The electrification planning report – the process, content and result

by Mikie Khumalo, Eskom

Eskom, acting as the electricity agent of the government, through the Department of Energy (DoE) and Department of Public Enterprises (DPE), has been mandated to execute the on-going government-funded electrification programme to meet the extended goals of the Universal Access Plan.

The South African President, in his presidential address to the nation, declared in 2005 that all South African citizens would have access to electricity by 2012. This date was later extended. The mandate was to become known as the Universal Access Plan (UAP) for electricity. The government’s intention with this plan was to improve the basic living standards of its people and stimulate economic activity through the delivery of other related services and infrastructure, which in turn will stimulate further growth.

In 2005, Eskom undertook to identify the national backlog of un-electrified connections in South Africa. A study known as the UAP quantified approximately 1,5-million connections that made up the backlog that needed to be electrified. The backlog was defined as all households not yet connected by 2000.

Eskom has, since the inception of the electrification programme, been managing the execution and commissioning of these electrification projects through the existing network asset creation value chain with all processes and protocols required for the approval of electrification projects following the same approval process.

Eskom’s network planning section is responsible for the development and approval of the development plan approval (DPA) and concept release plan (CRA), which are two functional processes in the project life cycle process. During these activities, network planning is guided by the body of knowledge contained in the planning standards and guidelines, good corporate governance and project motivation in order to recommend capital expenditure through infrastructure development to support the required electrification connections to the Eskom grid.

With the rising cost of electricity and the pressure felt by the shortage of Eskom’s generating capacity in 2007/8, the need for innovative, streamlined and standardised processes is now greater than ever, where low household densities escalate the electrification programme’s cost. Distribution network planning and counterparts in electrification planning need accurate consolidation demand side and supply side its information in order to optimise infrastructure cost.

The network planning section is completely responsible for the bulk infrastructure requirements to support the electrification programme, and have the task of ensuring that the network is correctly sized to provide an adequate and reliable supply. In addition, the motivation of capital for bulk infrastructure requirements must adhere to good financial practices in order to sustain the future networks through the tariff recovery and subsidy mechanisms. Failure to successfully implement a long-term sustainable programme will imply that the future maintenance of the network will suffer under financial constraints.

Eskom’s current electrification process makes use of a multitude of disciplines to ensure delivery on the electrification programme. Not all operating units have access to the same technology, resources and information, and this affects the operating unit’s progress of meeting the targets.

The process

Fig. 1 illustrates the interaction between network planning and electrification planning in developing a supply side electrification plan that supports the demand side request for electrification connections. The process that supports this interaction is mostly tacit agreements between the sections, and will be described in step-by-step form, so as to document the generic process.

The electrification process has both internal and external stakeholders. The external stakeholders are:

- The Department of Energy (DoE).
- The Department of Public Enterprises (DPE).
- The Department of Provincial and Local Government (DPLG) under which the Metropolitans and local municipality Authorities fall.
- The Department of Local Government and Housing.
- The Department of Education – Schools.
- The Department of Health – Clinics.
- Private Developers

These external stakeholders are responsible for identifying and formulating an electrification demand side connection plan for the country’s electrification needs, and the connection plan for the country’s schools and clinics. Certain areas in the country may have up to date energy sector plans that may identify the need for electricity and other services in their area of jurisdiction. Integrated development plans (IDPs) have become a high priority with the Department of Provincial and Local Government. These plans identify the need for infrastructure requirements, which include the identification of electrification areas that have been budgeted for in the coming financial years. The blind side of the demand side plan is that there is no knowledge of the electrical
constraints of the network such as resources, network capability and network availability.

The electrification planning section under the asset creation department within the distribution division is responsible for managing the relationship and liaising with the above external stakeholders. The purpose of this liaison is to ensure that the electrification needs for the present and future years are documented in order to compile an electrification demand side plan. This plan should have all the envisaged electrification prepaid connections, schools and clinics as consolidated per Eskom operating unit or municipal boundary.

Usually this information is collated by electrification planning from all the local authorities. This list is often compiled in a non-spatial format and relies heavily on the intrinsic knowledge of the electrification coordinator. Eskom does not have a national system, but is currently working on a model that has its roots in a system developed by the eastern region called “Spaceman”, which is short for “spatial manager”. This system manages all the prepaid electrification, schools and clinic connections spatially, and removes burden of individual memory with respect to the location and other attribute data of projects. This system will allow all internal stakeholders to visually account for the electrification plans as they evolve into executable projects.

The housing electrification programme (HELP) database (which may be in various formats at an operation unit level) may act as a further source of supporting input data that electrification planning can use in the demand side plan. The HELP database was populated to capture and document all un-electrified areas and may exist at various levels of updated states in some of the operating units. Another Eskom initiative is the acquisition of digitised satellite imagery to identify densification of households in electrification areas. This technology makes use of satellite data from the Satellite Pour l’Observation de la Terre (SPOT) 5 satellite and is currently being managed by electricity supply industry – geographic information system (ESI-GIS). Sample data of both the HELP database (where applicable) can be obtained from the local land development sections and SPOT5 images from ESI-GIS. Eskom also makes use of national systems such as Smallworld and the land and rights geographic information system (LARGIS), to support the input to the demand side plan. Figures below contains a high-level summary of the nature of the SPOT images. A building count has been performed using the SPOT 5 images, and should become part of a standardised way of operating.

Formulation of a demand side plan using the inputs from the above institutions and functional tools should be used to identify and position all of the connections required, together with their priorities and timing of their connections. This should be represented in single-source spatial database to avoid data being misinterpreted and creating problems that will affect project deadlines. It must be noted that this plan has multiple dependencies that will affect the manner in which the villages are connected as a result of the development of the supply side plan.

Electrification planning should make use of the land development sections of network planning in order to produce this electronic working copy of the electrification demand side plan in a spatial format. It should be noted at this point that no commitment can be made to the local authorities, as the suitability and availability to electrify the requested connections need to be tested with the supply side plan that is formulated by network planning.

The demand side plan is then supplied to the network planning section for the evaluation and formulation of the supply side plan that will inform the prioritised time frames of the demand side plan. This evaluation takes into account the technical network requirements based on the location of the connection as well as the supply side capacity constraints, in order to determine the extent to which the subsidised budget will be suitable for the number of connections requested. Eskom has previously developed, in conjunction with the Department of Minerals and Energy (DME), an electrification planning model, which has various inputs and produces on a high level the extent to which electrification can penetrate an area based on an allocated electrification subsidy. This tool, however, needs to be updated and maintained in order to render results that can be used by network planning in compiling the supply side plan.

In the absence of electrification planning model in the regions, the classical planning approach should be adopted in order to evaluate and formulate a supply side plan that suits the demand side plan in order to achieve a mutually agreed electrification plan. Network planning will need to consider various connection strategies to achieve the required connections in the most cost-effective way. This iterative process will result in feedback to the electrification coordinator, indicating the proposed plan based on the availability and suitability of the network. It should be noted that this supply side match to the demand side request has costing confidence levels of approximately 50%, as this is at the development plan stage. This being equivalent to the development plan approval stage as defined by the Eskom Standard Project Life Cycle Model Policy in the distribution business. Only once the plan is supported by all the stakeholders and projects identified for the three-year rolling plan and pre-engineering fees are made available, can the process to develop the costing and scope be completely more accurately.
Electrification Project: Network Planning Report

Sikhulu electrification area

Project summary
No. of connections: 704
Feeder and TRFR detail: Ingeli NB1 near TGG25
GPS co-ordinates: 29°41'46,1"E 30°25'33,33"S
Income level: 0 to 750
Network constrained status: Constrained
Existing customer base: 6571

ADMD, Herman Beta, and MV System Parameter Calculation and Assumptions

Elect. Proj. Name: Sikhulu  
Classification: Rural settlement

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Final (year 15)</th>
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<tbody>
<tr>
<td>ADMD (kVA)</td>
<td>1,0</td>
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<tr>
<td>Alpha parameter</td>
<td>0,461</td>
</tr>
<tr>
<td>Beta parameter</td>
<td>1,661</td>
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<tr>
<td>Circuit breaker size</td>
<td>20</td>
</tr>
<tr>
<td>Statistical current</td>
<td>AMEU</td>
</tr>
<tr>
<td>Network classification (C1=102%, C2=98%, C3=95,5%, C4=92,5%)</td>
<td>C2</td>
</tr>
<tr>
<td>Maximum allowable LV volt drop</td>
<td>7,5%</td>
</tr>
</tbody>
</table>

Notes
The information provided in the planning report is based on relatively high level information as provided to the network planning department. Should any of the inputs and assumptions on which the recommendations are based change, the recommendations will need to be adjusted accordingly. Whilst this report provides recommended design parameters based on this high level information, these parameters will need to be verified by the designer as part of the design. The responsibility still lies with the designer to ensure that the income levels/Herman Beta parameters are indeed representative for the customers to be supplied. Any deviation from the recommended values must be discussed with and approved by the network planning section.

The contractor needs to verify the validity of the census data results before completion of the design.

Any other lines longer than 1 km long are to be constructed in three phase FOX.

Income level per household per month provided by electrification planning department.

Classification based on zone no. MV recovery voltage from the substation to end of the network.

All transformers are to be locked in nominal tap for both initial and final design, with the no-load boost used to differentiate between the use of 400/230 V and 415/240 V transformers. For projects utilising 415/240 V transformers the no-load boost will be 3,75% (three phase transformers) and 4,35% (dual and single-phase transformers). If 400/230 V transformers are used (recycling existing transformers) the no-load boost will be 0%. Any 380/220 V transformers in the electrification area must be replaced as part of the project.

The Herman Beta parameters stated above are based on the specified circuit breaker rating. In reality a smaller circuit breaker may be installed, but the network must be sized based on the specified circuit breaker rating in order to cater for the anticipated loading levels.

Should the number of connections or income level vary by more than ±10% then the parameters provided in this report will need to be re-evaluated by Eskom’s network planning section.

Electrification project classification: deep rural, informal settlement, rural, township.

This report is valid until 30 August 2013.

Report by: Mikie Kumalo, distribution network analyst, Eskom, KZNOU

Fig. 3: An example of an electrification planning report

Recommendation
This project may not go ahead.

Dependency: This project is not to go ahead until the following infrastructure project is completed:
Job ID: STM-1107-2053
Job description: Ingeli NB1 Split
Projected completion date: 30 June 2013

MV Backbone Technology and Conductor Selection

Overview of area to be electrified.
Electrification planning is now in a position to negotiate the re-prioritised demand side plan and supply side plan with the external stakeholders for their support and endorsement. Naturally one has to make allowance for certain project delays that may materialize, as follows:

- Political changes on areas that are to be electrified and the timing of these projects.
- Project delays – planner initiating projects with incomplete information, route selection and acquisition (time lags for approvals), design reworks, construction delays.

The endorsement of the supply side plan and demand side plan (electrification plan) materialises into a three-year rolling plan with the first year fixed with supporting municipality/metro IDP letters and subsequent years semi-fixed. Updates to the business plan are completed on a yearly basis, pending the prioritisation of connection and changes in the projects due to changes in the electrification programme.

These annual or biannual updates, depending on the rate of change of the plan, will also account for ad hoc commitments that arise. These connections may have to follow a queuing system, as capacity on the network needs to be assessed according to their priority. Here tools such as “Spaceman” or similar tools will support the decision-making process, as the requester of this new connection will have to discuss the impact with the input stakeholders. Ideally, the three-year rolling plan should be fixed with approved execution release approvals (ERAs) completed in a staggered release format at least twelve months before the required commissioning date of the project. This will allow for adequate time to meet the commissioning dates as well as report within the DoE time frames.

Network planning must ensure that all network dependencies to support the connection plan are identified during the network development planning stage, either by a minor network extension or major bulk infrastructure development. These network expansions can then be released timeously from the DPA following the trigger from the electrification plan.

Once the project enters the asset creation value chain (ACVC) process, all normal business practices and processes will apply as defined by the Eskom Standard Project Life Cycle Model Policy in the distribution business. In a perfect world, the preceding process would progress seamlessly and effortlessly. However, data is often the single largest factor that impedes the progress of the programme. In reality, not all connections are known to all the internal stakeholders, and existing plans often need to be revised in order to accommodate new connections. These revisions create additional work for all parties and, for obvious reasons, are undesirable. One can appreciate the turmoil that is caused when a network extension plan is developed with various load flows to the networks to test compliance to voltage constraints under normal and abnormal conditions, only to have to rework the plan due to newly discovered connections that alter the manner in which the network extension is required to evolve.

Further complications can be appreciated if projects are released without long lead items, only to have the newly prioritised connections requiring bulk network upgrades which require long lead items.

It should be noted that CRAs can be released by both electrification planning as well as network planning. However, all bulk infrastructure projects are released by network planning.

The content

- All MV conductor sizes are to be specified unless inside the village.
- Only use two phase technology for supplies to small villages.
- Squirrel conductor can be used as it is still an Eskom standard conductor.
- Voltage levels are specified for peak and light loading for the medium term (10 years from date of connection).
- Voltage levels are provided at the end of the MV lines inside the group of villages (project).
- Fault levels are specified for the time of connection and for the future if strengthening is planned for the network.
- Fault levels are provided for each village.
- Further system development indicates future strengthening planned for this network.

- Voltage support (voltage regulator, capacitor bank, conductor upgrade) required within three years of connecting the electrification project must be included in the electrification project.
- Requests for electrification reports must come from project engineering and these reports must be sent to project engineering when completed.

Fig. 5 illustrates an example of an electrification planning report:

The result

Upon the endorsement of the supply side plan that meets the requirements of the demand side plan by the external stakeholders, network planning would be in a position to finalise the DPA in order to compile the three-year rolling plan and five-year business plan.

The electrification plan should be available, spatially indicating all connections that need to be connected to the Eskom grid on a project (village or settlement) or geographical area basis. This electrification plan and capital projects that support the connections constitute the DPA and will be required to be taken to management forums for approval. These projects would then inform the NDPs as they are updated, to provide senior management with a holistic view of the development and capital requirements of the networks for the NDP area and period.

The electrification plan and NDP will highlight the dependencies on bulk infrastructure projects required by the demand side plan. This includes the strengthening projects and their associated electrification projects. This plan must indicate preliminary routings of MV backbones and technology selection, as this affects the total connection plan. This is required to ensure that the optimum equipment sizing is done to ensure optimum thermal loading, back feeding, voltage apportionment and voltage regulation of the MV network.

The electrification plan can now be accepted by all internal and external stakeholders, and the three-year rolling plan and five-year business plan can be extracted from the plan with the necessary capital projects being released in the ACVC for execution.

Conclusion

In conclusion, Eskom is fully committed to the United Nations Millennium Goals towards eradicating poverty. As 2012 has been declared the International Year of Sustainable Energy for All, Eskom is in full support of developing long-term plans to provide access to sustainable energy for all by 2030, as envisioned by the United Nations.

Contact Mikie Khumalo, Eskom, Tel 033 395-3770, mikie.khumalo@eskom.co.za

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