Prepayment Metering in Rural Electrification Programmes: The Namibian Experience

By
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INTRODUCTION

The introduction of prepayment electricity metering can be singled out as the most significant contributor towards the success of the Namibian rural electrification programme. The technology has made widespread electrification of even the most basic rural homesteads a reality.

Government’s initial approach was to electrify only institutional buildings and installations (like schools, clinics, police stations, water pumping stations, government offices, telecommunications installations), as well as Government houses. No private households nor Cuca Shops were to benefit from electrification because of envisaged metering and billing problems. A primary obstacle to the full-scale electrification of rural settlements was the expected large-scale non-payment for electricity consumption. Experience in communal towns has shown that conventional credit metering causes large deficits in the supply authority's books as customers often cannot afford or do not want to pay their bills. In the rural areas this problem would further be compounded by unreliable meter readers and the possibility that rural customers never receive their electricity bills due to a lack of the necessary infrastructure.

Prepayment metering was proposed as a solution to these perceived problems, convincing Government of the advantages of this technology and thus changing the entire focus of the rural electrification programme from institutional customers only to whole communities.

2 THE NAMIBIAN RURAL ELECTRIFICATION PROGRAMME

Large-scale rural electrification was initiated shortly after Namibia’s Independence in 1990, commencing in the densely populated northern regions and proceeding clockwise around the country. The main motivation for this programme was Government’s conviction that electricity would act as a catalyst for economic development and empowerment as well as social upliftment in the underdeveloped regions of the country.

2.1 Rural Electrification Master Planning

The first 10 years of rural electrification have seen the connection to the grid of most major rural centres as well as a multitude of smaller centres in all 13 regions of the country. The next phase of rural electrification in Namibia is to cater for substantially smaller and more remote settlements and farms. Cost-effectiveness as well as financial and economic feasibility are critical factors in allocating available funds in an equitable manner among the unelectrified localities. It is in this context that NamPower and the Ministry of Mines and Energy have
commission the Rural Electricity Distribution Master Plan for Namibia, which will be completed by September 2000.

The Namibian master plan comprises of a dynamic software-based planning tool that enables the utility and infrastructure planners to re-evaluate electrification programmes as circumstances or priorities change. Scenario analysis is possible at any time and updates can be done on a continuous basis to ensure that the master plan always remains current.

A unique feature of this master plan is an integrated approach that considers both grid and off-grid options for rural electrification. In this way, grid and off-grid electrification programmes can be co-ordinated for the optimisation of fund allocation.

A computerised prioritisation tool has been developed that enables an objective ranking of electrification projects, based on electricity demand and electrification costs. Settlements that have a high demand for electricity by virtue of the existing infrastructure, but that are too costly to grid-electrify because of their remoteness, are automatically classified as off-grid priorities. For these settlements off-grid electrification solutions such as mini-grids, solar home systems (SHS) and hybrid systems are considered.

Environmental impacts of rural electrification have been addressed and highlighted in the master plan.

3 IMPLEMENTATION OF PREPAYMENT METERING IN RURAL ELECTRIFICATION PROGRAMMES

The concept of pre-payment metering was developed around urban and peri-urban applications in high-density areas of South Africa. In the urban context the logistics of vending electricity credit to end users is far less complicated than in rural areas, where distances are big and resources often insufficient. For a rural electrification application with low population densities remote from support infrastructure, certain compromises had to be made.

Namibia has a very low average population density of about 2 people per km2. Even in the most densely populated areas in northern Namibia population densities are relatively low and distances between major and small centres are significant.

For the implementation of prepayment metering this meant that the installation of a vending machine in every settlement was not economically justifiable. Therefore, magnetic token technology and group coding per settlement were initially chosen, with vending taking place in
3.1 **Group vs Unique Coding**

Rural settlements in Namibia generally have less than 100 customers and are scattered over huge areas. As a consequence, and due to the relatively high cost of vending equipment, it was necessary for a vending station to cater for a number of settlements. Group coding per settlement was thus adopted in favour of unique coding, with a vending station catering for up to 100 settlements. (Group coding means that all prepayment meters in a settlement are programmed with the same security code, and that a token encoded with that security code can be used in any meter in that settlement. Unique coding, on the other hand, means that each meter is programmed with a unique security code, and that a token encoded with a security code can only be used in the one meter with the corresponding code.)

The compromises made in implementing prepayment metering in rural electrification programmes have to do with system security and functionality. Unique coding of meters is a much more robust system compared to group coded meters, as the security risks associated with group coded meters do not exist. Unique coding of meters enables full functionality of the systems, with statistical analysis and reports of individual customers. Such functions are an important and powerful control tool for the supply authority which is not available with group coding.

3.2 **Token vs Keypad Technology**

With group coding the only possibility of vending electricity credit is by means of a token (magnetic card). Token technology also allows third party vending in settlements that are remote from the vending station (also referred to as shoe box vending).

3.3 **Tampering**

Despite the security risks inherent in group coding, prepayment metering has been well received by the communities and very little theft is being encountered. In 1998, Northern Electricity, a private electricity distribution company operating in northern Namibia, commissioned an audit of all its tariff meters, both credit and prepayment. The audit comprised of detailed testing and inspection of every meter. An overall meter failure rate of 4.7% was encountered, while only 0.5% of all meters had positively been tampered with.

**CHECK DETAILS: CREDIT VS PPM.**
It is expected that the situation in other parts of the country is similar if not better, due to recent electrification.

3.4 Introduction of STS Prepayment Systems

While group coding was the only feasible option for the first years of prepayment metering in rural electrification programmes in Namibia, the technology was limited to a single supplier. With the development the Standard Transfer Specification (STS) prepayment electricity metering systems competition was introduced. In 1996, the Namibian Ministry of Mines and Energy instructed to only use STS systems on future electrification projects. This brought about some new challenges to be addressed by the supply authorities, as follows:

♦ integration with existing proprietary system
♦ key management/back-up support/logistics
♦ group coding
♦ different tokens (magnetic cards)

3.5 Facing the Challenges

In August 1997, a national workshop was held in Windhoek to discuss and possibly agree on feasible means of administering pre-payment metering systems, and particularly key management, in Namibia. The workshop was attended by delegates from the Ministry of Mines and Energy, Ministry of Regional and Local Government and Housing, Northern Electricity, most Municipalities, Town Councils, Village Councils and Regional Councils, consulting engineers, as well as pre-payment metering system manufacturers and suppliers.

A specialist consultant on pre-payment metering systems was commissioned by the Ministry of Regional and Local Government and Housing to analyse the experiences with pre-payment systems in Namibia, and to present his findings, conclusions and recommendations at the workshop.

The following topics were covered:
♦ recent developments with pre-payment metering in Namibia
An analysis of the present situation with pre-payment metering in Namibia, with particular reference to system security, expertise, control and the integration of proprietary and STS systems

♦ a detailed explanation of proprietary and STS pre-payment systems
♦ a comparison of the advantages and disadvantages of proprietary and STS systems
♦ operational aspects of pre-payment metering

The following conclusions were reached:
♦ That proprietary and STS systems will both be represented in Namibia for the years to come, and that the two systems need to be carefully integrated
♦ That a co-ordinated key management effort is essential
♦ That new vending technologies which make unique coding viable may alleviate some of Namibia's potential pre-payment security problems

The following recommendations were made:
♦ Change over to STS as soon as possible
♦ Introduction of meter identification cards for both STS and proprietary systems to avoid confusion
♦ Investigation into the feasibility of establishing a single national key management centre for Namibia
♦ Investigation of the viability of changing from group coding to unique coding (eg. by the introduction of mobile vending equipment)
♦ Pressurise manufacturers to enhance STS group coding functionality

The workshop ended with the general consensus among delegates that a Pre-payment Metering Working Group (PPMWG) should be established with the purpose of formulating proposals on the integration of proprietary and STS systems investigating the feasibility of establishing a Namibian key management centre (KMC) acting as a forum for the general coordination of pre-payment efforts in Namibia

**Integrating Proprietary and STS Systems**

This matter was of particular concern for the supply authorities in rural areas, namely Northern Electricity and the Ministry of Regional and Local Government and Housing. Proprietary and
STS systems are being operated in parallel, with a gradual replacement process being implemented. A concerted effort was made in the training of staff and awareness creation among customers.

Handheld vending machines have successfully been introduced to enable unique (STS) coding in remote settlements.

3.7 Establishment of a Namibian Key Management Centre (KMC)?

The PPMWG compiled a document of its understanding of STS group coding and key management, which was sent to all STS prepayment meter manufacturers, the STS Association, ESKOM, the South African Key Management Centre, and a specialist consultant on prepayment metering matters.

The comments received were analysed and summarised by the PPMWG, and it was concluded that the cost/benefit ratio is too high to justify the establishment of a Namibian KMC at that point in time. Delivery delays on modules can easily be eliminated by keeping spare modules in stock (this is recommended anyway, even if a Namibian KMC was established). The South African KMC is performing well at little cost to Namibia. The PPMWG recommended that:

♦ Use be made of the South African KMC for the time being.
♦ Efforts in pre-payment metering in Namibia be co-ordinated in order not to duplicate efforts, but also to have more leverage with the South African suppliers.

The Ministry of Mines and Energy officially takes on the pre-payment metering co-ordination function. The Terms of Reference for this function should be carefully developed. The function does not necessitate the establishment of a full-time post, but it is important to delegate the responsibility to a person with adequate background and knowledge of the issues at stake. All stakeholders in the country, as well as the suppliers and other stakeholders in South Africa must be informed of this.

The Ministry of Mines and Energy becomes a member of the South African STS Association, in order to keep fully abreast of developments and to ensure that Namibia's interests in pre-payment metering are taken into account.

CONCLUDING REMARKS

Supply authorities often have very different reasons for introducing prepayment metering. In the rural areas of Namibia prepayment metering was in the first place a solution that enabled
the full-scale electrification of settlements, with only a secondary consideration having been
towards avoidance of bad debts. The motive for the introduction of prepayment metering in urban
areas is often the positive cash flow (avoidance of bad debts), as well as the reduction of
administrative overheads.

In Namibia, pre-payment metering has been received very positively by the customers, mainly
because of direct customer control over consumption. Conventional credit metering and billing
on the other hand has cost many supply authorities millions in bad debts, as customers had
the choice not to pay, for whatever reason. It was established that a major reason for non-
payment is that Namibian customers are apprehensive of their electricity bills as they have little
control over consumption; another factor is the basic charge that is payable even if there was
no consumption – a concept not easily understood by the majority of customers. Because of
the positive perception of prepayment metering, some supply authorities in Namibia have even
introduced this system despite a well controlled and managed metering and billing system.

But the secret of success of prepayment metering in rural applications is not limited to
customer perceptions. The pro-active and supportive approach of the supply authority,
coupled with sound management practices, is a key factor in ensuring customer satisfaction.
Issues like third party vending, and now handheld STS vending, require special arrangements
in terms of logistics and control. The low tamper rate among rural prepayment customers is
witness to a successful approach.

Namibia’s experience with prepayment electricity metering in rural applications now stretches a
10-year period. Vending problems in the beginning were solved with group coding of meters
and magnetic token technology. The introduction of STS systems brought with it a host of new
challenges that the Namibian fraternity addressed in a systematic way. Although dependence
on key management in a foreign country was perceived as undesirable, an investigation found
that the establishment of a Namibian Key Management Centre was not feasible due to the
small size of the Namibian market. To alleviate the potential problems, better arrangements
for back-up modules and faster processing were put in place by the supply authorities. The
integration of proprietary and STS systems was positively influenced by the development of
handheld vending technology. It is clear that supply authorities in Namibia are finding ways to
successfully address the issues that were initially identified as major problems when the
Ministry of Mines and Energy instructed that only STS be used in future.

Overall, it can be stated that Namibia has found a successful recipe for introducing
prepayment metering into rural electrification programmes.
Ralf Tobich is a consultant on electricity industry matters. He has assisted the Namibian Government with the drafting of the new Electricity Act and the preparation of the terms of reference for a study on the restructuring of the electricity supply industry. He has pioneered the commercialisation of electricity supply services in northern Namibia, which has resulted in the first-ever privately-owned electricity distribution company in southern Africa.

As a consultant, Ralf has been deeply involved with Namibia’s rural electrification programme. He has been instrumental in developing the technical standards as well as strategies for successful implementation of the programme. Ralf is currently leading the team that develops the Rural Electricity Distribution Master Plan for Namibia, a software-based planning tool that integrates both grid and off-grid electrification. His expertise ranges from feasibility studies, technical design, tender documentation and project management, through household energy surveys, electricity awareness campaigns, recruitment of customers and tariff advice, to the implementation of pre-payment metering technology.

Ralf has a very keen interest in renewable energy technologies. He is presently working on a proposal for the large-scale implementation of off-grid electrification programmes in Namibia. He has recently been involved with a feasibility study into the establishment of wind parks along the Namibian coast. Ralf was also involved with the FINESSE Namibia country study, and was project manager for a recent UNDP/GEF study into Barrier Removal to the Development of Sustainable Energy Services in Namibia. He is presently part of a team that investigates the establishment of a Renewable Energy and Energy Efficiency (REEE) Institute in Namibia. He participated in a number of renewable energy research projects, the most important of which include a comparative study between electric and solar water heaters and the bench-testing of a Namibian-developed PV pump.
Ralf holds a BSc degree in electrical engineering and an MSc degree in energy studies. He is managing director in an engineering consultancy as well as ESI consultant with Consulting Southern Africa.