Informal Electrification in South Africa

Experience, Opportunities and Challenges

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„Occupants of informal dwellings are usually the poorest sectors of society."

Context

Electrification can be grouped conveniently into three sectors: rural electrification, formal urban electrification and the electrification of informal urban settlements. This last group is the fastest growing household sector in South Africa and formal housing programmes have not been able to keep up, often resulting in alarming informal household growth rates in cities[1]. This situation is probably true of the rest of Africa and even globally. The vast majority of informal households also remain unelectrified. At least 10% of South Africa's population live in urban informal settlements – i.e. over 4.4 million people or 1.2 million households, although these figures are difficult to establish with any certainty and are likely to be higher in practice[2]. Informal household figures quoted by our large cities commonly indicate over 300 000 households or more each[3].

While a few years ago there was still a stated intention to eradicate informal settlements, today they are recognised in official documents such as the *Policy Guidelines for the Electrification of Unproclaimed Areas*[1] as a long-term feature of the South African landscape. They are now explicitly included in the Integrated National Electrification Programme, which is intended to meet a national target of 92% access by 2014.

> *Traditionally, the Integrated National Electrification Programme (INEP) focused only on electrifying formal housing in rural and urban areas. However, due to the growing trend in the increasing informal settlements and the Constitutional right of all citizens to basic services, the Department is obligated to ensure electrification of informal settlements as well. In line with the Energy White Paper, Government supports the electrification of residential and unproclaimed / informal areas.*
>
> ***(Policy Guidelines for the Electrification of Unproclaimed Areas – DoE 20 Jan 2011 rev6, p3)***

Amongst the factors behind the above recognition is the fact that informal households have not had access to Free Basic Electricity and the well intentioned Free Basic Alternative Energy policy has proven impractical and largely ineffective (SANERI 2008; SEA 2011), leaving this significant component of the population without adequate access to energy services.

The challenge of informal settlement electrification

Solutions to the problems of supplying electricity to informal urban settlements are elusive because the contexts of the settlements are so different and fast changing, and the resources available are generally inadequate. Nevertheless, some common characteristics can be identified.

Typically dense irregular layout of informal settlements in South Africa

An ongoing rapid growth of informal households occurring throughout South Africa

Example of an illegal electricity connection

A form of current informal settlement electrification in eThekwini municipality

1 Some cities appear to be experiencing informal household growth rates of between 10% and 16%

2 Policy Guidelines for the Electrification of Unproclaimed Areas - DoE 20 Jan 2011 (rev 6)

3 Johannesburg, eThekwini and Cape Town all report informal household numbers of 300 000 or more.

The dominant character is that urban growth, especially in developing countries, is mostly unplanned because the demand exceeds the capability of existing national and local government to proactively implement infrastructure consistent with the rates of population growth and urban migration. Poor people especially have few alternatives except to congregate in apparently available areas, taking whatever space they can occupy and defend, and often subject to informal organisation completely separate from the governmental institutions. In many cases the areas occupied are unsuitable for habitation because the land is unstable, prone to flooding, has been set aside for other uses (servitudes, roads, etc) or has health or environmental implications. As a result, the provision of basic services to households establishing themselves in such areas raises many issues including legality, financial viability, appropriate technologies and social ethics. Since electrification is a highly desirable approach to meeting a community's basic energy needs, the policies and processes need to respond to the relevant context of each community.

The contextual factors and their implications include:

Context factors	Implications for electrification
Public or private land occupation	Electrification of squatter households is limited by the argument that services provision conveys rights to illegal occupants over the rightful owners.
The occupants of informal settlements are usually the poorest sector of society (financial, educational, political poverty)	Electrification is unlikely to be financially viable, especially in the short term, but the communities needing electrification generally lack influence and access to decision making, so alternative (non-conventional) support is needed.
Continuously increasing density, infill of households into increasingly less suitable spaces, contiguous shacks, eventually multi-level shack development.	Conventional planning processes will be ineffectual. Utilities will struggle to gain access to construct the infrastructure, for operations, maintenance and subsequent reinforcement to meet increasing demand. Contiguous shelters make it difficult to identify individual households (customers).
A lack of formal electrification encourages illegal connections from nearby electrified areas	Safety is compromised, with frequent fatal accidents. Theft of conductors and cables from formal electrification networks disrupts the supplies to formal customers. High costs are incurred in 'risk management'. The inevitability of faults, theft and related problems are discouraging for utility staff.
Theft of electricity contributes to high 'non-technical' losses on the formal networks. High costs are incurred in 'revenue protection'.	Affects the financial viability of electricity utilities and the tariffs for formal customers.
Regulations applied to electricity systems for the purpose of public safety are mostly expressed in general terms.	Since the safety regulations reinforce the normal liability arising in *delict*, interpretations of the regulations by government officials are generally conservative and constrain technological options for low cost supply.
Institutional structures and tariffs in the electricity sector are subject to political influence	Conflict between national, regional and local policy inhibit the adoption of locally suitable organisational and tariff structures and revenue collection.

Photo: City of Cape Town

Contiguous shacks and infill of informal dwellings into increasingly less suitable spaces

Informal settlement on a slope in eThekwini municipality – example of an informal landscape

Clearly the problems in this multi-dimensional context are complex. This is illustrated, for example, by the sequence of a utility clearing illegal connections in accordance with government safety regulations to remove the electrocution hazards, street lighting and other conductors being stolen to replace the removed illegal wiring and needing to be replaced by the utility, and illegal connections being restored by the community within days, if not hours, of the clearance. Clearly, neither technological approaches alone nor periodic clearing of illegal connections will be adequate to resolve the twin problems of supply to informal areas and electricity theft.

Some South African municipal distributors have been grappling with the issue of providing electricity to informal households for over 15 years, and a significant body of experience has developed regarding how to undertake this successfully. Key aspects of this experience from selected municipalities are discussed in the next section to support municipalities in addressing this national imperative.

Examples of illegal electrical connections

Illegal connections in a trench

Unusual junction box (illegal wiring)

Settlements are often comprehensively reticulated, albeit illegally and unsafely

Flimsy wires and metal sheets

Taking illegal connection straight off the ABC

Illegal live electricity connection running across main access road and surrounded by water

Electrification approach: blanket or selective?

A utility adopting the approach of area coverage (also called blanket electrification), is affected by the processes of identifying the customers, planning and implementing the electricity system, and collecting connection charges. On the other hand households maybe electrified using a selective approach, where households are connected only when they pay a connection fee. Alternatively one can undertake blanket electrification and connect up all households while on site, and use an alternative mechanism to recover the connection fee. The former has clear disadvantages, in that illegal connections will continue by those who are not yet formally connected, perpetuating the serious safety concerns, revenue losses, and need for regular policing to disconnect them. Further key disadvantages are that the poorest households are generally the slowest to get connections hence, in South Africa, they fail to derive benefit from the social programme of Free Basic Electricity, and selective electrification makes it difficult to make new connections quickly to meet political objectives. Also, there may be some resistance by these illegally connected households to move to formal connection afterwards because they are accustomed to free electricity (albeit with the regular inconvenience of having to reconnect the illegal supply and experience a very variable quality of supply).

There are strong advantages to blanket electrification of an area. Some experience shows that this halts illegal connections, or at least reduces them substantially, with resulting safety and revenue collection benefits. The infrastructure is better utilised, potentially improving the overall welfare of more households, and it generates a greater return on investment. In addition, technicians do not have to undertake multiple visits to connect houses gradually as they pay the connection fees. This is significant because of the technical capacity constraints faced by most cities and towns. However, informal settlements tend to be much more dynamic than formal settlements, sometimes requiring re-planning, network modifications and new

Part of this settlement is in a regularly flooded area in eThekwini municipality – can they can still be connected (they are already, but illegally and unsafely)?

connections. While this can be mitigated by blanket electrification, such future attention is unlikely to be completely avoidable because it is always likely settlements will become more densely settled.

But how are connection fees recovered? Firstly, it should be noted that connection fees are nominal. Actual connection costs may be of the order of R8 000-R12 000 per household. A connection fee of a few hundred rand, as is typical, does not go far to repaying this cost, and it will certainly not cripple a distributor if the fee is not recovered immediately. These fees are often set more to establish a commitment by the household. It is preferable to not charge any such fees upfront, but connect all households and recover the connection fee by deducting an amount (14% as is occuring in at least one city) off all purchases until it is paid. This is possible with almost all prepayment meters used in South Africa, where the SPS encoding features allow for 'partitioning' of charges in electricity billing.

Housing in many informal settlements 'overflows' into floodplains, road and powerline reserves etc. The above is not implying that houses in such areas should be connected as well[4]. However, flood plains are particularly arbitrary, because they are defined by a probability of flooding (example a 10 or 50-year return flood) and are subject to structures including embankments, vegetation and other housing that change the floodlines.

Technical options

Basic technology used for informal settlement electrification is generally not very different to that used for decades in formal household electrification – pole or ground-mounted transformers, aerial bundled conductor (ABC) feeders, and 'Airdac' household service connections. The biggest difference may be more around adopting a measure of flexibility in certain technical aspects and design layout rather than substantial changes in technology choices. Specific technical considerations are listed below:

1. In the dwelling

- Dwellings vary in construction material, and may be of mud, wood, plastic sheeting, corrugated iron etc. Fixing of the supply point therefore needs to be determined on site, ensuring that safety issues receive proper consideration.
- The supply to the dwelling is typically into a distribution board ('ready-board'), with sockets and a light. This board satisfies regulatory safety requirements and allows the owner to extend the network inside the dwelling with extension leads.
- The support for the ready-board should be undertaken in a flexible manner depending on the circumstances – sometimes house walls provide adequate support, sometimes an additional sheet of wood can be used to mount the board on a flimsy wall. This 'as needed' approach has been successfully used in Cape Town for many years where the dwellings have often proved to be more substantial than expected.
- Dwellings can also share walls where different family groups live in what is effectively a single structure. Each of these groups is likely to require a separate supply.

2. Low voltage distribution (230 volts)

- Distribution network design is largely determined by the layout and density of the dwellings and by the ADMD[5] per dwelling (normally taken from NRS034). The DoE guidelines[6] indicate that a 20Amp supply with design ADMD of 0.8 to 1kVA is adequate for new electrification projects. Some municipalities install full 60Amp supplies for political reasons as well as to minimise future visits for upgrade applications. While experience shows that appliance uptake, such as fridges, is relatively

4 See *Policy Guidelines for the Electrification of Unproclaimed Areas - DoE 20 Jan 2011 (rev 6)* for settlement criteria for electrification

5 ADMD – After Diversity Maximum Demand

6 Suite of Supply Policy Guidelines for the Integrated National Electrification Programme (INEP) 2012/13 – DoE 10 March 2012 rev8

Photo: © CT Gaunt, 2012

Maypole house connections

Photo: © CT Gaunt, 2012

Maypole showing open 9-way box

Photo: © CT Gaunt, 2012

Maypole with two 9-way boxes

Municipal electricity connection for informal households showing service pole and prop from the pole to support the readyboard in the house

fast in newly electrified poor households, in practice the 60Amp supply remains unnecessarily large, and a 20Amp supply would satisfy even most mid-income households.

- The service connection is made with concentric cable where the live conductor is effectively screened by the neutral /earth for safety (commonly referred to as 'airdac' cable).
- Overhead insulated bundled conductor (ABC) is widely used. In many cases the insulated low voltage feeder will have to cross over dwellings, due to the unplanned layout and the changeable nature of the settlement. Attempts to avoid this have resulted in expensive complex pole layouts and ultimately in the electrification of the settlement being impractical. Many examples of insulated feeders hanging above roofs exist where this practice has been followed, without incident and without future maintenance complications.
- Prepayment meters are universally used. It is preferable to use split-type meters with the active units mounted in pole boxes, and just the keypad in the house. This reduces tampering, as any theft on the connection cable is on the household side of the meter.
- Using the 'maypole' method of house connection is likely to be amongst the most cost efficient technology choices, as service connections to households are simple and effective. Maypoles of 9m provide enough elevation to connect up to 27 households, as they can accommodate up to three pole boxes with 9 connection points each, but one or two 9-way boxes are usually adequate.
- Another system in use for informal settlement electrification involves a service pole per house, and a brace from the pole to support the ready board in the house. The simpler and cheaper maypole system with 'as needed' approach to ready board support is however likely to be adequate in most circumstances.
- Although 9m wood maypoles are recommended due to the elevation and thus coverage they provide, in some instances settlement density might result in their being difficult to carry into suitable locations. In these circumstances shorter poles can be considered (e.g. 7m or 8m).
- Keeping records of dwellings connected and numbering the pole boxes facilitates maintenance response.

3. Medium voltage distribution (11 000 volts)

- The medium voltage (MV) supply to a settlement is dependent on the size of the settlement. Some settlements are large enough to require MV internal reticulation. In these cases either open wire or bundle conductor are most suitable, the latter particularly if access ways are not formal roads.
- The distribution transformers can be pole or ground mounted and sized according to local standards and the size or density of the settlements.
- Long term maintenance considerations are important, and it is advisable to keep access to MV lines and transformers reasonably clear.

Although crowded and non-linear, this settlement layout could be effectively supplied with the maypole system

4. Supply adjacent to flood plains

- Experience has shown that clear demarcation of areas to be electrified and those that will not be electrified because they are considered to be on 'floodplains' are respected by most communities, but illegal connections will still be made into the non-electrified areas.
- Electrification infrastructure that is predominantly aerial (pole mounted transformers, ABC and airdac service connections) instead of ground mounted substations and kiosks keeps most of the network out of reach of floodwaters. However, experience has shown that utilities must provide isolation points easily accessible to their operators to be able to disconnect areas when flooding occurs.

Community engagement

Thorough community liaison is a vital part of successful electrification of informal communities. It is seldom sufficient to just liaise with formal community representatives or councillors, as this typically does not adequately inform and involve the community itself. Direct and regular interaction with the community members is important. This sometimes requires after-hours community meetings in the community itself. It is recommended that the community be engaged right at the outset of the electrification process and on a regular basis throughout the project. There should be a constant liaison with the community by specifically appointed Community Liaison Officers. This requires significant effort, but the result is likely to be comprehensive community buy-in and support. Such a process enables the city to make clear to the community what their requirements are (including helping and protecting electricity staff, guarding against theft, help with prioritisation of electrification areas), and the community can clarify their needs in the process. It also enables capacity building around safety issues and the benefits of electricity.

Reviewing current tariffs

It appears the context and conditions of supplying electricity have changed quite substantially since tariff structures were last reviewed and there might be benefits derived from reassessing the approach to tariffs for poverty alleviation.

Free Basic Electricity (FBE) tariffs were adopted in their various forms almost ten years ago. It is now evident that the concerns identified in 2002 about coverage and leakage of subsidies were valid - the very poor do not benefit because they do not have access to electricity, while the costs of FBE subsidies have grown significantly.

In a review, consideration could be given to formulating tariffs suitable for different types of customers, including the poor who typically do not have high individual maximum demands and cannot implement load shifting effectively, which characterises them differently from other groups of customers. The objective should not be to adopt a single tariff structure for all domestic customers and instead to adopt differentiated structures, from which customers can choose, while at the same time being politically acceptable, cost reflective and encouraging appropriate patterns of electricity use. This principle is explicitly supported by national policies[7].

7 Suite of Supply Policy Guidelines for the Integrated National Electrification Programme (INEP) 2012/13 – DoE 10 March 2012 rev8

Case Study: Cape Town's informal settlement electrification lessons

Community engagement in KTC (Nyanga, Cape Town)

- 15 years ago City of Cape Town's Electricity Department was commissioned with implementing informal electrification, motivated by political pressure which recognised the rapidly growing presence of informality in the City.
- The Electricity Department embarked on this initiative by initially engaging with the community through a series of workshops in each of the 50 informal areas. Key community representatives from each of the communities were identified and involved in further workshops. The initial phase was concluded with a workshop where all community inputs from the previous workshops were consolidated to finalise the priorities and the plan. At this final workshop preceding implementation, the City announced the finalised numerical rollout order of electrification and pledged to abide strictly by the plan. KTC was the first targeted area.
- In KTC, and subsequent informal electrification projects, workshops and regular community liaison were undertaken by officials from Cape Town's Electricity Marketing Unit, specifically two Community Liaison Officers (CLO's) whose dedicated daily task was to engage with the community throughout the duration of the electrification programme.
- The workshops entailed identifying and prioritising the areas to be electrified, the energy needs of the communities and determining community priorities relating to area sequencing. This input formed the basis of the implementation plan. Workshops were attended by community leaders, street committee representatives, ward councillors and relevant NGO's, and were facilitated by the CLO's. These workshops were held at venues within the community, in makeshift community halls and other community gathering places. The City of Cape Town Metro was adamant not to hold these workshops at their City offices, but to engage with the community in their familiar surrounds and experience the reality of their issues more directly. While the two CLOs constituted the City's dedicated capacity to drive the community engagement process throughout the programme, the City official leading the electrification programme participated in almost all of these community engagements, at the request of the community.
- Close engagement with the community of KTC continued throughout the electrification process until handover of the completed project. On-going bi-weekly meetings were conducted

Photo: © Mark Lewis

throughout the KTC electrification programme to inform on progress and problems and to allow general engagement. A demonstration truck (an old van converted into a demonstration vehicle) was driven around the communities on a daily basis, to demonstrate the benefits and safe use of electricity. Key information imparted to the community included that while electricity can't be seen, its intrinsic value resides in the end-use applications such as cooking, lighting, heating, refrigeration and access to media that can be performed as a result of its use.

- All workshops included a safety awareness component relating to electricity use. Peak caps and other forms of promotional material on electricity benefits and safety were distributed at these gatherings.
- Prior electrification of KTC, community members were made explicitly aware of the City's requirements from the community before proceeding. These included:
  - protection of City's assets - cables, tools etc;
  - safety of staff – the community needed to ensure staff were adequately protected throughout the process of electrification;
  - relocation of shacks where required for locating infrastructure and access ways; However if housing space was a constraint and shacks could not be moved, the City worked around it.
  - co-operation by the community through the attendance of meetings to resolve problems arising throughout the process. Informal community law worked well in resolving breaches in City-community agreement.
- Each household received a 'goodie pack' on connection which comprised a kettle, iron and 2 plate hot plate. (although not done in this instance, in future distributors could consider including high power CFL lamps, typically 18W, and an extension lead. Bad on-wiring is a key cause of unsafe installations.)
- Local community labour was utilised, mainly for digging pole holes and carrying poles, all tasks were supervised by City staff. The community allocated labour on a rotational basis.
- The final handover workshop focused on community ownership where it was declared that the network belonged to the community of which they are now custodians. The handover party was attended by councillors and community representatives, where keynote speeches were made and refreshments offered.

Photo: © CT Gaunt, 2012

Changes in technical approach

- The Cape Town informal electrification programme started off in KTC, Nyanga, followed by Joe Slovo settlement in Langa township. Initially 20% of households on the outskirts the KTC settlement were electrified using underground copper cabling, and the City turned a blind eye to "on-selling" or the use of extension cords to supply other dwellings from a legal supply point arising from this form of electrification. While the underground approach to electrification was advocated by 'old school' officials, aerial reticulation and connection was eventually adopted after extensive processes of debate and negotiation that illustrated its cost effectiveness, cable theft reduction, greater efficiency in the face of the changing nature of an informal settlement, and more importantly, safety characteristics. This in turn gradually changed to the maypole approach, which has proved a cost-effective, safe and efficient method of informal settlement electrification over its years of use.

Planning and implementation approaches and capacity

- The City utilised municipal funds for informal electrification. The Electricity Department had to apply in advance to the Council for a budget. Once the budget was approved, electrification planning started.
- Planning began with aerial photographs being taken of the identified sites, followed by site visits with community liaison
- Two to three sets of plans for different areas were developed, so that in instances of delays arising in one area for example due to community disagreements, there were alternative areas that could be readily electrified, ensuring that the informal electrification budget could be completely utilised within the financial year and thus not lost as a result of not being spent.
- Once the infrastructure backbone was in place, the design was 'tweaked' according to local settlement constraints encountered. This required that 'as built' drawings were done afterwards. It was essential that construction maintained an element of responsiveness to actual conditions encountered on-site, as such settlements are seldom linear and change regularly. All this was undertaken in compliance with regulations and standard codes of practice.
- The Drawing Office staff recorded the exact asset location and reticulation routes using GPS, which was fed into the 'as-built' drawings. This helps maintenance staff in locating major faults and with individual household power failure tracking.
- While informal settlement electrification started with one pioneer in the City, it ended up with 150 staff, and utilised contractors to speed up implementation. Approximately 1000 households per month were connected.

Photo: © CT Gaunt, 2012

Conclusion

Informal settlement electrification has recently become a clear national imperative, and is a critical part of meeting the national target of 92% electricity access by 2014. Municipal distributors will need to engage with it to a much greater degree if this ambition is to be fulfilled, and if they are to meet their service provision obligations to this fast growing component of our population. A few cities have developed significant experience with informal electrification over the past decade, clearly demonstrating that it can be done effectively and safely, with significant welfare benefits for the most marginalised of South African society. Among the key lessons from this experience as reflected in this paper are summarised as follows:

- There is no reason not to undertake electrification of informal settlements. It requires a slightly different approach, but it is not difficult, and there is a large amount of experience demonstrating that it can be done successfully;
- Such electrification requires a greater degree of flexibility, including greater on-site planning rather than desk-based planning, and making network layout and technology decisions in response to conditions encountered during implementation;
- Thorough community liaison is very important before and during the process;
- Connect all households. Request no up-front connection fee– rather recover connection costs through a deduction from energy purchases.

In addition, distributors should consider developing more appropriate tariffs for electrification which better match the affordability and electricity use characterising customers.

Appendices:

National government response to electricity service provision to different categories of informal settlements:

Category	Condition/Status	Response
Category 1:	On suitable land (complies with the set criteria and is likely to go through in situ upgrading)	Will be subsidized for electrification.
Category 2:	Settlements that do not need immediate relocation and will therefore go through the process of regularization which is preformalization (providing basic services with plans to relocate in future)	Will be subsidized if the settlement will not be relocated in the next 3 years.
Category 3:	On unsuitable land (do not comply with the set criteria, areas such as on dolomite land, in toxic areas, or in a dangerous area) and need relocation	Settlements that have been there for a reasonable amount of time will be considered on a case by case upon application by the Department.

From *Policy Guidelines for the Electrification of Unproclaimed Areas* – DoE 20 Jan 2011 rev6 (p8)

Relevant documents

- Policy Guidelines for the Electrification of Unproclaimed Areas - DoE 20 Jan 2011 rev6 (p8)
- Suite of Supply Policy Guidelines for the Integrated National Electrification Programme (INEP) 2012/13 – DoE 10 March 2012 rev8
- NRS034 – South African National Standard. Electricity distribution - Guidelines for the provision of electricity distribution networks in residential areas.
- SANERI (South African National Energy Research Institute), 2008. Improving energy welfare in unelectrified urban informal households. Report prepared by Sustainable Energy Africa for SANERI. Report available from Sustainable Energy Africa, Cape Town.
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