THEN

Smart meters, by definition, are electronic measurement devices used by utilities to communicate information for billing customers and to facilitate overall management of their networks. Initially this technology was applied to commercial customers only; however, the introduction of electronic meters and decreasing costs have permitted a migration to include all customer classes.

Smart metering is an integral component of the smart grid and hence many utilities worldwide have introduced programmes to replace existing traditional meters with smart meters throughout their networks. Although numerous compelling reasons can be given for this migration, the resultant benefits for both energy providers and their customers alike are considered substantial.

Furthermore, in support of the fight against climate change and better utilisation of natural resources, governments worldwide are also supporting, and indeed in many instances driving, this initiative.

Emerging regions also provide a unique set of challenges, typically with rapid growth and industrialisation in cities and suburbs as well as non-technical losses, resulting in a climate where the demand for energy is outweighing supply.

Smart metering and smart grid technologies offer great benefit to utilities in these regions. Efficient demand forecasting and demand side management, including accurate billing information, can be readily provided. Thus issues such as load shedding can, for example, be controlled by real time information from each meter. An intelligent analysis of readings, together with two-way communication of control measures can be effectively deployed to effect load limitation.

Although the term 'smart meter' normally refers to an electricity meter, it is equally applicable to devices measuring gas or water consumption.

Historical

Traditional electro-mechanical meters, developed in the late 19th century, measured electricity consumption by means of a rotating magnetic desk and were successfully deployed for many years. These meters typically provide an accurate measurement of electricity consumption; however, a major shortcoming was always the inability to measure any form of time of day consumption. Similarly, meters used for gas and water consumption measurements were traditionally also mechanical.

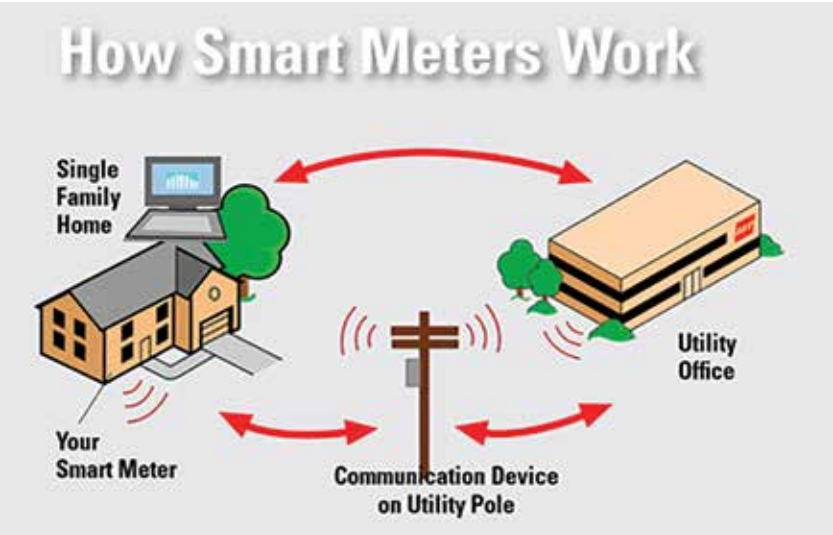
The first step-up in terms of meter evolution was the replacement of the electro-mechanical meters with solid state devices. Electronic meters offer several advantages when compared with their electro-mechanical counterparts. These incorporated the ability to measure other parameters such as power factor and reactive power. Moreover, meter data could now be measured and stored at specific time intervals, thus permitting a utility to offer time of use price plans. In addition, electronic meters, since they cannot be influenced by external magnets and orientation, are more tamper proof and also inherently more reliable.

Communications

Utility metering, be it electricity, water or gas, was, and still is in many countries, carried out on a stand-alone basis whereby the meter installed at the customer's premises is manually read, typically on a monthly basis. However, the introduction of electronic meters made it entirely feasible to incorporate communications technology within the meter so that meter reading data can be remotely accessed via a communications network.

Different system architectures have been developed over the years to support remote reading: these include walk-by, drive-by and networked systems. In a networked system meter data is typically fed to a fixed data collector and thereafter back to the utility via a wireless or PLC network.

While both walk-by and drive-by systems greatly increase the number of meters that a utility employee can



▲ *Figure 1 – Basic Smart Meter Architecture*

THEN & NOW – a smart metering story

read in a day, a networked system provides instantaneous readings at the utility premises and thus eliminates the requirement to dispatch meter readers. Consequent labour and transport cost savings are substantial and accuracy of meter data recorded is furthermore enhanced.

Smart Metering Benefits

The implementation of smart metering can provide many benefits for all entities associated with the supply and consumption of electricity, water and natural gas. These include the following listed below.

Consumers

- Near real time energy consumption can be displayed on the meter, thus allowing users to adjust consumption accordingly (typically readings are taken every 30 minutes)
- Permits the user to reduce costs by taking advantage of off-peak lower tariff during off-peak periods
- Electrical appliances can be automatically controlled
- Information relating to energy costs and carbon emissions is immediately available (remotely provided by the utility)
- Estimated billing can be eliminated

Utilities

- Reduce costs by not having to physically read meters
- Fraud and leakages can be more easily detected
- Can influence the energy consumption of customers
- Up-to-date and accurate data is immediately available
- Protect revenue by means of remote disconnection for non-payment
- Provides a new communication channel to customers
- Facilitates more effective grid management and thereby reduce the requirement for load shedding (match generation with consumption)

Government

- Can be considered a significant contribution toward the fight against climate change
- Assist with the liberalisation of energy markets
- Will entice consumers to manage their consumption better and consequently reduce usage, leading the way to improved service levels

Smart Metering Technology

In the beginning, the replacement of manual meter reading was simply seen as a means to reduce costs (labour, transport etc.). However, it soon became apparent that Automatic Meter Reading (AMR) allowed utilities to provide higher order benefits and services to enhance energy efficiency. These included real time pricing, instant fault reporting and more accurate data recording for better network profiling and revenue collection.

Advanced Metering Infrastructure (AMI) takes the technology to the next level whereby two-way communication with the meter is enabled. Thus measurement, collection, and analysation of energy usage combined with communication to and from metering devices (electricity meters, gas meters, heat meters, and water meters), either on request, or on a schedule, is entirely feasible. A graphic representation of AMI technologies and interfacing is shown in Figure 2.

Data Management: a Meter Data Management System (MDMS) is a major component of smart meter deployment. This software platform receives data from multiple smart meter technologies and verifies and stores the data. Thereafter, data subsets are delivered to utility operations applications, which include billing, maintenance, outage management, etc.

Communication: Essentially two basic categories for communication of smart meter data can be deployed: Radio Frequency (RF) and Power Line Carrier (PLC). Both have advantages and disadvantages and the utility should select the technology which best suits its demographic and business requirements.

Radio Frequency: Smart meter data is transmitted wirelessly via radio from the meter to a collection point and then by various means to the utility data systems for processing at a central location. Two types of RF technology are normally deployed.

- Mesh Technology. Smart meters communicate with one another to form a LAN cloud to a collector. The collector transmits data to a central processing location using a WAN technology. Advantages include acceptable latency and large bandwidth (typically operating in the licence free bands of frequencies). Disadvantages mainly involve terrain and distance challenges in rural areas.
- Point to Point Technology. Smart meters communicate directly with the collector and the tower collector transmits the data to a central processing location. Advantages include little or no latency, direct communication with each endpoint, large bandwidth, use licensed spectrum and hence can cover larger distances if required. Disadvantages relate to licensing, Line of Sight considerations and proprietary communications used for some technologies.

Power Line Carrier: Smart meter data is fed across utility power lines from the meter to a collection point, typically in the distribution substation feeding the meter. Data can then be delivered to utility data network for processing at a central location. Advantages include the utilisation of existing infrastructure, more effective over difficult terrain and can work effectively over long distances. Disadvantages involve higher latency, lower bandwidth and high cost in urban areas.

In addition to the abovementioned, Wi-Fi, cellular, satellite and other Internet related networks can also be considered for communications to and from smart meters.

Transmission Control Protocol / Internet Protocol (TCP/IP)
Currently, a growing trend toward the use of TCP/IP technology as a common communication platform for smart meter applications is evident. Utilities can then deploy multiple communication systems, while using IP technology as a common management platform. A universal metering interface would allow for development and mass production of smart meters and smart grid devices prior to the communication standards being set. This would lower the risk of investing in the wrong standard as well as permit a single product to be used globally, even if regional communication standards vary.

Safety and Security

Most health concerns raised relate to potential harmful effects from the pulsed radio frequency radiation emitted by smart meters. However, studies have shown that RF exposure from smart meters is minuscule when compared to cell phones and microwave ovens. Other factors such as location, distance from the transmitter, meter enclosure shielding, attenuation due to building materials and low transmit duty cycles also significantly reduce any perceived risks.

> ***"Cyber security and integrity of customer meters continues to be a major concern …***

Since the inception of meters with communications capabilities, utilities and vendors have recognised the need for robust security systems to protect the integrity of data and revenue information. The evolution to AMR and AMI further exacerbated the situation and the protection of data became even more imperative. Hence, security systems have extended beyond the endpoints to the collector and head-end systems and include level access control, data validation, error checking and encryption of data.

Cyber security and integrity of customer meters continues to be a major concern for utilities and vendors. Like bank ATMs, all smart meters need to be both adequately firewalled and protected from physical attack. Similarly, just like the banks, utilities need to deploy

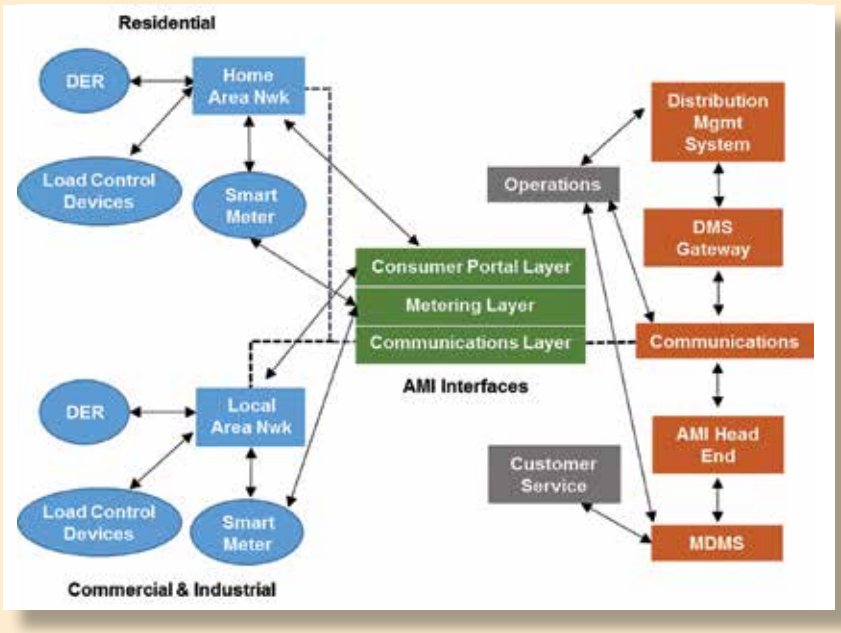


Figure 2 – AMI Technologies

PROTEA METERING

SMARTER SOLUTIONS FOR UTILITY MANAGEMENT

Protea Metering offers integrated utility management solutions and services encompassing metering of electricity, water, sewerage, gas and solar energy for multi-tenanted complexes and buildings.
Protea Metering have built up a formidable portfolio of clients over the past 2 decades which includes major retail shopping centers, office blocks and numerous residential and security estates through out Southern Africa.
We pride ourselves on our accuracy and professionalism in the market place and are recognised for our client service.

ELECTRICITY SOLUTIONS

Protea Metering offers electricity services to Commercial and Residential Properties including:

Electricity Metering

- Conventional Metering
- Prepaid Electricity Metering
- Electricity Metering *Smart Metering (OAMI)

Meter Supply

Our Paradigm is "The best of the Breed" and we employ world class metering equipment including: Landis & Gyr, Elster, Kent, Sensus and Echelon meters.

Meter monitoring, maintenance and testing.

Protea have a dedicated technical team, comprising of technicians, electricians and plumbers that are available to conduct electricity and water consumption audits, installations and testing of meters and replacement of meters.

WATER SOLUTIONS

Protea Metering offers water services to Commercial and Residential Properties including:

Water Metering

- AMR- Automated water meter reading (online)
- Prepaid water meters
- Hot water metering
- Protea Metering can install and maintain hot water meters for most types of installations.

Leak detection

This service will be provided to clients within the Protea metering prortfolio.

Sewerage

Sewerage is charged as a portion of water consumption.

PRETORIA: 80 Rauch Avenue, Georgeville, Pretoria • (012) 804 1039

MIDRAND: Tuscan Gardens, Suite 5, 14th Avenue, Noordwyk • (011) 238 2900

WWW.PROTEAMETERING.CO.ZA

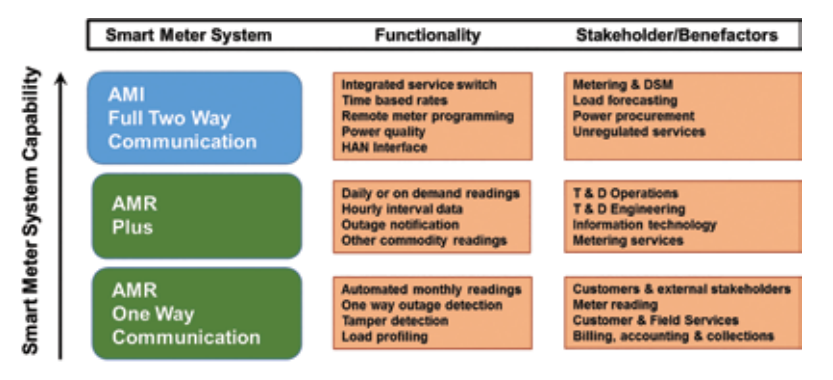


Figure 3 – Smart Meter Technology Evolution

numerous technologies and processes to ensure adequate monitoring and protection of access to data. Considering the potential for energy theft and other fraudulent financial opportunities, there can be little doubt that smart meter networks will prove extremely attractive to hackers.

Case Study – United Kingdom

Smart metering has been implemented in numerous countries worldwide: these include Australia, Canada, Italy, Japan, Netherlands, New Zealand, Nordic countries, Spain, UK and USA. Implementation is also imminent in the following countries: France, Ireland, Iran and Malta.

The rollout in the UK is considered to be the largest programme ever undertaken and it is envisaged that it will enable a more energy efficient system for Great Britain.

In August of 2007, the UK government embarked upon a consultative process for a smart meter (electricity and gas) rollout programme. The consultation attached the necessary draft regulations and proposed that from 2008 domestic customers provide comparative historical consumption data and electricity suppliers provide a real-time display unit within time limits.

In December 2009, the UK's Department of Energy and Climate Change (DECC) announced its intention to have smart meters installed in all homes in Great Britain by 2020. Hence, by the end of 2020, around 53 million smart meters will be fitted in over 30 million premises (households and businesses) across Wales, Scotland and England. The programme is already underway and by June 2015 over two million smart meters were installed.

The model is a competitive-supplier-led rollout with a central communications body, called the Data and Communications Company (DCC), which was established in September 2013. As well as the DCC, the government established Smart Energy GB to lead the nationwide publicity for the rollout programme.

Impact assessments were carried out by Government to help establish if there exists a positive business case for Britain to roll out smart metering. These looked at the potential costs and benefits of rolling out smart meters to suppliers, network operators, customers, and Britain as a whole. DECC's Impact Assessment, updated in January 2014, concluded that there is a positive business case overall of £6.2 billion (US$8.89 billion) of net benefits.

Concerns

A number of concerns relating to cost, safety, communication and security issues associated with smart metering have been voiced by consumer groups in the UK. These include the following:

- Cost to consumers
- Savings will not be as large as predicted
- Effectiveness of chosen telecommunications technologies
- Cyber security issues – impacts could range from fraudulent transactions for financial gain to the crippling of critical operations
- Customer reluctance
- Lack of evidence to support utility and government claims
- Increased unemployment – large layoffs of meter readers

Smart meters also record substantial personal information, including the time that homeowners were at home or not. Since the readings undoubtedly contain private information, it has been stated that power companies need to be more upfront about their handling of the personal information gathered by smart meters.

Conclusion

Smart metering is an integral component of smart grid and it is clear that these technologies offer numerous benefits for both utilities and customers alike. And also, due to reduced consumption and improved grid management, it should prove beneficial to the environment as well. Academic studies have shown that savings of between 3 and 5% are indeed achievable.

However, a successful implementation is very much dependent upon careful planning and meticulous implementation. Furthermore, it is essential that concerns raised by the public and consumer groups are adequately addressed. Since the technology represents a radical departure from traditional methods, and it will also be required that customers carry the cost of smart meter installation, cooperation and buy-in is a crucial aspect.

Also, if predicted savings are to be realised, customer education is a key aspect. This implies that consumer awareness and understanding of smart meter principles must be grown and confidence in smart meters built before rollout can commence.

From an electricity utility perspective, the benefits of improved grid management are particularly pertinent to developing markets. So very often in these markets demand far outstrips generation capacity, resulting in countrywide load shedding being implemented. This highly undesirable scenario can be reduced, or even avoided altogether, by the ability to be able to remotely manage the load that smart metering technology brings.

Acknowledgement

This article is made available to ESI Africa for publication courtesy of African Utilities Technology Council (AUTC), a non-profit trade association. Their mission, led by AUTC director, Corrie Vermeulen, is to shape the future of utility mission critical technologies by driving innovation, fostering collaboration, and influencing public policy. Visit www.autc.biz for membership enquiries.