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**Electricity Supply to Africa and Developing Economies –
Challenges and Opportunities**

Enabling Universal Access to electricity in developing economies

Servicing backyard dwellings with electricity in the City of Cape Town

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SUMMARY

In view of rapid urbanisation and the shortage in formal housing faced in many parts of the country, informal dwellings at the back of formal dwellings are increasingly used to provide much-needed housing in urban areas, if only on a temporary basis. The advantage to the occupants of such dwellings is that they have access to basic services through the main dwelling. However, the additional informal dwellings pose a few challenges to the suppliers of basic services.

This paper is a recollection of the City of Cape Town's Bonteheuwel backyarder electrification project to date. The aim of this project, amongst others, is to pro-actively create a suitable network to support the electrical supply to informal dwellings.

Challenges that have been faced are discussed hand in hand with the solutions that were implemented. These challenges were not only of a technical nature but also associated with the dynamics of the community in which the project is set.

Statistics of the project are provided to assist with benchmarking of similar projects.

KEYWORDS

Backyard dwellings; backyarders; informal dwellings; residential; housing; electrification; community liaison officers; Herman-Beta method; overhead to underground.

1. Introduction

The provision of sufficient housing, particularly in the urban areas of South Africa, is a challenge with 20% [1] of the population residing in informal dwellings. Having informal dwellings at the back, or sometimes at the front, of formal dwellings is increasingly contributing toward the provision of housing [2]. These are sometimes referred to as back yard dwellings. The advantage to the occupants of such dwellings is that they have access to basic services through the main dwelling. However, the owners or tenants of the main dwellings often exploit the backyarders in terms of the cost and reliability of the electricity they provide. This undermines the potential benefits of such housing arrangements. Further, the additional and unplanned informal dwellings pose challenges to the suppliers of basic services.

In relation to the national statistics the Western Cape and North West provinces have the heaviest load of backyarders [3]. Service departments in the City of Cape Town Municipality are pro-actively investigating the impact of backyard dwellings in delivering basic services. Resulting from these investigations are initiatives to address the challenges. This paper presents the approach and implementation of a solution to address the supply of electricity in an area where there is a prevalence of backyard dwellings.

A continual process of investigation into the impact of additional load on the electrical network and implementing pilot projects is in progress at the City of Cape Town. Royal HaskoningDHV were appointed to render professional services to the City of Cape Town at a time when the Bonteheuwel project was planned.

2. Design Phase

Design background

In general there are two approaches when informal dwellings are being added in an established electrical network:

1. A re-active approach that allows the informal connections. In this approach network strengthening is only embarked on when the magnitude of the continual addition of load results in the unacceptable overloading of infrastructure.

2. A pro-active approach that assesses the number of envisaged backyarders and then strengthens the electrical network to cater for the additional load.

Both these options have strengths and weaknesses, these are analysed qualitatively in the table below. The table also includes some ways to limit the impact of the weakness.

Table 1 : Approaches to electrify back yard dwellings - advantages and disadvantages

Approach	Strength	Weakness	Impact limiters
Re-active	No upfront work to upgrade installed infrastructure.	Network overloading will arise by an increase in maintenance events.	Monitor load growth.
Pro-active	Result will be a stable network.	Upgrade required to an installed, operational network (capital expenditure and widespread trenching in the area).	This work could be scheduled to coincide with network replacement based on operational aspects.
		Allowance for a maximum number of informal units needs to be well informed.	Careful selection of planned backyarders per property.

To Utilities with installed networks the reactive option may be the best approach with monitoring of the load growth and outage events and planning for the utilization of equipment. However the creation of a stable, suitably sized network will always be appealing (i.e. the pro-active approach).

In the event that an installed network, with backyard dwellings present, needs large scale improvement an ideal opportunity presents itself to make provision for backyarders. This opportunity presented itself in the case of the Bonteheuwel suburb of the City of Cape Town as described below:

- It was planned to replace the ageing, mid-block, overhead electrification infrastructure in Bonteheuwel with an underground street front network.
- The area has backyard dwellings present. According to the City of Cape Town Housing Department information 661 backyarders on 1867 City of Cape Town owned properties. This represents 35% against the provincial statistics of 12% [3].
- The community leaders were engaged and indicated tolerance to such a change in electrification.
- The City of Cape Town's Electricity and Generation Department has already embarked on pilot backyarder projects and had established guidelines and policies to institutionally enable this work.

Design brief

The proposed arrangement of electrical components is illustrated in Figure 1. For the sake of clarity, only the last portion of the network, close to the final consumer, is shown. The main dwelling (formal) and each of the backyard dwellings (informal) receive an independently metered electrical service connection.

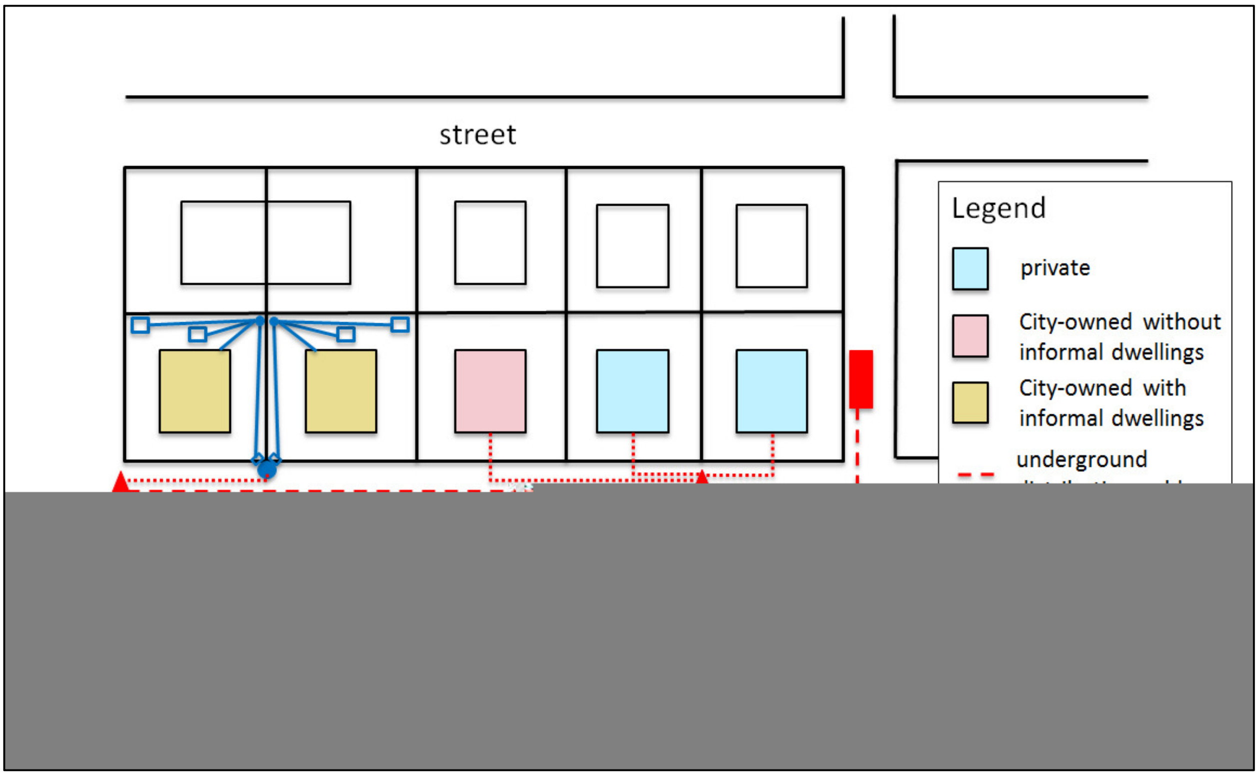

Figure 1 Schematic diagram of the proposed arrangement

Notable items on the proposed layout:

- Based on current municipal bylaws only backyarders on properties owned by the City of Cape Town will receive a subsidized electrical service connection.
- The capacity of the backbone infrastructure is designed to accommodate backyard services on private land, in the likely event that this will become a reality in future.
- Properties earmarked for the electrification of backyarders receive an overhead supply on the property (risk management given the informal dwellings).
- The underground service cable to the pole, and subsequently to the pole top box, is a three phase supply.

Further details of the design brief that informed the detail design are provided in the following table:

Table 2 : Design brief for Bonteheuwel

Aspect	Brief	Origin/Reason/Justification
Number of backyard dwellings for each main freestanding dwelling.	3.	Experienced and refined as part of previous pilot projects.
After diversity maximum demand of main dwelling.	2.66 kVA.	Aligned with SANS 507 for Living Standard Measure of 5 and 6.
After diversity maximum demand of backyard dwelling.	1.13 kVA.	Incorporated from SANS 507, informal settlement value.
Street furniture.	Current standard City of Cape Town units.	To ensure maintainability of infrastructure.
LV cables.	Standard sizes, aluminium as conducting material.	To ensure maintainability of infrastructure and reduce vandalism and theft.
MV network.	Design for an integrated MV network required by means of 3-feeder group/s.	To cater for the envisaged increase in load on the bulk medium voltage networks.
Backyarders eligible.	Initially only backyarders on City property will receive a subsidised service connection.	Municipal bylaw. It is envisaged that this might change in future to include all properties.
House connection.	Overhead for City rental stock, underground for connections to the main dwelling on private properties.	The overhead connection was mandated on City property as a safety measure to mitigate the risk of unintentional contact with or damage to electrical cables in an informal and fluent environment. The same principle applies in informal housing settlements.

Note:
Combination houses (semi-detached historical housing schemes) were also assigned an appropriate number of backyarders as the size of the plot permits.

Design challenges

During the initial design and through implementation a number of design challenges were encountered. This section focusses on these challenges and the solutions implemented in the Bonteheuwel case.

Combined ADMD

The design of the network was compiled based on the Herman Beta statistical method as specified in SANS 507 [4]. The calculation models as well as the software used for simulating the effects of diversity in the network are based on a single set of load parameters throughout the area under investigation. In the backyarder situation there are two sets of parameters, that of the main dwelling and that of the informal dwellings. To address this the two sets were converted by a method described in SANS 507 to a single set that could be used per consumer, regardless if it is a main or a backyard dwelling (in a homogenous distribution).

This is summarised in the following table:

Table 3 : Combination of load parameters

Consumer	After diversity maximum demand	a	b	c
Main Dwelling	2.66 kVA	0.98	2.41	40 A
Backyard dwelling	1.13 kVA	0.74	5.34	40 A
Combined dwelling (freestanding case)	1.5 kVA	0.63	3.17	40 A

The addition of the backyarders increased the after diversity maximum demand per plot from the normal allowance of 4.04 kVA to 6.05 kVA (an increase of 49.8 %).

Phased upgrade of the 11 kV network.

The Bonteheuwel area has been divided into eleven areas to allow phased construction. All low voltage networks are contained in these areas, however the 11 kV networks span across the areas. To limit the trenching operations the 11 kV cables, required for the future/adjacent areas, are installed as required. Most of these cables cannot be operated now as the terminating substation location has not been reached; nor have the terminating substations been built. The challenge with this gradual installation of the cables is to energize the cables immediately after installation to reduce theft and enable monitoring of the cables. To allow the energizing of the cables two solutions were implemented:

- If two cables are installed along the same route, the cable ends are jointed at the remote side and the cables are energized from the sending end with one of the sending circuit breakers normally open.

- If a single cable is installed, a temporary RMU is placed at the remote end to allow for the termination and energizing of the cable.

Exposure of clay during trenching

During trenching the ground conditions in Bonteheuwel were found to contain large amounts of clay. The clay on the sidewalks was stabilized during initial construction of the roads. During trenching the weathered stabilization was broken and the clay material was exposed. The exposure of the clay, compounded by sidewalks that are used extensively for parking, compromised the stabilization. To ensure that the area was left in a similar or better state after construction it was decided to embark on re-stabilization of the whole sidewalk.

3. Challenges faced during Implementation

Day to day implementation of the project was enhanced by good working relationships between the employer (City of Cape Town), consultant (Royal HaskoningDHV) and the contractor (Jake Trading). This good working relationship was well suited to address anomalies and variances expected from a complex, pilot-type project. This section focusses on challenges that were faced during construction.

Vandalism

pro-actively meet with affected owners on a one-on-one basis as much as is possible. During these one-on-one meetings the proposed plans and implications for the work in and around the dwelling is discussed.

Safety and security

management. Over and above the benefit to the backyard dwellers, the maintenance teams benefit from the overhead to underground aspect of