# INVESTMENT IMPERATIVES FOR UTILITIES TO ENSURE SUSTAINABLE ELECTRICAL INFRASTRUCTURE DEVELOPMENT

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**Abstract.** Electrical Power is vital for any modern day economy. The critical issue today is that demand for electrical power keeps expanding faster than the growth of supply, which is constrained by financial, environmental, technical and manpower related challenges. Despite the many indicators of deteriorating performance, it is evident that access to service is on the increase. Current experience shows that in many instances distribution infrastructure requirements far exceed the existing conditions, leading to a forced prioritisation of implementation strategies. In many cases this is a result of skills shortages, procurement challenges, infrastructure theft and a lack of adequate planning. Restoring the integrity of distribution networks throughout South Africa has become an interesting challenge, requiring a focused, systematic approach in identifying and implementing strengthening and refurbishment projects.

**Keyword Index** – Distribution Network Planning, equipment age & condition assessment, environmental impact, load forecast, strengthening, refurbishment.

## 1 Introduction

The energy sector is a major player in South Africa's economy and access to electricity significantly affect the country's level of literacy and wealth.

There is a general concern that the electricity distribution business within South Africa is suffering from a lack of investment and recapitalisation of its ageing infrastructure.

Current experience shows that in many instances infrastructure requirements due to growth in demand far exceed the existing conditions, leading to a forced prioritisation of implementation strategies. Implementation plans are normally under pressure mainly due to the lack of sufficient qualified skills and available capital budgets, as well as worldwide pressure on existing resources and material. This situation is further exacerbated by the nature of procurement processes within local government organisations, often leading to extended delivery times. Experience with recent investment planning studies has indicated that it can take between four to five years to practically develop infrastructure required today.

Restoring the integrity of distribution networks throughout South Africa to an acceptable level thus seems to be a mammoth task. A systematic and focused approach should be adopted in identifying and implementing strengthening and refurbishment requirements that will ensure long-term, sustainable infrastructure. The approach should follow sound and holistic asset management principles.

## 2 Current Reality

Despite the many indicators of deteriorating performance, it is evident that access to service has increased considerably in terms of both average per capita energy usage as well as percentage of population served. These increases in access have required sustained high rates of investment and expansion, placing an ever increasing burden on entities which do not have sufficient qualified manpower to meet the requirements of both expanding and operating their power systems.

The then NER convened a Maintenance Summit in 2003, followed by another in 2008, to strategise a response to the concern that electricity distributors are spending far less than required to maintain and refurbish networks to retain the required condition.

One of the critical strategic goals in the creation of RED's is to provide a blueprint for the critical wires processes, governance and key business metrics for the long term desired end-state, based on international best practise. This is intended to strive for excellence in the asset management process, efficiency in CAPEX/OPEX, appropriate to the country's growth and electrification targets, and for the provision of reliable and sustainable service levels. It should be therefore necessary to review and to assess the current short-term infrastructure strengthening and refurbishment strategies and methodologies, and to align those with the identified blueprint for the wires industry.

The current state of the electricity supply industry absolutely points towards the need for an accelerated approach to asset management to ensure that system reliability is adequate for the entire country in the medium to long term. In creating a blueprint for the future electricity supply industry the following best practice gaps needs to be addressed:

Planning and Standards processes:

- Network planning processes are inconsistent or executed in a non-standardised manner,
- There is a lack of proper maintenance on critical assets and refurbishment planning, as well as execution,
- Standards used in the industry differ dramatically,
- There is a lack of sufficient skilled capacity and appropriately experienced resources even where the desire exists to attend to issues.

The above analysis points to the following as the most important issues to address:

- Holistic and standardised asset management strategies supported by best practice approaches,
- Improvement in network and refurbishment planning,
- Sufficient resources to support this, inclusive of the availability of technical skills in the long run, and sufficient funding.

# 3 Field experience

Experience from field visits as part of refurbishment an network planning exercises has revealed a number of issues that influences the asset management activities, especially with regards to refurbishment and network strengthening..

The following section provides a general view of a number of these important issues that confirm the views of the current state of the industry. These factors must be addressed in implementing the asset management strategies.

## *3.1 Capital Program Shortfalls*

In general the distribution entities have a multi-year rolling plan in place catering for strengthening and refurbishment of the distribution networks. In the majority of cases though, this rolling plan amounts to less than what is required from a sound planning perspective. In most cases the rolling plans are generally based on what the entity can achieve within the existing resource capability and other constraints, often using experience from previous financial years, rather on what is actually required.

## *3.2 Procurement Processes*

Without exception, the procurement processes within the distribution entities are not supportive of an efficient electricity business. The process in itself should allow for a structured and auditable mechanism to fairly evaluate and adjudicate procurement activities. The current procurement committees are time consuming and ineffective, resulting in extended lead times for projects to be implemented.

One of the key reasons for the ineffective operation of the procurement process within most of the entities was identified as the lack of the procurement committee’s understanding of the technical request at hand.

## *3.3 Skill Development & Training*

Without exception, it was found that distribution entities are under-staffed and that vacancies exist throughout the entire spectrum of the business.

In the majority of the cases, the personnel shortage has resulted in remaining personnel ‘fighting fires’ or required to do work which they are not qualified to do. This shortage has further contributed to deterioration of all major activities including maintenance, planning, construction, as well as safety and security.

## *3.4 Long-term Development Plans*

Not all distribution entities have medium to long-term infrastructure development and refurbishment plans. In the majority however, no significant planning for strengthening and replacement plans are in place. In an alarming number of cases a lack of understanding exists regarding the processes and methods required for distribution network expansion and renewal.

Without these plans, it is impossible to have adequate investment to ensure a sustainable utility, both from a technical and financial point of view.

### 3.5 *Infrastructure Theft*

Theft of electrical infrastructure is currently on the increase, having a detrimental effect on the day-to-day operations of an already understaffed industry. In the majority of cases the direct impact to the economy far outweighs the material cost. A secondary effect of theft is that the focus has turned from pro-active maintenance and operations to reactive replacement of stolen equipment. This needs to be taken into account in the planning, design and operation of the utility.

## 4 Network Planning Principles

Distribution network expansion and renewal planning forms one of the cornerstones of asset management and is the art of spending money today in an efficient manner such that it will have lasting value in the future. Done properly, this is a significant and complicated task that requires detailed distribution system models and computer analysis tools [1]. In general, distribution network planning deals with capacity and reliability analysis [3] as well as network renewal or refurbishment planning. Capacity analysis addresses thermal and voltage limits while reliability, perhaps more importantly, addresses the impact on cost and customer satisfaction.

As discussed in the previous section, apart from Eskom Distribution, only some of the larger Metropolitan Municipalities and very few of the Local Municipalities conduct capacity analysis in a structured and auditable manner. Refurbishment planning forms part of the long-term strategy but is rarely done on a consistent basis. Reliability analysis is currently in its infancy and is only done in some of the Eskom Distribution regions. The following sections provide a high-level overview of a typical best-practice distribution network planning process, as well as basic aspects of some of the most important building blocks of capacity analysis and network refurbishment planning. Following these principles and processes in a structured manner, will have a major impact on the adequacy of the electricity distribution industry in the medium to long-term.

### 4.1 *Fundamental Network Planning Process*

A typical long-term distribution network investment plan follows the generic process as outlined in Figure 4-1.

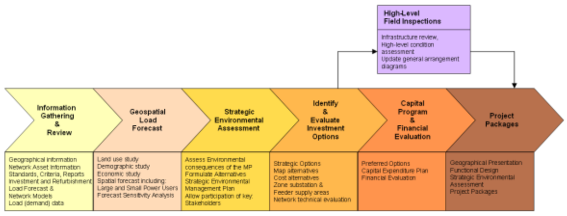


*Figure 4-1: Investment Planning Approach*

The process involves aspects such as general and specific information gathering and reviews, strategic studies to support a spatial or geographically based load forecast, field inspections to support practical project definition and refurbishment plans, strategic environmental assessments, network assessments and scenario planning as well as cost estimates, financial analysis and project definitions.

The following sections provide insight to some of the most important building blocks of this general process.

### 4.2 *Long-term Load Forecast*

Regarded as one of the most important inputs to long-term strategic planning, the aim of load forecasting is to determine the present and future electricity requirements of electrical end-users within a specific spatial area in order to reconcile this with the available resources and electrical services [2]. The forecast normally presents a dynamic assessment in terms of historic and the most probable future trends.

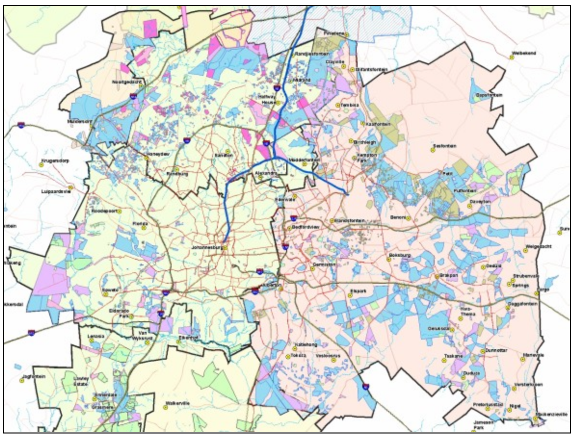

*Figure 4-2: Potential Short- Medium-term Developments*

The focus throughout the forecast falls on the electricity needs and requirements of the various user sectors as determined by the characteristics and trends of each. The forecast therefore highlights where and when imbalances between electricity requirements and supply are most likely to occur. This informs decisions required for the timeous development of electricity infrastructure options, the spatial location and level of intensity per user group. A proper load forecast thus provides the network planner with a spatial view (location, timing, growth patterns, density and electrical characteristics) of the long-term electricity need scenarios, which form the basis for the electrical infrastructure requirements.

### *4.3 Equipment Condition Assessment*

Aging equipment is undoubtedly one of the primary concerns for asset owners. Failure rates increase as equipment ages and requires proportionally more inspection and additional maintenance cost than new equipment [4].

A life extension or refurbishment program that permits continued economical operation of the electrical system and improved reliability by reducing failures must address both:

- Individual substation facilities as they approach design life, and
- Individual equipment on a system wide basis.

Asset specific assessment normally provides a systematic estimate of the remaining life in substation and line facilities. In conjunction with the life extension methodologies, it can further provide a planned programme to extend that life to meet future needs [5]. The output from an equipment condition assessment study should clearly indicate:

- Assets posing an immediate safety hazard or those that require immediate to short-term replacement based on assessment outcomes or policy (critical assets),
- Assets that require monitoring or testing to assess actual conditions (concerning assets), and
- Assets that operate satisfactory under intended conditions (normal assets).

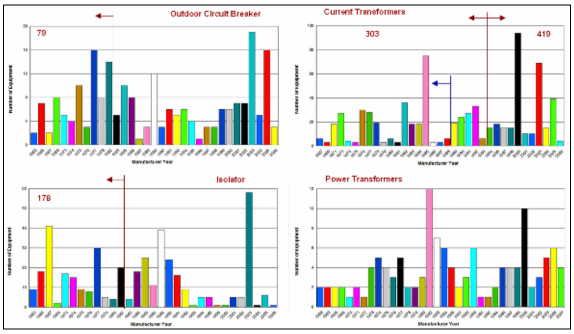


*Figure 4-3: Equipment Age Profiles*

It is important that asset replacement and renewal strategies should be executed in conjunction with strengthening and expansion strategies.

### *4.4 Environmental Impact*

Being pro-active in assessing the potential impact of infrastructure on the environment during the planning phase can have a significant effect on construction lead times. Such a pro-active approach involves a Strategic Environmental Assessment (SEA) which includes the use of a multi-disciplinary team of environmental experts and specialists to assess the potential environmental consequences of a strategic long-term infrastructure investment plan on the environment. Alternative plans and strategies can be formulated where required.

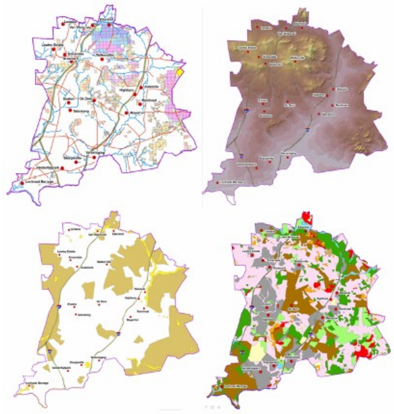

*Figure 4-4: Geology, Ecology, Hydrology, Historical Sites, Visual impacts etc.*

The SEA normally focuses on understanding the biophysical, social and economic environment and the values of these. Opportunities, constraints and values of the study area, including the needs and desires of the relevant stakeholders are assessed. These are then formulated into a desired state of the environment that recognizes appropriate development options. The long-term development plan is then evaluated against a set of sustainability criteria. A Strategic Environmental Management Plan is then normally used to guide the implementation of future EIA related projects.

The SEA further involves a key stakeholder engagement phase which allows for relevant stakeholders to pro-actively contribute meaningfully during the development of the investment plan.

## 5 National Policy & Planning

A blueprint for a wires business should include best practices and standards for the various components of a holistic asset management approach.

One of the items is planning and standards, with particular focus on network planning. It is therefore imperative that a national policy and guideline be established for distribution network planning. This should include the strengthening of available analytical tools and practical methodologies.

The national policy is underpinned by the availability of appropriate technical skills. It is therefore essential that a capacity building, training & skills development program be established and coordinated to ensure sufficient skills available for refurbishment and network planning in support of the asset management strategy.

## 6 Utility Funding

A utility can only function effectively if sufficient funds are available for operational purposes, as well as for capital related projects, as identified through the network planning and refurbishment exercise and coordinated within a network master plan framework.

The funding of utility operations should be based on a prudent cost recovery principle; therefore utility tariffs should provide sufficient revenues to satisfy these needs. Two types of expenses need to be considered; namely operational expenses to cover the day-to-day operation of the utility, and secondly capital related expenses to establish, and retain in good order, an electrical network that can supply the customers electrical needs.

As revenues generated from sales are not in all cases on a true cost recovery basis, NERSA has provided guidelines for expenses in determining tariffs, i.e. 5% of revenues for network maintenance, refurbishment and recapitalisation, and 17% towards capital expenditure.

Operational expenses should always be executed on a cash basis, funded from revenues from electricity sales at agreed tariff levels.

Capital expenditure can be funded in a variety of ways, i.e. government grants for specific projects, loans serviced by cash generated from sales and directly from revenues generated by sales.

A utility should determine the funding mix in such a way that the return on assets is maximised, to maintain a healthy debt/equity ratio, and to minimise the impact on tariffs, whilst maintaining a sufficient asset base to supply the required electrical energy. A funding plan and strategy should therefore consist of the right mix of the funding options available.

By not providing sufficient funding for normal operations, the performance of equipment will deteriorate, as maintenance will be neglected. A shortage of funding for capital related projects will result in these projects being delayed, preventing the customer base, and sales volumes from growing, which will negatively affect the national economy. This has been experienced lately with the shortage of generation capacity and other performance related power outages. It has been proven through financial modelling that growth of the utility in terms of sales and customer base is required for a utility to remain sustainable.

Prudent tariffs should be based on cost recovery for electricity services only. In the past revenues from electricity sales were used to subsidise other services within Municipalities, and then disproportionately allocated, resulting in revenues generated from electricity sales not being made available for electricity related activities, like network maintenance or refurbishment. This could be corrected in future by providing government grants for municipal services, i.e. to avoid the historical cross-subsidies.

It should be a goal for the electricity distribution industry that electricity sales only recover relevant costs, thereby eliminating cross-subsidies for other services.

Where current resources and funding is insufficient, a backlog will be created in maintenance, refurbishment and short-term strengthening. This will need leadership in future funding strategies to prevent or overcome this problem.

## 7 CONCLUSION

It is clear that the long-term sustainability of a utility depends on proper network planning to support the growth in new customers and sales. This must incorporate refurbishment planning, as the replacement of outdated equipment should be taken into account in the long-term network alternatives.

Appropriate funds should be allocated for the day to day operation of the utility, supported by sufficient technically skilled staff.

The current situation in South Africa requires leadership to bridge the technical skills gap, and to assist in establishing proper asset management strategies.

The success of tomorrow is based on best planning today.

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