

## NRS049 – ADVANCED METERING INFRASTRUCTURE (AMI) FOR RESIDENTIAL AND COMMERCIAL CUSTOMERS



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### 1. Introduction

Automated Meter Reading (AMR) is a relatively familiar concept to most electricity supply utilities, but the term Advanced Metering Infrastructure (AMI) will be fairly new to most utilities. NRS049 – *Advanced metering*

*infrastructure for residential and commercial customers*, has been drafted and published to create a standard specification for AMI systems in South-Africa. This paper will provide an overview on the requirements as listed in NRS049 for AMI in South-Africa.

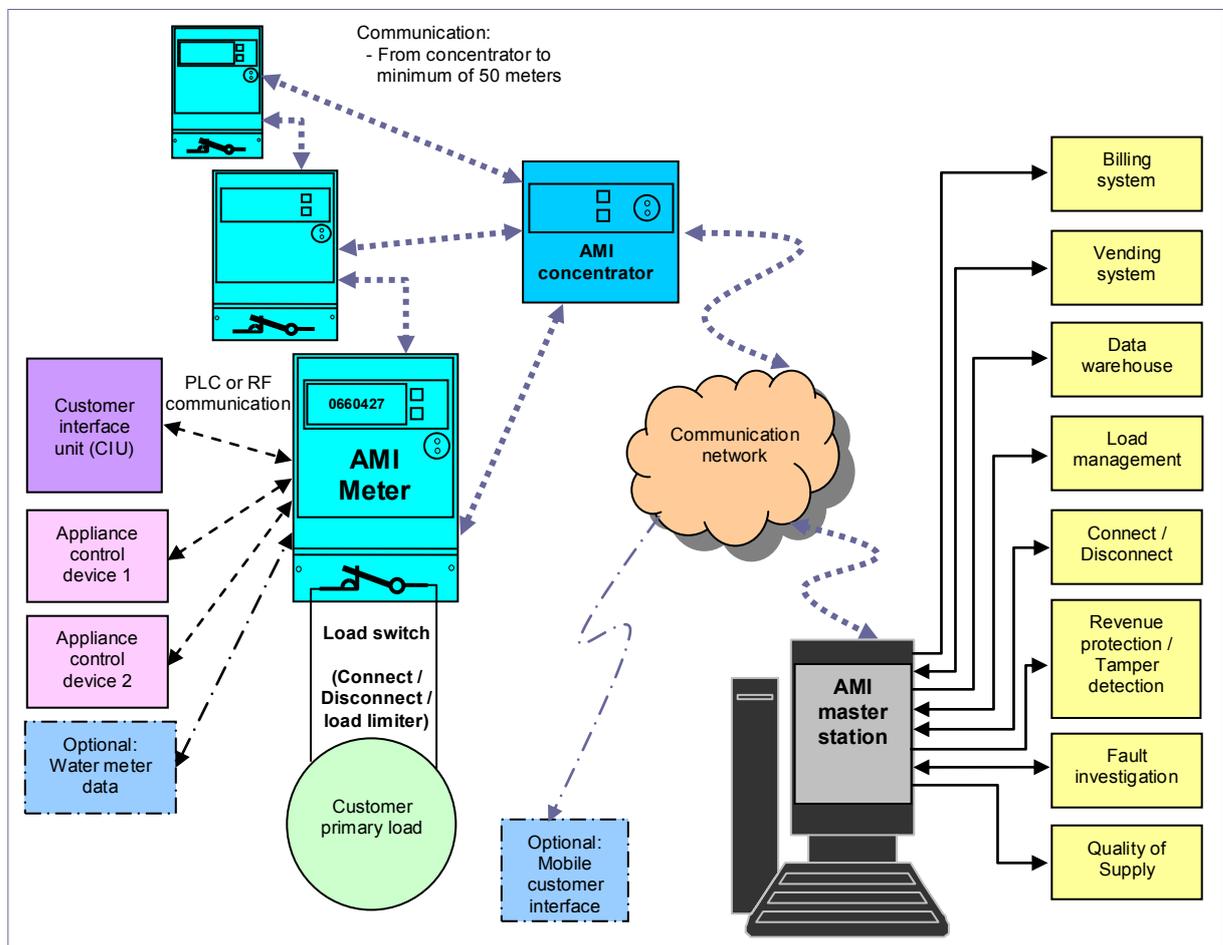


Figure 1: AMI system overview utilising data concentrators.

### 2. System overview

The AMI system incorporates an AMI master station from where the configuration and functionality of the system is controlled, a communication network, the AMI meters, a load switch (disconnect / reconnect / load limiting), the appliance (load) control devices

(activated through the meter), a customer interface unit and optional interfaces to communicate with a mobile customer interface and to retrieve water consumption data.

The AMI master station provides connectivity to back-end systems including a billing system,

connect/disconnect system, fault reporting system, meter data management system, tamper detection system (revenue protection), load management system and quality of supply system, and in the case of prepayment system applications, to the vending management system. Interfaces to these back-end systems are not specified and will be utility dependant.

NRS049 specifies two AMI configurations: Figure 1 depicts an AMI system where data concentrators are utilised. Figure 2 depicts a system where the communication is directly to the meter (data concentrators excluded). The communication from the first meter is linked to other meters or it can be applied as a stand-alone application.

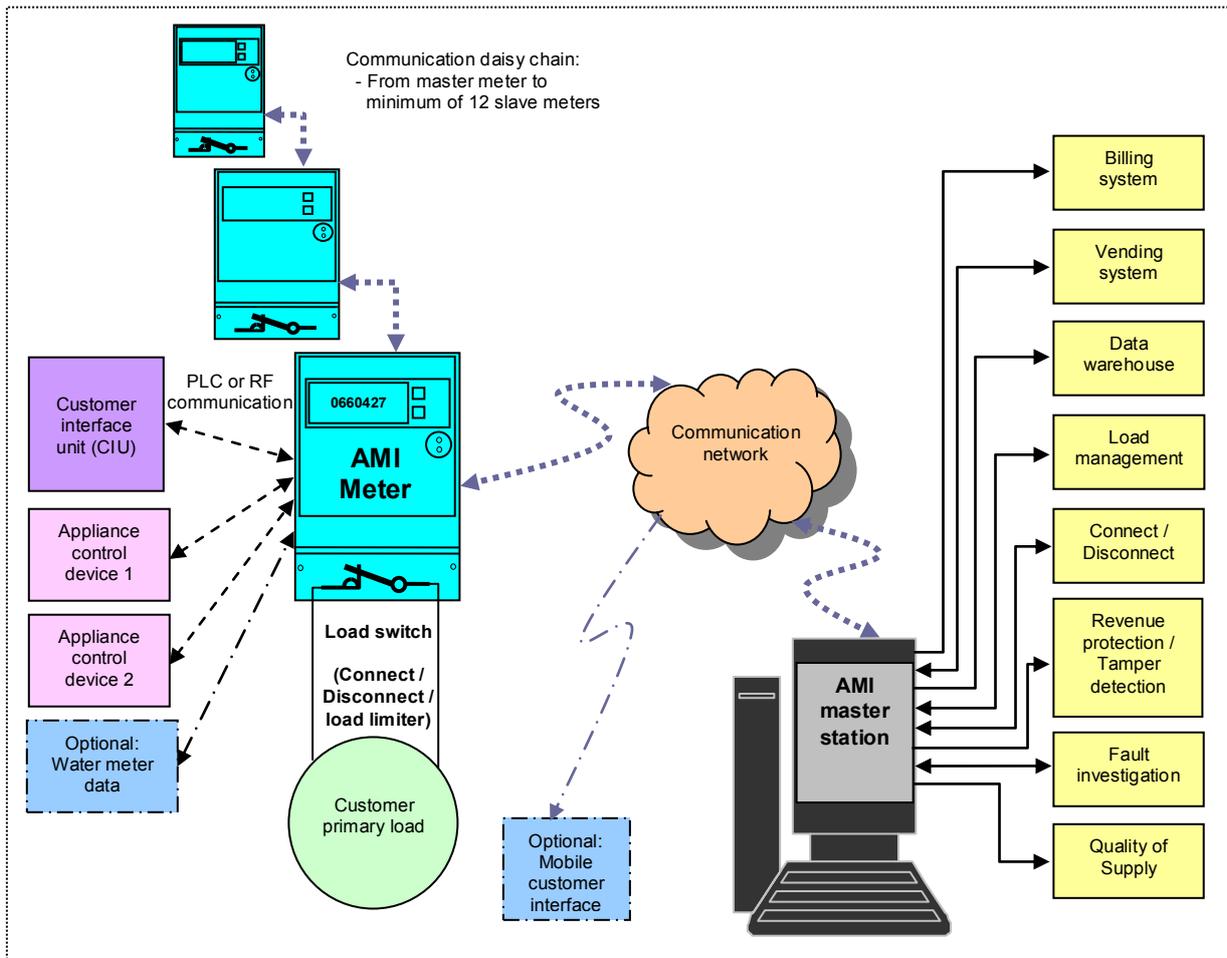


Figure 2: AMI system overview utilising direct communication to the meter.

### 3. Functionality explained

The functionality of the AMI system as specified in NRS049 is explained by looking at the individual requirements.

#### a) AMI meters

The meter forms the basis of the AMI system at the customer installation. The functionality of the meter will primarily be to register active energy consumption data, it will relay the data through to the data concentrator or master station, it will relay commands through to the appliance control devices, it will sent information through to the customer interface

unit, and supply capacity control (load limiting) will be done through the internal connect/disconnect contactor.

The meter will typically be installed in a secure cabinet where the customer will not have access to it to prevent tampering or bypassing. Customers will have access to billing and other information through the customer interface unit.

The meter must be able to support a time-of-use tariff structure. NRS049 specifies that active energy consumption data must be stored on the meter as total register values (normal cumulative energy data) as well as

half-hourly data. The data retrieval system (AMI master station) must be able to support both the retrieval of the billing register values as well as half-hourly data. It will be up to the electricity supply authority to decide if they will bill customers through meter register values or half-hourly values.

Apart from billing data it is also specified that the meter must be able to record different events such as when tampering is identified, supply outages, under and over voltage conditions, when disconnect commands were applied, when load control was done through the master station and for meter configuration changes.

#### b) Customer interface unit

The customer interface unit will be installed in the premises of the customer from where the customer can obtain first hand knowledge of his consumption data, energy cost, status of the appliance control devices, status of load limiting and all event alarms.

#### c) Appliance control

The appliance control device will connect and disconnect loads from the supply through commands sent by the meter and master station.

Under normal operating conditions the appliance control devices will be switched by the meter according to the time-of-use daily pattern. Loads will be switched off during peak time-of-use periods. The benefits will be to both the utility and the consumers. The utility will experience less loading during peak consumption periods and the customers will have load automatically removed from the peak periods which will save them energy cost.

The appliance control devices can also be operated from the master station in situations where there is severe strain on the capacity of the electricity supply system.

The status of the appliance control devices will be controlled by the meter and this information will in turn be sent from the meter to the customer interface unit.

The "turn-on" times of the appliance control devices will be scattered through a predetermined and randomised time maintained from the meter to avoid the creation of another peak loading condition at "turn-on".

#### d) Supply capacity control (load limiting)

The meter will control the supply capacity to an end user by monitoring the load for exceeding

the set supply capacity limit. When this occurs the meter's connect/disconnect contactor will be opened and the supply to the customer will be interrupted.

The supply will be switched back again after a certain time and the load will be monitored again. If it still exceeds the limit then the supply will again be interrupted, but the duration of this second interruption will be longer than the previous. The interruption period will increment by a settable time period after every subsequent operation.

Under normal operating conditions the supply capacity control can be switched by the meter according to the time-of-use daily pattern. By implementing it this way it will ensure that the appliance control devices are not bypassed – if those loads are still connected to the supply then the supply capacity limit will be exceeded and the customer supply will be interrupted.

The benefits of supply capacity limiting during peak periods will again be to both the utility and consumer. The utility will experience less loading during peak consumption periods and the customer can save on energy cost by reducing their loading at the high electricity price periods.

In a situation where there is severe strain on the capacity of the electricity supply system, then commands can be sent from the AMI master station to further reduce the supply capacity setting on the meter. The meter should first remove the large loads from the customer supply by operating the appliance control devices and then it will revert to the new setting.

Messages on the status of the supply capacity limit will continuously be sent from the meter to the customer interface unit. This information should be used by the customer to determine if additional loads must be switched off to avoid supply interruption.

#### e) Connect / disconnect

When a supply is to be disconnected or connected due to change of ownership or non-payments, then in the past a technician had to be sent out to the installation to disconnect or connect at the customer's supply point. With AMI a command can be sent from the master station to the meter and the contactor on the meter will be operated to either connect or disconnect.

It is envisaged that before any disconnection is enforced the master station will send messages to the customers to inform them of impending disconnection.

#### f) Prepayment

The AMI prepayment functionality is different to that of the normal prepayment meters because the command to disconnect is not determined by the running-out of credit on the meter, but rather on the AMI master station. When the credit of a customer is running low, then a message will be sent to the customer interface unit that the customer must buy additional electricity or risk being disconnected. The AMI master station will issue commands to disconnect customers once their credit is exhausted.

#### g) Under-frequency supply control

An option was included for under-frequency supply control through the meter as a stand-alone feature. When the meter registers an under-frequency condition for a prolonged time then both the appliance control devices and the supply capacity limits can be activated to reduce loading.

The installation will be normalised again after the under-frequency condition is cleared and switch-back actions will be the same as for normal operation to again avoid the creation of a "turn-on" peak load.

#### h) Mobile customer interface

An option was included for the master station to send messages through to customer mobile phones. This will typically be to inform customers for impending disconnect or can be used when the supply capacity is to be limited beyond normal settings.

#### h) AMI master station

The master station shall provide for all the functionality as specified in the subsections above.

The master station shall also be capable of integrating into the utility's existing management systems and be capable of extracting data from the AMI system that is relevant to those systems in a secure and auditable manner. Examples of the utility's management systems are the billing system, revenue protection system, load control system, data warehouse system, asset management system and quality of supply system.

## 4. Challenges

#### a) Standardisation

South Africa and in particular Eskom has learnt with the implementation of pre-payment metering that proprietary systems should be

avoided to ensure interchangeability between suppliers in a certain area.

Most of the AMI systems employed in the world have their own proprietary protocols and designs and interchangeability will be almost impossible.

Some of the major manufacturers have realised that there is a dire need for standardisation in this field and there are various initiatives taking place to standardise on communication protocols to allow for interchangeability of components at installed AMI systems. Pilot projects have been initiated where major manufacturers are working together to ensure that they follow a standardised approach which will allow for interchangeability between their AMI system components.

South-Africa needs to learn from those initiatives and adopt standardisation when implementing AMI systems.

#### b) Electricity regulation act

New regulations for electricity reticulation services have been published in the Government Gazette of 18 July 2008 which requires that end users with a monthly consumption of 1000kWh and above must have a smart system and be on a time of use tariff by not later than 1 January 2012.

The definition of a smart system, as stated in the Government Gazette, is an electricity meter that allows for:

- Measurement of energy consumed on a time interval basis
- Two-way communication between the customer/end user and the licensee
- Storage of time interval data and transfer it remotely to the licensee and
- Remote load management.

The electricity supply utilities are now sitting with a predicament. It will not be wise to install proprietary AMI systems because it defeats the objective for standardisation and can lead to costly replacement of AMI components before their normal service life have expired, yet they have to comply with the act.

Electricity supply utilities will need to study the market carefully when deciding on AMI systems. Systems where no international standard have been adopted should be avoided.

### c) System support

System support will form a fundamental component for the success of AMI in South-Africa.

The skills of the electricity supply utility's meter installers and readers may not be adequate to support AMI equipment. Specialised skills will be required to support the commissioning of data concentrators, meters, appliance control devices, customer interface units and communication modems.

The continual maintenance of the equipment will again require specialised skills.

Utilities will need to establish a new central operation centre from where the AMI master station software will be controlled. Operators for the AMI master station need to be employed and trained.

## 5. Next steps

Most electricity supply utilities will at some stage have installed AMI at residential customers. The revised act is forcing electricity supply utilities to speed-up their programs for the installation of AMI.

Utilities will now have to start with specifying their AMI system, follow a tender process, perform a proper evaluation of the systems and then install the equipment.

### a) Specification of AMI

NRS049 - *Advanced metering infrastructure for residential and commercial customers*, was created to ensure that uniform systems will be installed in South-Africa. Electricity supply utilities can use the requirements of NRS049 as a basis for specifying an AMI system for their end users.

### b) Evaluation of the AMI system

Adequate time must be allowed for a proper evaluation of equipment, communication and software. Some of the requirements of NRS049 are unique to South-Africa and equipment may be newly developed and will thus not be "tried and tested".

It is envisaged that Eskom will require that equipment deemed to be suitable for installation be subjected to its accelerated environmental stress testing programme. Through this testing program the whole system will be extensively tested – equipment, communication, performance and software.

AMI systems which have passed the accelerated environmental stress testing will then be installed at large scale pilot programs,

where their performance in normal field conditions will be evaluated.

Large scale roll-out of AMI will follow thereafter.

## 6. Conclusion

There remain a lot of challenges for the successful implementation of AMI on a large scale in South-Africa and utilities and industry needs to work together to get the most optimal solution for South-Africa.

NRS049 - *Advanced metering infrastructure for residential and commercial customers*, was as a first initiative for standardisation in South-Africa developed by the NRS working group and is now available to guide electricity supply utilities in their requirements for an Advanced Metering Infrastructure.

## 7. References

NRS049 (2008) - *Advanced metering infrastructure for residential and commercial customers*.

Government notice R.773 (18 July 2008) Electricity Regulation Act (4/2006): *Electricity Regulations for Compulsory norms and Standards for Reticulation Services*,