THE ROLE OF SMART METERING IN REVENUE PROTECTION

JE Calmeyer, GPG Human
Strike Technologies (Pty) Ltd

ABSTRACT

The electricity regulations for compulsory norms and standards for reticulation services of the Electricity Regulations Act No.4 of 2006 specifies that all end-users or customers with a monthly usage of 500 kWh or more need to be on a smart metering system and be on a time-of-use tariff by 01 January 2012. This is expected to represent substantial revenue growth in the electricity meter market, as each smart meter unit is significantly more expensive than traditional credit, electro-mechanical and prepaid meters. Will this imminent legal commitment by Utilities towards implementing smart metering systems yield the benefits they were intended for and will they help to protect the revenue collection of these Utilities? This paper will seek to address these questions and look at the various technological alternatives available to Utilities.

1. INTRODUCTION

The capability and technological growth of electricity metering over the past two decades in South Africa has been remarkable. The main areas of growth have been into electronic metering for both single-phase and three-phase consumers and well as the incorporation of advanced communication capabilities on these meters.

These technology changes have enabled the expansion of the meter reading and billing dimensions available to Utilities from manual meter reading to automated meter reading systems. While the legality and feasibility of the regulations are not discussed here, the one aspect that needs to be addressed involves the applicability of the new technologies. Is the relative increase in hardware costs providing a suitable return on investment by means of lower electricity input costs and higher revenue collections? Two aspects are addressed here namely, determining if the overall investment is feasible and secondly deciding between the various technologies on offer.

2. TECHNOLOGY GROWTH

Figure 1 illustrates the placing of the various technology trends in terms of functionality and the technology they are based on.

Automated Metering Infrastructure (AMI) rightly provides the culmination of functionality and technologies. In South Africa, AMI systems enable the following:

- Bi-directional communications from central server to meters and devices and from these devices back to the central server.
- Customers are able to have a portable customer interface unit in their premises that can read information off a meter and receive information from the Utility.
- Be able to control up to two relays for load control (such as hot water cylinder and a swimming pool).

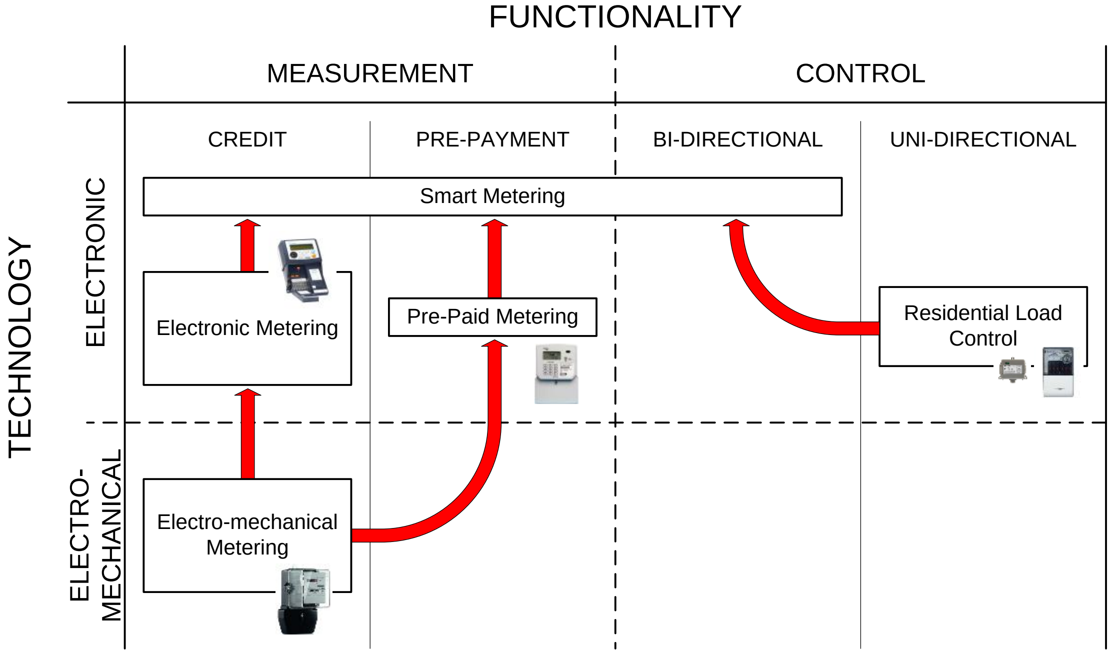

Figure 1: Overview of metering technologies in terms of functionality and technology base

- Be capable of remote load disconnect for revenue protection of the Utility.

AMI hardware provides a strong and dynamic technological platform on which Utilities can handle their customers according to either a credit or pre-payment philosophy without needing to change the field instrumentation. In simple terms, Utilities can switch between these two modes of revenue collection without having to change the metering hardware. Similarly, the hardware is independent of the electricity tariff structure and rates that are implemented by the Utility.

3. CREDIT REVENUE PLATFORMS

In terms of credit metering, the growth in capability is illustrated in Figure 2.

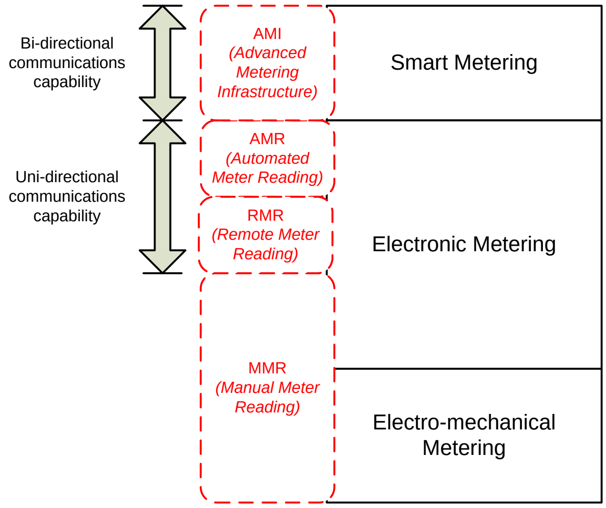

Figure 2: Expansion of credit metering systems

Manual Meter Reading (MMR) systems are based on the physical and manual collection of billing information (energy per period and/or demand) by meter reading personnel on a monthly (or other set period) basis. In instances where meters are not physically read each month, the use of monthly consumption averages is occasionally deployed. In certain instances, end-use consumers and customers are able to read the meters themselves and forward this information either telephonically or electronically to the Utility.

Remote Meter Reading (RMR) systems utilise the communication capabilities of the metering in order to manually collect the billing information from a centralised master station or server. Typically cellular networks are used to communicate with the meters. Most often the proprietary software of the metering manufacturer is used to enable the RMR. RMR systems also provide remote access to the technical configuration of the meters which allows technically competent personnel to remotely verify the meter setup.

Automated Meter Reading (AMR) systems, like RMR, utilise the communication capabilities of the metering in order to automatically collect the billing information from a centralised master station or server. In this instance however, load profile information is also typically collected and a single software platform is usually deployed that is capable of implementing the protocols of a range of electricity meters from various manufacturers. The software platform in other words is not hardware specific or bound. In advanced AMR systems, consumers have the capability of accessing their own load profile and billing data via a web-based front end. Collected data is stored in the master station and from there it can be accessed by a wider audience comprising both customers and technical personnel.

Advanced Metering Infrastructure (AMR) systems, as discussed, provide all of the functionality of AMR systems with the exception that the metering is capable of disconnecting the electricity supply of an end-user or consumer in the event of non-payment, can operate in either credit or pre-payment modes, can communicate and alert the master control station in the event of tampering and includes a platform with which to communicate with the end-user or customer. There is an added dimension of direct load control of appliances (such as hot water cylinders and swimming pool pumps) installed in the customer's premises.

4. SIMPLE INVESTMENT DECISION

Investing in new metering systems will always need to be carefully considered. One method of determining this would be to consider the return on net assets (RONA). RONA is a measure of the financial performance of the Utility based on the usage of their fixed assets. RONA is defined as follows:

$$RONA = \frac{Net\ Income}{Fixed\ Assets + Net\ Working\ Capital}$$

Where, Net Working Capital (NWC) is defined as:

$$NWC = Stock + Debtors + (Creditors)$$

Based on this definition, the investment into an upgraded or advanced metering system will be viable if the RONA of the Utility remains the same (or is improved). For this to happen, the following should be considered:

The fixed assets will increase. Although some of the existing metering assets will be replaced and will essentially be removed off the asset list, the new technology will add greater assets than those that are removed. A factor of consideration here will also be the age of the current metering assets as very old equipment will have very low financial or book value due to depreciation.

The debtors (particularly overdue debtors) should decrease as a result of alternative technologies (such as pre-payment metering platforms) and the ability for the Utility to automatically and remotely disconnect end-use customers in arrears (either via pre-paid technology or AMI systems).

The net income of Utility could realistically be expected to increase because the tampering and energy balance capabilities of AMI systems will ensure that illegal reconnections are monitored and automatically reported and the non-technical energy losses are lowered. The active management of non-technical losses via energy balances and other initiatives will help to increase the revenue collection and net income against existing output costs. On the other hand, the new metering system may be more complex to operate and maintain and may increase the relative operational costs of the Utility. This will lower the realistic growth in the net income.

In summary then, the increase in fixed assets should be matched by a combination in the decrease in debtors and an increase in the net working capital over the useful life and depreciation of the new metering asset in order to achieve RONA balance. Bear in mind that the deployment of an AMI system will have higher initial returns in terms of lower debtors and increased net income but as the deployment of this technology matures, these will taper off relative to the starting year. This is illustrated by way of a simple example in the table below, where the relative RONA is maintained.

	Year 0	Year 1	Year 2	Year 3	Year 4
Increase in Fixed Assets (Asset Value)	10	8	6	4	2
Reduction in Debtors	2	1.6	1.2	0.8	0.4
Increase in Net Income	1	0.8	0.6	0.4	0.2
RONA %	12.5%	12.5%	12.5%	12.5%	12.5%

Please note that in this instance, the revenue from electricity purchases (input tariff) and electricity sales (against output tariffs) is considered to remain in balance already. In other words, input cost increases and passed on in proportion to the end-use customers. The focus therefore is on real changes in net income, fixed assets and debtors.

Considering the above scenario, it is important to note that a more prudent approach that could be taken would be to consider smaller phases or more profitable end-use customer markets first. In this manner the sudden increase in fixed assets is limited. Alternatively, it may be more feasible to consider rolling out an AMI or AMR solution for the more profitable sectors (such and commercial and industrial customers) who contribute a greater amount of revenue to the Utility.

It is also worth noting that typically, Utilities may have easier access to operational expenditure (OPEX) over capital expenditure (CAPEX) so rental-to-own or leased type solutions could be considered as viable financial alternatives.

5. TECHNOLOGY COST COMPARISON

In comparing the various technologies, various costs need to be considered. In this example, the costs of MMR, AMR and AMI systems will be compared to each other. Figure 3 illustrates the various components associated with each of these platforms.

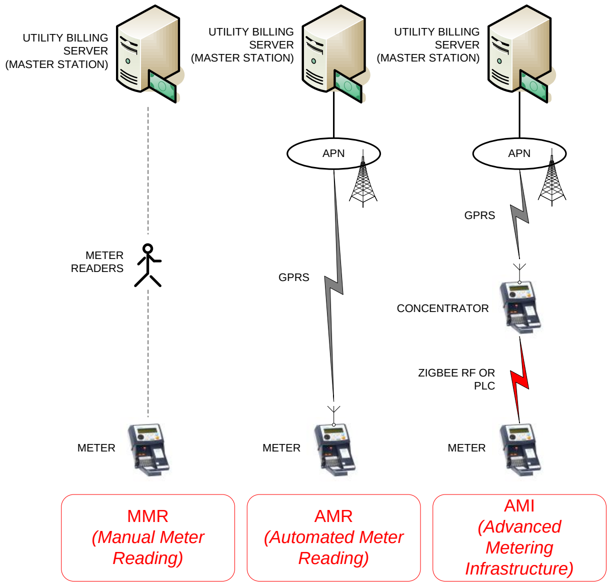

Figure 3: System components per system platform

In this instance, the ability of a smart metering system to implement load control (via load control relays) is not being considered. Only the costs of meter reading (i.e. revenue collection) will be discussed further.

5.1 DATA COSTS OF A CELLULAR NETWORK

The emergence and maturity of cellular technology has enabled the growth of AMR and AMI platforms and rendered them as viable solutions. Typically this is achieved with an APN (Access Point Name) which allows metering to be allocated a unique IP address. The costs involved with an APN typically include the following:

S_{APN} Initial setup costs for an APN system
C_{APN} Fixed cost per month for an APN (irrespective of usage)
C_{GSM} Cost per meter or connection per month for GSM network traffic (including SIM card)

The initial setup costs (S_{APN}) include the APN creation as well as the installation of leased lines (or similar connectivity) between the GSM network and the master station server. Figure 4 illustrates these costs against the number of connections (or meters).

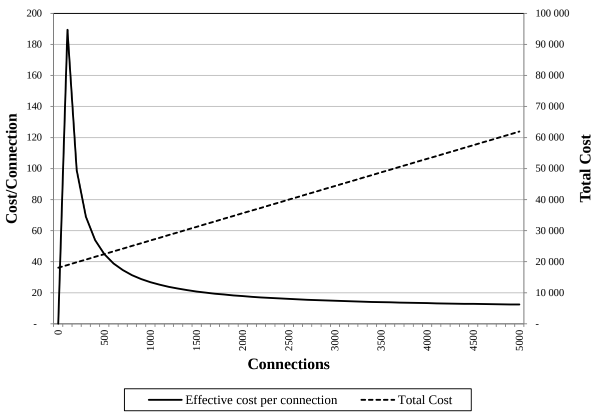

Figure 4: Comparative APN costs per connection

In terms of operating costs, the main difference between and AMR and AMI systems is that the last mile communications of an AMR system is based on GSM or GPRS technology. In other words, the master station makes an IP connection to each meter via the GSM network whereas in smart metering or AMI systems, these connection are drastically reduced because GSM connections are only required with each data concentrator. Each data concentrator then communicates with each meter connected to it (anywhere from 20 to 500 devices or meters) using either power-line carrier (PLC) or wireless RF (ZigBee) communications. In AMI systems the cost of the last mile communications (PLC or RF) is usually included in the hardware cost and does not involve licencing or monthly fees.

5.2 MMR COSTS

The costs of an MMR system are represented by:

$$C_{MMR} = (M_T + M_R \cdot p) \cdot n$$

Where:

C_{MMR} = Total MMR platform cost
M_T = Hardware cost of the meter
M_R = Meter reading service cost per meter per month
p = Project period (months)
n = Number of metering points or end-users

Note that the project period (in months) is used as a base for comparison between the various systems. Typically a period equal to the shortest product lifetime or warranty of any system component would be used.

5.3 AMR COSTS

The costs of an AMR system are represented by:

$$C_{AMR} = (M_T + M_D + p \cdot C_{GSM}) \cdot n + (S_{APN} + C_{APN} \cdot p)$$

Where:

C_{AMR} = Total AMR platform cost
M_T = Hardware cost of the meter
M_D = Hardware cost of the modem
p = Project period (months)
C_{GSM} = Cost per meter or connection per month for GSM network traffic (including SIM card)
n = Number of metering points or end-users
S_{APN} = Initial setup costs for an APN system
C_{APN} = Fixed cost per month for an APN (irrespective of usage)

5.4 AMI COSTS

The costs of an AMI system are represented by:

$$C_{AMI} = \left(M_{TA} + \frac{M_C + C_{GSM} \cdot p}{R}\right) \cdot n + (S_{APN} + C_{APN} \cdot p)$$

Where:

C_{AMI} = Total AMI platform cost
M_{TA} = Hardware cost of the AMI ready meter
M_C = Hardware cost of the GSM/GPRS ready data concentrator
p = Project period (months)
C_{GSM} = Cost per meter or connection per month for GSM network traffic (including SIM card)
R = Concentration ratio of meters per data concentrator
n = Number of metering points or end-users
S_{APN} = Initial setup costs for an APN system
C_{APN} = Fixed cost per month for an APN (irrespective of usage)

5.5 COST COMPARISON RESULTS

Using the formulas for each platform, we can consider two scenarios namely, the deployment of new technology for three-phase commercial and industrial customers and the case of deployment for single-phase residential customers.

In each case, the cost of installation is not considered as the complexity and costs involved are virtually identical irrespective of the revenue platform that is utilised. The costs for the various components are based on typical product and service market values.

In the case of a three-phase metering convention, the project duration (p) is assumed to be 60 months and the concentration ratio (R) of meters per data concentrator is assumed to be very low at 30 meters. The reason for this low concentration is the geographical saturation of suitable three-phase customers. In the case of a single-phase metering convention, the project duration (p) of 60 months is also assumed but the concentration ratio (R) of meters per data concentrator is assumed to be higher at 200 meters as proclaimed residential areas will tend to have a better geographical saturation of suitable customers.

In terms of the three-phase customers (in this example), an AMI platform is cheaper than an AMR platform. In terms of single-phase customers, an AMI platform will always be more viable than an AMR system (due to cheaper last-mile communications) and could also be more viable over a manual platform in systems greater than around 2,000 metering points. Naturally the variables of each specific application will render accurate results under those specific circumstances.

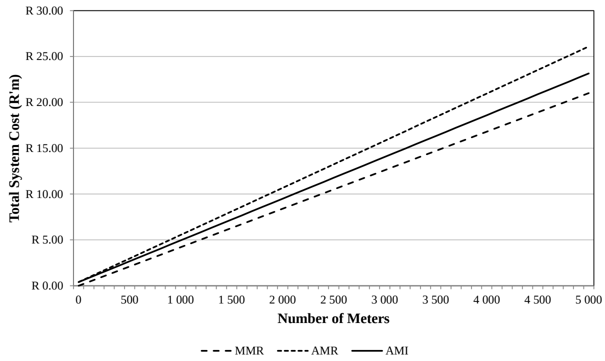

Figure 5: Comparison of platform costs for a three-phase system

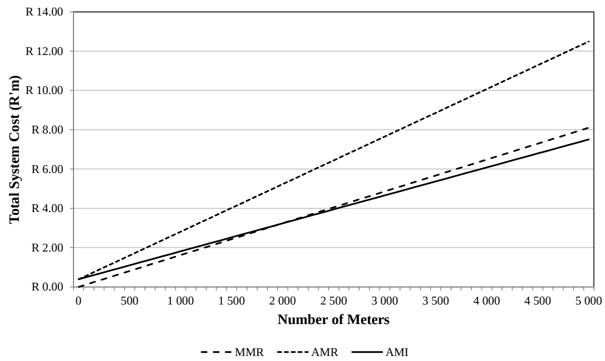

Figure 6: Comparison of platform costs for a single-phase system

It is important to note that in reality there will be a mixture of single and three-phase customers and these will be able to leverage off much of the same AMR and AMI infrastructure (such as an APN and data concentrators etc.)

6. CONCLUSION

It is possible to use the financial modelling tools presented here to compare the various credit electricity measurement platforms. These include both the aspect of evaluating the cheapest platform as well as determining the feasibility of the investment based on the return on investment.

In terms of an AMI platform, it is important to critically evaluate the number of metering points (n) or end-users that will be connected to the system as this will increase the overall cost. This overall cost needs to be taken into account when considering the investment feasibility. In other words, will a more expansive (and more expensive) measurement system provide satisfactory returns in terms of reducing debtors and increasing net income?

Other factors that need to also be evaluated include the project duration (p) or lifetime of the asset. The longer the lifetime of the equipment, the lower the overall cost of an AMI system will be due to the avoided communications costs. Lastly, the concentration ratio (R) of meters per data concentrator will play a significant role in determining the overall costs of an AMI system.

Two aspects are involved here. The first deals with the ability of the hardware platform to handle a higher number of metering devices per data concentrator (ranging from 50 meters to 1,000 meters typically). The second deals with the number of viable customers located nearby the data concentrator. For example, a residential suburb may have a high penetration of single-phase customers located around the data concentrator but not all of these customers will have a monthly energy consumption that is greater than the proposed 500kWh benchmark. Even if an AMI system were used to measure these high-end users, what system will be used to measure the other customers below this limit? Will it be viable to use this more expensive technology for all residential customers?

In the examples used in this paper, the manual meter reading systems have seemingly lower costs. However, it is important to remember that the current measurement systems employed by Utilities in South Africa are very old (i.e. a well worked asset) and they are incapable of handling dynamic time-of-use tariff structures. On the financial face of it, it does not make sense to replace the existing paid off metering systems with more modern AMI type systems as the asset value of the Utility will be greatly increased. However, the existing systems are out dated, cumbersome and cannot satisfy the needs of the Utility in a future dynamically priced energy system.

7. REFERENCES

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