
Mall of the North Smart Microgrid

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Power Meter Technics deployed the first advanced metering infrastructure (AMI) system in a commercial environment in South Africa at Mall of the North shopping centre in Polokwane using Meteringonline Meter Data Management System (MDMS) and Echelon NES smart meters.

Introduction

Mall of the North is the largest shopping mall in the Limpopo province in South Africa, located in the province's capital city, Polokwane. The mall has 180 stores, restaurants and entertainment venues with five national anchor tenants and a 6-screen cinema complex. The complex consumes approximately 2.6GWh per month with a maximum demand of approximately 7MVA.

The Mall purchases electricity from the Polokwane City Council at a Medium Voltage bulk time-of-use tariff and resells this to each of the tenants at the appropriate retail tariff, which is dependant on the size of the tenant's load. The larger anchor tenants are given the benefit of the low voltage time-of-use tariff and the smaller tenants are billed on the standard commercial kWh energy tariff.

Business requirement

The ability to accurately account for all energy consumed, to minimise losses and to charge tenants fairly for their energy consumption was an important consideration in the choice of the metering design, but one of the primary considerations was to ensure that the metering system would be able to meet any future demands placed on it.

The long term profitability of any shopping mall is dependant on the ability to not only attract quality tenants and to maximise occupancy, but to ensure that these businesses are able to also operate profitably within the Mall environment and to minimise the number of tenants defaulting. One of the key areas that directly impact on the profitability of tenants is the cost of electrical energy. The price of electricity in South Africa has increased by more than 260% since has January 2008. The financial burden placed on tenants for their electricity consumption is fast approaching parity with the actual lease itself and this trend has resulted in an alarming increase in the rate of tenants who can no longer operate their businesses profitably and default not only on their electricity bills, but also on the lease and other financial obligations.

The solution is to ensure that the electricity consumed, either directly by the tenants or in communal spaces, is accurately accounted for and fairly charged for. Meteringonline will be employed to provide tenants with immediate near real-time access to their electricity use and its costs via the

Web Portal. Tenants can be alerted to anomalous consumption using emails or even SMS text messages, making it easy for them to adjust their energy use and focus on energy conservation. Additionally, the new technology will allow the Mall management to easily implement supply-side controls of hot water heating systems, HVAC and other communal loads in order to optimise consumption obtain maximum benefit from the time-of-use tariff. Future implementation of renewable energy sources into the system is catered for ensuring that the shopping mall can become a true smart micro-grid.

The basic principles in the design of the AMI system were:

- Every electrical load within the mall would be metered.
- Every supply point to the mall would be metered.
- Check meters would be installed at every node in the electrical network to verify that the energy entering the node is equal to the energy leaving the node.
- The metering system would be smart and future proof allowing for any smart-grid or energy management initiatives in the future.
- All meters would be remotely read at least four times a day
- The metering would allow the collection of active and reactive profile data for all loads, both single and three-phase.

Metering layout

Electricity is supplied to the Mall at 11kV from the Polokwane City Council and reticulated internally at the low voltage (230/400V) level. There are four 11kV intake points in the building each with two 1.5MVA transformers. There are 373 metering points within the Mall, which can be divided into 8 categories as shown in Table 1.

Table 1: Placement of smart meters

Load type	Meters
Transformer Incomers	8
Tenant supplies	188
HVAC	20
Lifts and escalators	9
Common area lighting	107
Signage	6
Standby generation	4
Internal check metering	31
Total	373

Tenants are charged for their direct consumption as well as portion of the common area lighting, HVAC, Lifts and escalators and signage consumption, calculated on a pro-rata basis according to their relative size.

Smart micro-grid

It was decided to use Echelon NES smart meters with the Internet based Meteringonline Meter Data Management System (MDMS) developed by Power Meter Technics. A shopping mall such as Mall of the North is an ideal application for for a smart metering systems using A-band PLC communication since it is in essence a self-contained micro grid. The electrical reticulation in a shopping mall can be thought of as being analogous to that of a small town. The Mall has range of electricity consumers from large anchor tenants to small boutique shops. There are common areas that have to be supplied electricity, which is analogous to street lighting in a town and even a degree of local generation.

There is no possibility that the A-band PLC communication within the Mall can affect the operation of other PLC devices in the actual Municipality that supplies the Mall since this would be blocked by the supply transformers. The landlord is effectively the licensed distributor and when seen in this light, it is perfectly acceptable to make use of A-band PC and this opens the doors to implementing a range of smart technology within the Mall.

Data acquisition

Meters are automatically read every half an hour using Meteringonline and the Echelon NES platform. Data acquired from the meters are stored off-site

in the central Meteringonline database managed by PMT in Midrand. In addition to tenant metering all other loads and distribution points are also metered, ensuring that all common area consumption and other loads such as signage are correctly accounted for and apportioned to tenants.

The fact that the incoming supplies and all internal loads within the centre are measured make it possible to perform a real-time energy balance to ensure that no consumption is unaccounted for and that both technical and non-technical losses are quantified and managed.

Performance measurement

The performance of the metering system is constantly monitored in two ways. The first is to ensure that all the energy consumed within the mall is properly accounted for and compared with the total energy purchased. The second is a financial analysis to ensure that the owners of the mall derive maximum income from the sale of electricity.

Energy balance

During the test period in July 2012 a total of 2,560,451 kWh was supplied to the mall by the Municipality, of which 2,558,151kWh or 99.11% was accounted for by the internal smart metering system. A breakdown of the energy consumption during this period is shown in Figure 1.

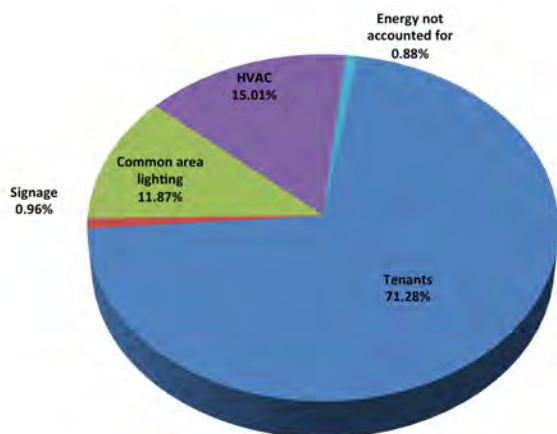


Figure 1: Energy consumption breakdown

The energy consumed directly by the tenants is of course completely recovered from them. A portion of the HVAC and common area consumption is also recovered from tenants on a pro-rata basis

calculated on the total lease area for each tenant, resulting in a total recovery of approximately 92%

Table 2: Energy consumption analysis

Load	Units (kWh)	%Recovered
Tenant consumption	1,839,609	100%
Signage	24,845	100%
Common area lighting	306,347	65%
HVAC	387,350	78%
Total	2,558,151	92%

Financial analysis

Electricity is purchased from the Municipality at a bulk time-of-use tariff and resold to the tenants at the applicable retail commercial tariff. The difference between the bulk and retail tariff rates and the benefits of demand diversity result in a total surplus of 15.3% or R245,874.93 or accrued by the landlord as shown in Table 3

Table 3: Recoveries from tenants

Charge	Amount)
Administration charge	R1,839,609
Consumption charge	R24,845
Maximum demand charge	R306,347
Total	R1,607,025.67

The future

The centre management is currently putting systems in place to better manage electricity consumption in communal areas such as Mall lighting, HVAC, hot water heating and other systems. Additional features such as the ability to restrict loads to tenants in times when the National Grid is under stress to prevent load shedding is also being investigated.