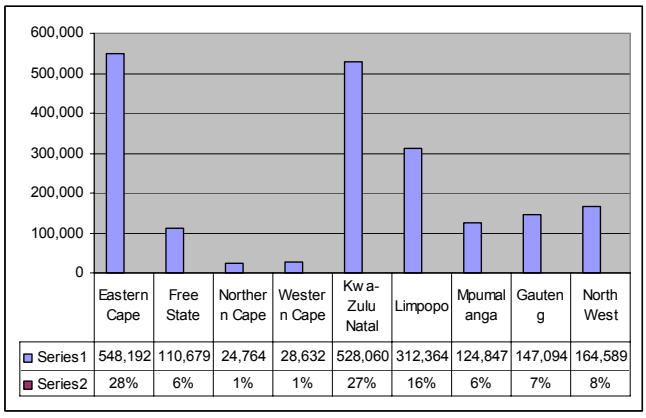
5 Results

5.1 Backlog

High and low scenarios were developed as part of the modelling exercise to illustrate the sensitivity with regards to the assumptions. In order to construct the high case scenario, it was assumed that Government capital spending is adjusted 10% upwards and that the AIDS prevalence rates saturate and decline to 18% in 2012. For the low case scenario, it was assumed that the Government spending is 10% lower than the base case and that the AIDS prevalence rates remain constant at 23%. The results of these two scenarios for the Eskom areas of supply can be seen in the following table:

Scenario	2006	2012
Low Case	1,887,886	2,188,565
Base Case	1,989,221	2,540,713
High Case	2,111,639	3,628,854

Table 1: Backlog Estimates, Eskom supply area

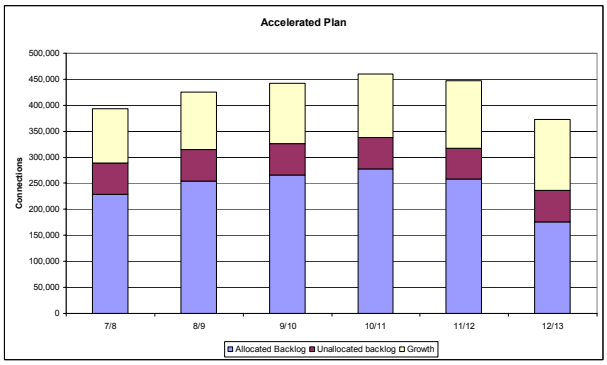


Graph2: Backlog per province

5.2 Accelerated Plan to Meet 2012 Targets

Scenario 1 - No constraints

The graph below depicts the accelerated plan without taking constraints into account for the Eskom area of supply.



Graph2: Accelerated Connection Schedule, no constraints

The maximum number of geospatially allocated backlog connections that can be done before running into network constraints are tabled below.

Region	Connections
Central	30,000
Eastern	120,000
Northern	75,000
North Western	12,000
Southern	10,000
Western	10,000
Total	**257,000**

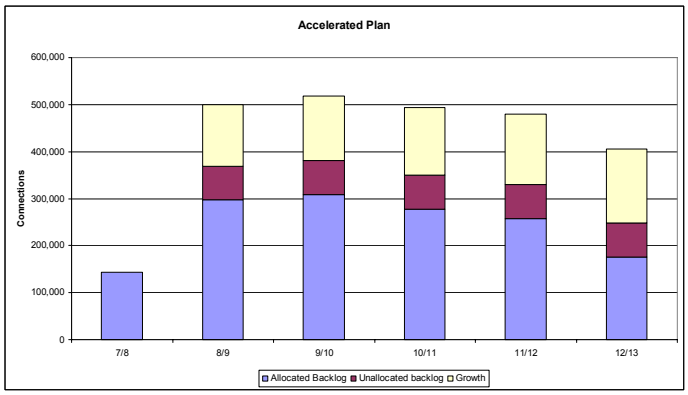
Table 1: Connections Possible within Network Capacity

Substantial infrastructure will therefore be required by FY08/09 to enable universal access.

Scenario 2 – Pragmatic Plan

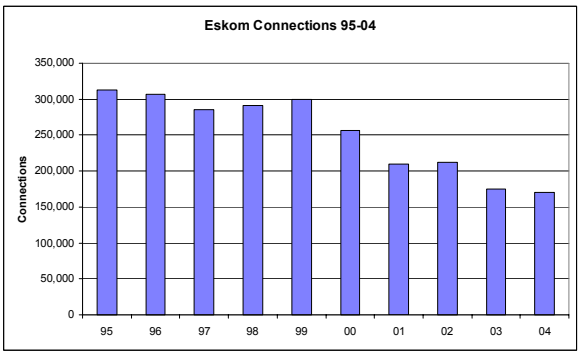
Funding allocated towards the Eskom electrification programme by Government for FY 07/08 is in the order of R 1bn (excluding VAT).

Assuming the budget and connection figures for FY 07/08 above, some projects would need to move to later years..



Graph3: Accelerated Connection Schedule, with F07/08 approved budget

The number of connections completed by Eskom in the late 1990's to the middle of the 2000's is illustrated below:



Graph4: Eskom Connection History

As illustrated, Eskom was able to complete approximately 300,000 connections per annum in the middle to late 1990's. These numbers are of the same order of magnitude as the geospatially allocated backlog scheduled in the plans above but substantially less if the growth and unallocated backlog is added. If the growth and unallocated backlog are added, the required connections will be in excess of 500,000 per annum.

Industry resource constraints is of concern for the universal access programme. It is believed that due to scaling down of electrification programmes in the recent years, many consultants and contractors associated with electrification have either changed their focus or moved to international markets elsewhere in Africa. Many Eskom resources have also been redeployed to other

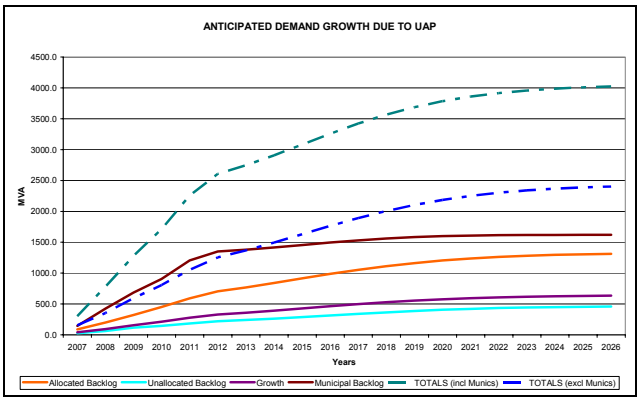
departments or have moved on since the electrification programme was at its height.

Furthermore equipment and material for electrification projects are sourced internationally in many instances and prices as well as supply are influenced by several factors.

The table below summarises high level estimates of materials and resources required to achieve universal access by 2012.

	FY07/08	*FY08/09*	*FY09/10*	*FY10/11*	*FY11/12*	*FY12/13*
Meters	143,950	500,219	517,623	493,548	480,057	405,315
Poles	757,269	1,099,179	1,182,878	1,127,729	1,128,709	885,607
LV Lines (km)	7,622	25,970	27,801	29,437	23,737	26,814
MV Lines (km)	3,806	12,941	13,844	14,677	11,851	13,409
Trfrs (Units)	1104	3579	4066	4477	3376	4247
Trfrs (MVA)	66	211	233	200	230	181
HV Lines (km)	799	10797	2335	3343	1167	630
HV Substations	31	60	45	10	8	0
Consultant	25	84	86	83	82	64
Surveyor	12	42	44	39	39	32
Contractor Large	17	62	69	62	58	51
Contractor Small	83	293	292	287	281	237
EIA's	40	70	60	9	7	2

Table 2: Estimated material an resources



Graph4: UAP Increase in Demand

6 Critical Success Factors

- The plan is currently based on Eskom areas of supply only. In order to have a national view of universal access and to refine the impact of municipal areas of supply on sub-transmission, it is crucial that municipalities that supply electricity are involved in future iterations;
- The data on which the electrification plan was based needs to be verified. Issues with the settlement data have been identified. Future projections are based on Census 2001 data, which is old and only available on municipal level. The accuracy of the plan should be enhanced through the use of satellite imagery and/or aerial photography. If this is done, an update to the plan will be required;
- The geospatial plan should be maintained on a regular basis to ensure that the information captured is not lost, going forward. This would require regular updates to the plan with input from the regional electrification planning coordinators, land development and project engineering
- It is important that Stage 2 of the programme continues. This will not only allow an update to the electrification plan and improve the accuracy but would enable Eskom to produce master plans over a 20 year horizon.
- A supplier forum should be held in order to gauge the industry capacity and complete a pragmatic plan.
- It is important to understand how the national electrification programme will be affected by industry restructuring;
- As new customers are connected to the network, it is crucial that operational expansions are made to serve these customers e.g. creation of new technical service areas, creation of additional vending points etc.

7 UAP Business Plan Summary

The cost below includes the cost of infrastructure projects required to support Eskom and municipal areas electrification. It includes the cost of Eskom areas of supply electrification projects but not that for municipalities that have distribution licenses. The backlog of 2.54 million is for Eskom supply areas only, while it is estimated that the total electrification backlog (including municipalities) is approximately 3.4 million connections (in 2012 terms)

Backlog	2,540,713
Load	˜4000 MVA
Cost	R 24.7 bn

8 Conclusion and Recommendations

The current proposed plan takes the funding allocation for FY07/08 into account. The result is a plan to eradicate backlog by FY12/13 that requires up to 500,000 connections per year. Considering what has been historically possible, 500,000 per annum appears high considering that in the late 1990's, when the electrification programme was at its height, Eskom connected at a rate of 300,000 connections per annum.

In the accelerated plan, taking into account the funding allocation for FY07/08, approximately 300,000 geospatially allocated connections are planned per year which is similar to the maximum that Eskom has been able to achieve in the 1990's.

It has also been found that a skills shortage exists in the Eskom structures should the plan be accelerated, especially with regards to buyers, environmental advisors, project coordinators, project engineers and electrification planners.

The funding allocation for FY07/08 allows Eskom the opportunity to further improve on the accuracy of the backlog and if satellite imagery for the following three years is procured, trends could be established to verify connection growth assumptions. Also, as mentioned above, the backlog has been determined through desk top studies and it is imperative that the figures are verified either through site visits or by means of aerial photography or satellite imagery.

Satellite imagery would also allow for the incorporation of the municipal areas of supply for sub-transmission planning purposes which have not been done on a geospatial basis. The fact that the programme is not accelerated in FY07/08 also affords Eskom the opportunity to "up-skill" resources in the electrification area and to prepare for future years when the plan is accelerated.

It is also important that the supplier forum is organised and that the results from the forum are used to update the pragmatic plan in the business case and to verify the assumption of 300,000 connections per annum.

9 Abbreviations

UAP	Eskom's Distribution Business
DME	Department of Minerals and Energy
ESI-GIS	Eskom Data and GIS Agency
AMEU	Association of Municipal Electricity Undertakings
TIPS	The Integrated Planning System
NDP	Network Development Plan

10 Definitions

"Distribution Networks:" All sub-transmission and reticulation electrical equipment (substations, lines and cables) owned and managed by Eskom's Distribution Group, from 132kV to LV (400/230V) with subsets as follows:

"Reticulation Networks:" 230V – 22kV

"Sub transmission Networks:" 33kV – 132kV

"Scenario:" A postulated future event or sequence of possible events