

How implementing an online meter monitoring and feedback system has helped the City of Ekurhuleni to manage both revenue and demand for its Large Power Users

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Introduction

Ekurhuleni Metropolitan Municipality

Ekurhuleni Metropolitan Municipality is a metropolitan municipality that forms the local government of the East Rand region of Gauteng, South Africa. Ekurhuleni is situated in South Africa's manufacturing heartland. Ekurhuleni was formed by the amalgamation of nine towns and cities around the eastern and southern part of Johannesburg into one of the six metropolitan municipalities in South Africa.

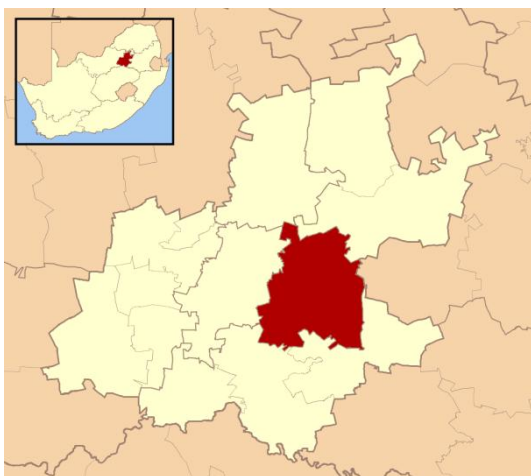


Figure 1: Map showing the location of Ekurhuleni in Gauteng

Geographically, the metro covers an area of approximately 2 600km² with over 2.5 million residents and more than 8 000 industries. Ekurhuleni is responsible for about 23% of the gross geographical product of Gauteng province.

Electricity Statistics

The Metro has an electricity demand of more than 2 400MW with an annual sale of electricity exceeding 10.8TWh. The predicted revenue income generated from the sales of electricity is about R9.4 billion for the 2011-12 financial year. This customer base consists of 12 000 Commercial and Industrial (C&I) customers who are responsible for 66% of the revenue derived from electricity sales.

Historical background

The first advanced metering system for large power users was piloted using Meteringonline in 1998 in the town of Boksburg (before the creation of the Ekurhuleni Metro). The project was initiated by Mark Wilson who is now the General Manager: Energy for the Metro. This was a ground breaking project in that it was one of the first AMR systems to make use of the GSM network to acquire data from meters and to make use of the Internet to provide information on electricity consumption directly to the customer.

Mark recognized that, in order to be successful, a modern electricity utility has to

do more than just provide electricity as a simple commodity. This prompted him to initiate a project for an internet based Automated Meter Reading (AMR) system for large commercial and industrial customers with the focus being on customer service.

He identified the necessity to embark on a programme that would not only form a key part of the Municipalities integrated revenue management and enhancement program, but critically also enhance customer service. At that time customer relations was generally poor with low confidence in the Municipality's electricity metering and billing system. It was critical that concrete steps be taken to improve the situation and gain the trust of customers, which would inevitably also positively influence the revenue cycle within the organization.

Recent AMR project

The most recent contract for the supply of this service was again awarded as from 1 July 2011 till end of June 2012.

There are currently about 6 050 meters that are being read on a daily basis using Meteringonline with an additional rollout of more than 1 000 meters planned during the first half of 2011. Approximately 60% of the Metro's total income is achieved by means of this system. In 2010 electricity sales using data from Meteringonline was almost R4 billion.

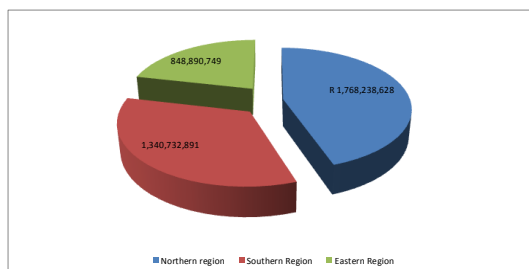


Figure 2: Electricity sales per region using Meteringonline for 2010

Project description

The AMR project provides for much more than just a simple “*meter reading*” function to be carried out by the contractor. The existing installed metering infrastructure within Ekurhuleni consisted of a variety of different types of electronic and electromechanical meters. Many of the installations were more than 15 years old and there was little in the way of traceable information regarding the technical compliance of the meters in

accordance with modern international standards.

In terms of the contract, the meter management service provider was required to implement a comprehensive refurbishment and rehabilitation of the metering system:

- All out-dated electromechanical and electronic meters were replaced with modern multifunction high-precision electronic meters. This function was performed as a combined effort with both Ekurhuleni and the service provider technicians.
- Each and every new meter installed was first calibrated by a SANAS accredited laboratory before being put to use. Certificates of calibration can be made available to the customer on request.
- Each metering point was comprehensively audited and certified in accordance with stringent technical requirements to ensure compliance with the South African Code of Practice for Metering, NRS 057 to ensure the integrity of the metering system and to minimise technical losses in the system.
- The service provider took full responsibility for the integrity of the metering points including all equipment up to the primary plant (VTs and CTs).
- Problems identified were attended to within 24 hours in most cases (8 hours for high priority customers) by the service provider regardless of the nature or cause of the problem. Only problems that involved primary plant were referred back to the relevant Ekurhuleni division.
- A comprehensive fault management system was created to allow both the Service provider and Ekurhuleni personnel to quickly and easily manage outstanding faults.
- Ekurhuleni makes use of the Venus Billing System and a project was successfully completed to automate billing data transfer from Meteringonline to the Venus system.

Installation rollout

The first rollout of just over 350 metering points in Boksburg in 1998 was targeted at key customers who were encouraged to move to a Time-of-Use (TOU) tariff with financial incentives.

Since then, the rollout of Meteringonline points has progressed to more than 6 050 sites as shown in Figure 3 and 4.

These include:

- 5 526 Commercial and Industrial customers
- 71 Internal sites such as Civic Centres
- 454 Substations including all Eskom intake points.

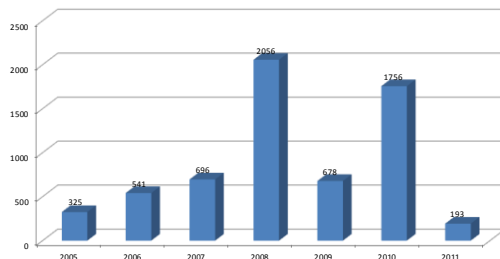


Figure 3: Rollout of Meteringonline AMR installations

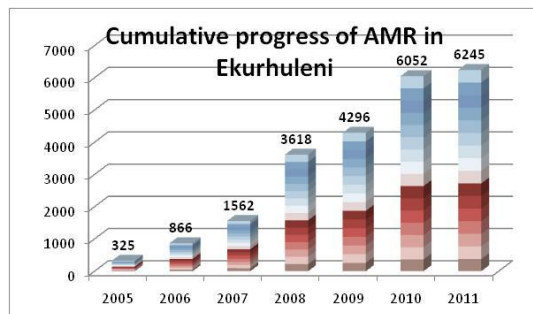


Figure 4: Cumulative progress of Meteringonline AMR installations from 2005 till 2011

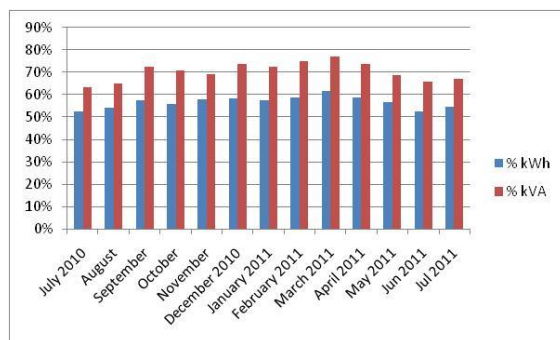


Figure 5: % kWh and % kVA accounted for by Meteringonline vs. purchases from Eskom

Meteringonline overview

Meteringonline is an internet based AMR system that provides a unique operational tool to manage metering services and billing information for utilities, municipalities or individual commercial and industrial users.

Meteringonline uses state-of-the-art smart metering data acquisition technology to communicate with utility meters automatically. Metering data such as energy registers, load profiles, event logs and other critical metering information is converted into metering information accessed on a powerful internet portal that provides a large variety reports and graphical interfaces to allow commercial and industrial customers to better understand their energy usage and improving business performance and increasing revenue for the utility. The service is easy to use and is available twenty four hours a day, every day.

The best way to describe Meteringonline is via the diagram shown in Figure 6:

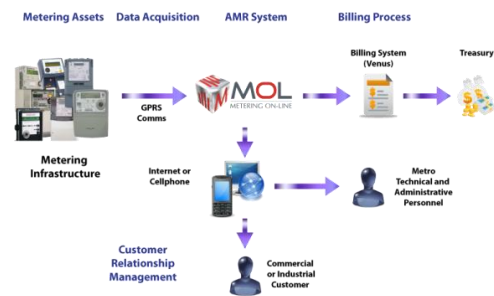


Figure 6: Meteringonline System Overview

Metering infrastructure

Systematic testing and inspection of metering systems was regarded as an absolute necessity to ensure the continued integrity of the metering installation and also to engender confidence with the metering system with the customers.

Before being connected to Meteringonline, each metering point was comprehensively audited and certified in accordance with stringent technical requirements to ensure compliance with the South African Code of Practice for Metering.

A further very important consideration was that Meteringonline should be able to communicate with all makes and types of electricity meters used by the Metro.

Meter data acquisition

Initially Meteringonline was designed to perform data acquisition by means of data communication on the GSM network (similar to the old dial-up modems on land lines). As technology improved, URM invested heavily in

R&D and pioneered the acquisition of metering data using GPRS technology.

Data from the meters are downloaded at a frequency dependant on the customer priority; high priority customers are serviced once every half hour and lower priority customers are serviced less frequently, but at least once every 24 hours.

Metering data is stored in a centralised SQL compliant database. This data consists of:

- Half-hourly profile data of active and reactive energy.
- Energy billing registers.
- Instantaneous voltages and currents.
- Meter events and alarms such as fuse failure or tampering.

Metering database

All data collected is passed to a Metering Database. The database itself is the heart of the whole system and can be any SQL compliant relational database management system in theory, but there are aspects that should be considered carefully before making a choice.

Administration of the system is implemented by a suite of applications collectively referred to as the Back Office System. The main components of this system are:

- A database administration suite
- A fault handling suite
- Data validation processes
- A process for dealing with customer queries

The main output of the system is a Billing System Interface which processes raw metering data obtained from the data acquisition into metering data and seamlessly transfers this metering information to the Ekurhuleni Venus billing system so that accounts can be processed. All metering data is backed up on a daily basis to an off-site backup database to ensure data security.

Internet portal

Most AMR systems address the issues of data acquisition, storage and billing system interfaces, but very few pay any consideration to customer interaction. Ekurhuleni strongly believes that the value of an AMR system does not simply lie in reading meters alone, but also in providing a value added service to benefit to our most important asset – our customers. Meteringonline provides a powerful yet simple to use internet portal as a customer

interface to allow end users to monitor many aspects of their energy usage.

Essentially, Meteringonline takes data read electronically from electricity meters and converts this into *information* that can be used effectively by people who are not electrical engineers or metering professionals.

This metering information is immediately made available to the individual Ekurhuleni customers on the MOL Internet site www.meteringonline.com. Customers have access to up to date profile statistical information and billing data as well as historical information for analytical purposes. Raw primary metering information can be downloaded from the MOL site into a spreadsheet for further analysis and extrapolation.

Load profile

The greatest benefit of a load profile graph is that it makes something that is normally obscure, intangible and invisible to most people, electricity consumption, not only instantly visible, but intuitively understandable.

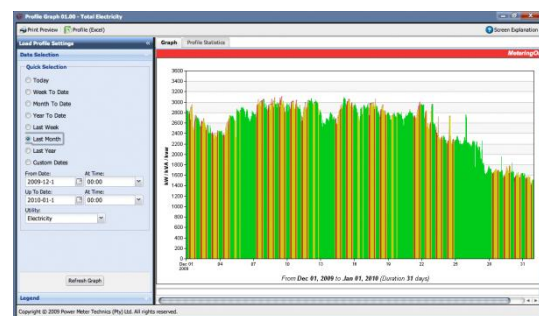


Figure 7: Load profile graph

Quality of Supply monitoring

One of the added monitoring functionality of an AMR system is to provide online information over the supply capacity notified maximum demand. This may required that the network have to be reconfigured and may add value that will inform network planners on important loading of the network during winter and summer times.

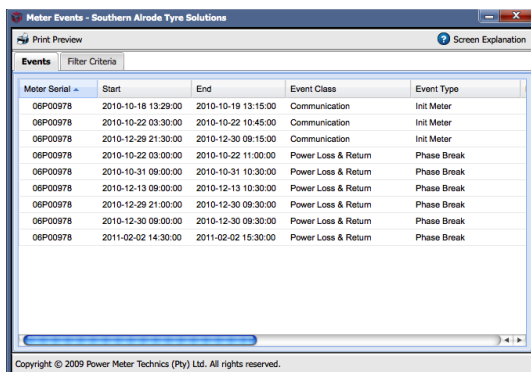
The AMR meter functionality of Quality of Supply (QoS) monitoring and other event recording provides a range of benefits including a reduction in cost of recording and reporting QoS data.

Furthermore a significant proportion of complaints are related to voltage. The investigation of voltage related complaints can involve the placing of recording equipment at customer premises to monitor voltage levels. It

can also involve investigating whether certain network operational arrangements are creating QoS issues.

At present, licensees such as Ekurhuleni do not have the capability to continuously monitor the voltage that is supplied to most customers on a continuous basis. Meteringonline assists in providing such capability.

The ability of Meteringonline to store and report on meter events such as “meter loss of supply and outage recording” allows accurate record keeping of outages.



Meter Serial	Start	End	Event Class	Event Type
06P00978	2010-10-18 13:29:00	2010-10-19 13:15:00	Communication	Init Meter
06P00978	2010-10-22 03:30:00	2010-10-22 10:45:00	Communication	Init Meter
06P00978	2010-12-29 21:30:00	2010-12-30 09:15:00	Communication	Init Meter
06P00978	2010-10-22 03:00:00	2010-10-22 11:00:00	Power Loss & Return	Phase Break
06P00978	2010-10-31 09:00:00	2010-10-31 10:30:00	Power Loss & Return	Phase Break
06P00978	2010-12-13 09:00:00	2010-12-13 10:30:00	Power Loss & Return	Phase Break
06P00978	2010-12-29 21:00:00	2010-12-30 09:30:00	Power Loss & Return	Phase Break
06P00978	2010-12-30 09:00:00	2010-12-30 09:30:00	Power Loss & Return	Phase Break
06P00978	2011-02-02 14:30:00	2011-02-02 15:30:00	Power Loss & Return	Phase Break

Figure 8: Meter event log

Phasor analysis

The Meteringonline system takes “snapshot” views of the basic electrical parameters such as the voltages and currents measured by the meter at the time of each acquisition.

The resulting Phasor information is processed by an advanced Expert System to determine faults or abnormalities in the electrical connection to the meter. This allows early detection of common problems such as fuse failures, tampering and so on.

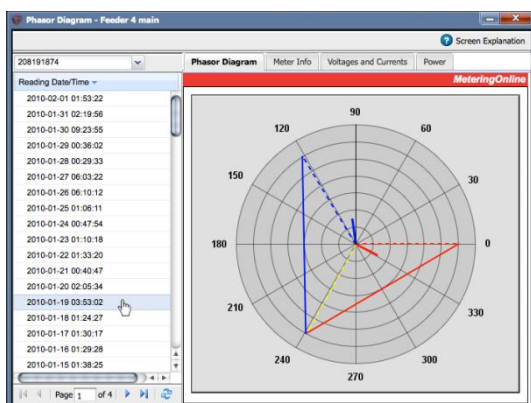


Figure 9: Phasor diagram

Energy Management

Consider the following energy management conundrum:

Electricity customers worldwide are being pressurised to reduce their consumption, but there is a problem: how do they obtain a comprehensive under-standing of the electricity that is currently being consumed?

- Where
- When
- How much
- What is it costing

How do they really know if the corrective initiatives that they have adopted are sufficient to reach the targets set?

In the absence of any useful information many customers do nothing or at most “window-dressing” programs. It is next to impossible for a utility like Ekurhuleni to impose energy quotas on customers when the only information they receive on their energy consumption is a bill at the end of each month.

There is little point in informing the customer that they have exceeded their quota after the fact. In short, how does one empower customers to manage their own electricity usage? In order to address this problem, additional facilities were added to Meteringonline which enables each customer to monitor their progress in achieving the required energy reduction, whether self-imposed or a statutory requirement.

One of the energy management tools in Meteringonline is the Energy Target Prediction Graph which enables a customer to monitor their progress in achieving the required energy reduction. This consists of simple graphical representations of the quota management system as shown in Figure10, Figure11, Figure12 and Figure13.

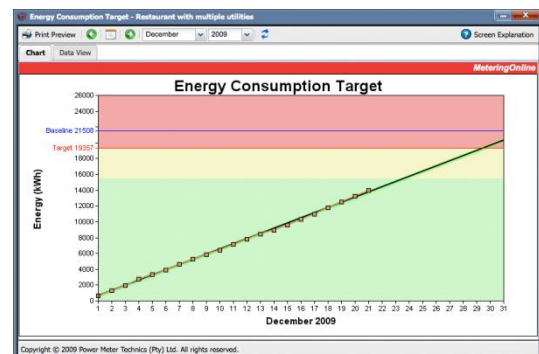


Figure 10: Energy target graph

Figure 11, below can depict over/under consumption by means of a gage.

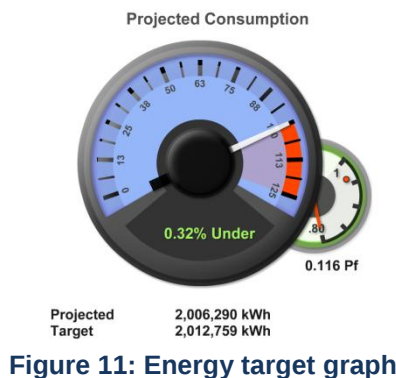


Figure 11: Energy target graph

Figure 12, below clearly indicates target and actual consumption, the red line indicates the desired target that should preferably not be exceeded for the month.

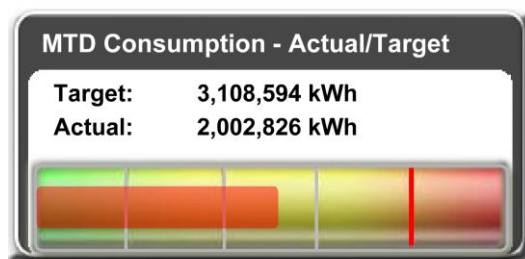


Figure 12: Energy target graph

Lastly but not the least is typical a graph that will depict to the customer its Carbon foot print and emissions that are directly related to the use of electricity.

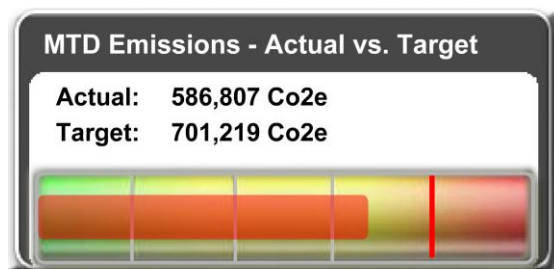


Figure 13: Energy target graph

Reports

Meteringonline is equipped with a rich assortment of graphs and reports available to the user which translate metering **data** into metering and financial **information**. Graphs showing detailed profile information, billing reports and performance benchmarking are all available from the Meteringonline desktop without relying on IT resources or additional software.

On top of this detailed monthly tariff reports can be exported in Excel format which contains all relevant information that a tariff designer will need to analyse and create tariffs in detail. Within the billing summary report one will typically find all customers detail e.g. account number, Stand number, Customer name, Units (kWh), Demand (kVA) readings, Tariff, Total Bill etc. This type of information is especially handy when tariffs are restructured.

The role of the WEMMC (Water and Electricity Meter Management Consultants) in the AMR value chain.

Ekurhuleni have also appointed various Engineering Consulting Firms to perform the duty as a Meter Management Consultant to manage the Ekurhuleni Metropolitan Municipality's electricity meters and meter related materials. This includes inter alia:

- Effective and efficient management of new meter installations, repairs to and reinstatement of existing meter installations and replacement of meters. This applies to prepayment, conventional CT, conventional CT-VT and conventional non CT driven meters.
- Effective and efficient management of the automated meter reading (AMR) process of large power users.
- Effective and efficient management of meter installation related materials.
- Effective and efficient management of the process to act on errors identified through the error report originating from the meter reading process.
- Effective and efficient management of the appointed Ekurhuleni Metropolitan Municipality's Meter installation contractors that performs work on the electricity meters and electricity meter installations.
- Monitoring of all meter related ICT systems to ensure correct functioning of these systems and pro-actively identify problems with them.

Work to be executed by WEMMC's

In terms of the successful and accurate upload of the remote metering data from the Remote Meter Service Provider (RMSP) to the Finance Billing system the WEMMC have to manage, and perform the following functions:

- RMSP generate an electronic data file of successfully generated meter readings which will consist of the consumer consumption data as per tariff structure and in accordance to the RMSP contract and forward to the WEMMC. The RMSP will also forward a data file of meter readings that could not be generated due to various reasons.

WEMMC upon receiving the data file for successfully generated readings; interrogate the data file in terms of tariff structure, historical data, consumer data versus meter data etc. for possible upload into the Finance Billing system. The WEMMC will also investigate the file where meter readings could not be obtained and apply penalties where applicable or provide reports for the correction of the meter installation to the respective technical staff. If meter reading data is missing, the WEMMC will inform the RMSP of the missing meter reading data on which the RMSP will act on and rectify or rerun data uploads and provide the WEMMC updated meter readings.

- If it was found that the meter readings could not be obtained from a desk top exercise, the RMSP technical staff will conduct an onsite inspection to ascertain the cause of the failure to obtain the readings. If it is within the scope of the RMSP technical staff to rectify or to clear the fault, the RMSP is expected to rerun the data interrogation and provide new meter reading data to WEMMC on the missing data.
- In the event that the RMSP technical staff cannot resolve the fault, the RMSP will report to the EMM Energy Department the cause of the fault and it will be the Energy Department's responsibility to clear the fault.
- In the event of data adjustment required such data adjustment to be flagged by the WEMMC in order for EMM Finance to perform the necessary adjustments.
- Once meter reading data has been processed by EMM and errors have been

found, the errors will be sent to WEMMC to investigate, rectify or to refer to RMSP.

- In the event of the accurate meter reading data has been successfully uploaded, the WEMMC are required to verify the billing data against the data that was provided for uploading.
- For the meter readings that could not be obtained due to maintenance and faulty meter installations, the WEMMC is expected to follow up on a regular basis of the progress made in terms on the repairing of the faulty meter installation.

Problem Statement – AMR Systems

The following problems have been identified and a brief description will be given as how some of the challenges were approached.

- a. AMR electronic metering systems are not flawless
- b. Data bases are not reliable due to inconsistent/ incorrect data capturing processes
- c. Billing systems bill whatever readings are submitted
- d. Electricity tariffs are not applied correctly.
- e. Meters are not installed and maintained effectively
- f. Metering processes allow incorrect installations and failures to exist for quite some time before faults are corrected
- g. Very few overall quality management processes are used
- h. Metering and billing errors are costing utilities dearly in the bulk supply sector
- i. Customers are at the mercy of utilities as far as correct billing and metering is concerned and it is a major project to convince a utility to talk to the customer and assist with corrections. The end result is major cost implications to either the customer or the utility.

Correction strategy

- a. Identify the sources of possible revenue collection losses
- b. Design monitoring triggers to flag a problem when it occurs
- c. Use appropriate analysis methodologies to identify and correct problem
- d. Use appropriate reading/ data correction methods
- e. Establish customer liaison process
- f. Establish bill correction process.
- g. Ensure that effective quality control is used when meter is installed.

- h. Ensure that all processes from the application to the monthly billing are effectively linked and data integrity maintained.
- i. Communicate with the customer to obtain his inputs and consent.
- j. Ensure that a comprehensive over-all meter management process is in place
- k. Integrate technical, tariff and financial skills in the management team to ensure that the total problem is analyzed and corrected.

Typical errors encountered in meter reading and billing processes.

The following errors were encountered during the project and serves as a representative but not exhaustive list of problems occurring in bulk customer metering and billing systems:

- a. Incorrect billing readings due to metering or reading errors. As accuracy improved, this figure also improved drastically.
- b. Gaps (not all 1/2h data received) in data and bills caused by data collection and billing problems.
- c. Meter time change spikes due to technical processes can cost the customer a significant amount if it affects the demand or NAC readings.
- d. Communication errors form part of the problems encountered. The communication system (mainly GPRS) and modems are not 100% reliable enough to ensure that data will always be available when required. Communication network failures as well as modem failures are common issues to address continuously.
- e. Tariffs incorrect due to the fact that tariff determination and the implementation of tariffs on the AMR and billing systems lack a procedural and reliable process. Some staff members who are responsible for tariff implementation simply do not understand more complex tariff structures and the interaction between tariff components.
- f. Meter installation incorrect due to technical and installation data capturing. These problems include incorrect CT/ VT installation as well as ratio implementation. The electronic metering systems do not all operate in the same way and where a large number of different makes and model of meters are used one often finds that the setups and ratio data are different causing confusion when the systems are implemented. The system should rather be

standardized on only two or three systems making maintenance and operation significantly less complicated.

- g. VT/CT failures. These problems can normally be identified effectively if the AMR system also reads the meter events as well as phasor diagram information and instantaneous voltage and current readings during normal customer operational times. Many AMR systems only read profile data that makes remote monitoring of the meter system very difficult. It is absolutely essential that this information be retrieved from the metering system for management purposes.

- h. Billing components incorrect (units corrected but not MD and NAC)

Conclusion

The City of Ekurhuleni has made much progress in establishing an AMR monitoring system and it has certainly now reached a matured state of what was envisaged.

AMR technology can be and is of great assistance but good management practices are still required to ensure that a utility manage its readings and bills successfully.

The selection and appointment of a suitable service provider need to be evaluated carefully on both its ability and reliability of the service to be provided. Take into account that one error on a large account can potentially result in losses far exceeding the total annual Ekurhuleni internet billing costs paid for the AMR service.

Internet metering has significant financial advantages to the City of Ekurhuleni, one of these being the ability to quickly react to any deviation in billing quantities due to a metering circuit fault or third party intervention. Accounts are produced on the exact calendar month, providing customers with a financial management tool that can be directly related to production processes.

Interval data for various electrical parameters are stored at 30 minute intervals, negating any claim that may be brought against Council for inaccurate readings. The high quality of data and the online ability has enabled the current service provider to integrate the future load management on request for voluntary load reduction into this system. This will provide Ekurhuleni with a very unique opportunity to

manage this aspect should the national grid supply become constraint.

It is advisable that should a new contract be awarded it be run in parallel with the existing contract in order to ensure a safe period to execute transfer operations to the new service provider. By nature, this contract cannot be transferred to a new service provider instantaneously and a period of up to 6 months may be required to affect such a changeover.

An appointed dedicated team (internal or contractual) may still be required to supervise and manage all AMR processes to ensure that quality billing is in place.

Accurate billing data together with comprehensive consumption reports via meteringonline had a tremendous positive impact on the City of Ekurhuleni electricity tariff design processes.

The information now available to assist with the tariff adjustment justification process has made the life of the tariff designers much easier. This can be extended to a requirement to be able to assess and quantify investment and recovery of return on investment by means of tariff adjustments / differentiation.

Further initiatives will be to enhance the value of the City of Ekurhuleni by reporting specific energy load flows and/or load reductions per area or substation and report improved energy balancing by monitoring and reducing losses in the network , etc.

Acknowledgement

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