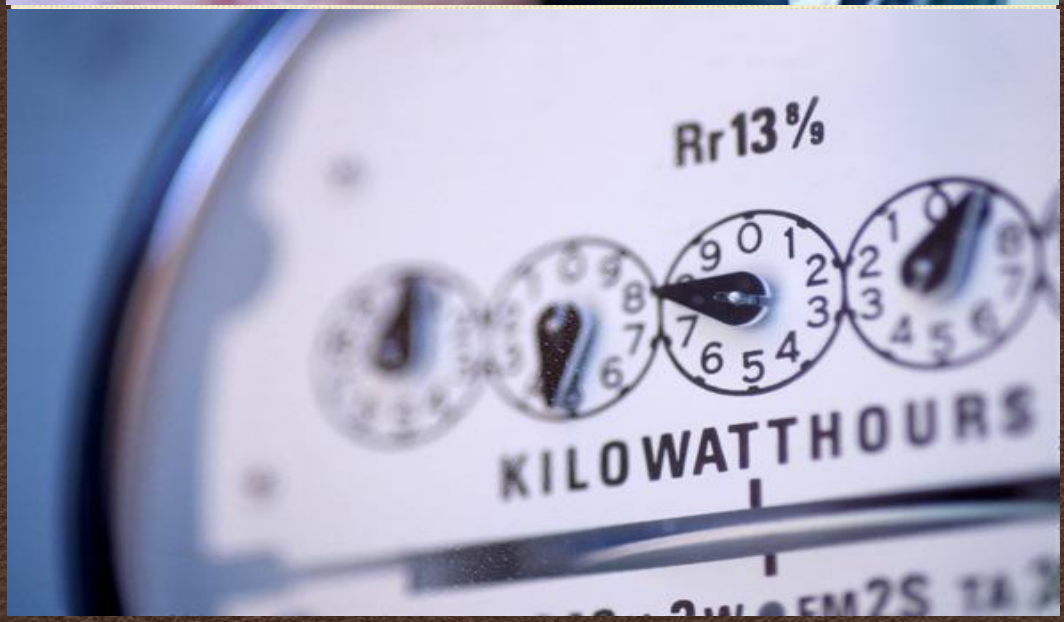
Applicability of Smart Metering Technology in Sri Lanka



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Content

Abbreviations

AMI – Advanced Meter Infrastructure

AMR – Automatic Meter Reading

BPL - Broadband over Power Line

CEB – Ceylon Electricity Board

DSL - Digital Subscriber Line

DSM – Demand Side Management

Enel - Ente Nazionale per l'energia ELettrica

ESC - Essential Service Commission

FOC - Fiber Optic Cables

GPRS - General Packet Radio Service

HAN - Home Area Network

IP - Internet Protocol

LAN – Local Area Network

LECO – Lanka Electricity Company

LESCO - Lahore Electric Supply Company

MDMS - Meter Data Management System

MOPE – Ministry of Power and Energy

MPLS - Multi Protocol Label Switching

PEPCO - Pakistan Electric Power Company

PLC - Power Line Communications

PUCSL – Public Utilities Commission in Sri Lanka

RF - Radio Frequency

SAIDI – System Average Interruption Duration Index

SEA – Sustainable Energy Authority

SM – Smart Meter

TOU – Time of Use

UK – United Kingdom

WAN - Wide Area Network

1. Introduction

Although electricity was considered a luxury in the past, today it has become an essential basic necessity with the enhanced living standards of people and growth of the technology and industrial sector. Therefore the electricity demand in most of countries of the world is growing day by day. To meet this demand most of the developing countries have added more fossil fuel generation to their systems as they are the low risk proven technologies in large scale despite the environmental impact caused by them. Current trends in power generation and use are patently unsustainable economically, environmentally and socially. Without decisive action, increased fossil fuel demand will heighten concerns over the security of supplies and energy related emissions of carbon dioxide (CO_2). In today's world most of the developing countries are already swamped with power crisis due to inadequacy of generation to meet the demand.

Therefore there is a pressing need to implement mechanisms to manage the growing demand and improve the efficiency while reducing the energy losses, accelerating the development of low-carbon energy technologies such as renewable power generation, in order to address the global challenges of energy security, climate change and economic growth.

One promising means of reducing the transmission and distribution losses is through the distributed generation of electricity closer to the end user such as net metering schemes. And the other approach is managing customer consumption of electricity in response to supply conditions, for example, stimulating electricity customers to reduce their consumption at critical times or in response to market prices, thereby reducing the peak demand for electricity. In order to assist consumers to make informed decisions on how to manage and control their electricity consumption, consumers should have a system to monitor their real-time electricity consumption as well as a communication network with the service provider. But traditional electricity meters only record energy consumption progressively over time, normally in monthly basis and provide no information of when the energy was consumed. Therefore the necessity of Advanced Metering Infrastructure (AMI) has been emerged to address the above matters. Nowadays most of the nations are looking to rollout into Smart Meters enabling faster automated communication of information to consumers on their real time electricity consumption, and to service providers.

2. What is a Smart Meter?

There is no absolute definition of what a smart meter is, but it basically refers to using Advanced Metering Infrastructure in conjunction with faster automated communication systems to allow customers to monitor their energy consumption in real time. Simply, a smart meter electronically measures how much energy is being used and how much it costs, and then communicates it to the energy supplier and the customer. Smart meters can also enable the provision of new services to consumers as it can record consumption of electric energy in intervals of an hour or less, and also gather data for remote reporting using two-way communication between the meter and central system.

***Figure 1**. A Traditional Electromechanical Watt*

***Figure 2.** A Modern Digital Smart*

3. Smart Metering Technology

Advanced metering infrastructure (AMI) can be explained as a system that collects, measures and analyzes energy usage of consumers by enabling data to be sent back and forth over a two-way communications network infrastructure connecting smart meters and the utility's control systems. Smart meters can provide electricity distributors with a depth view of the behavior of the networks extending the visibility right down to the end consumer, where previously distributors' observation of power flows stopped at substations.

Smart metering systems are comprised of two main components:

- Advanced electronic meter module (Smart Meter)
- Communication network with the ability of remote communication.

Smart electricity meters record much more detailed consumption information than classical electricity meters. And recorded consumption data is made available to consumers by a digital display feedback system.

In addition, smart metering enables electricity customers, who choose to generate electricity under net metering schemes (micro generation) to measure and monitor their contribution to the national grid, and distributors to better manage this contribution.

These meters have the ability to transmit the data to flow from meter all the way to utility and vice versa, in real time speed through commonly available fixed networks such as Broadband over Power Line (BPL), Power Line Communications (PLC) or Fixed Radio Frequency (RF) networks which form the bridge between the smart meter and the Wide Area Network (WAN). And also it forms the bridge to the network inside the home or building, referred to as the Home Area Network (HAN).

The information extracted by the meter is normally transmitted to a Meter Data Management System (MDMS) that manages data storage and analysis to provide the information in useful form to the utility for the necessary actions.

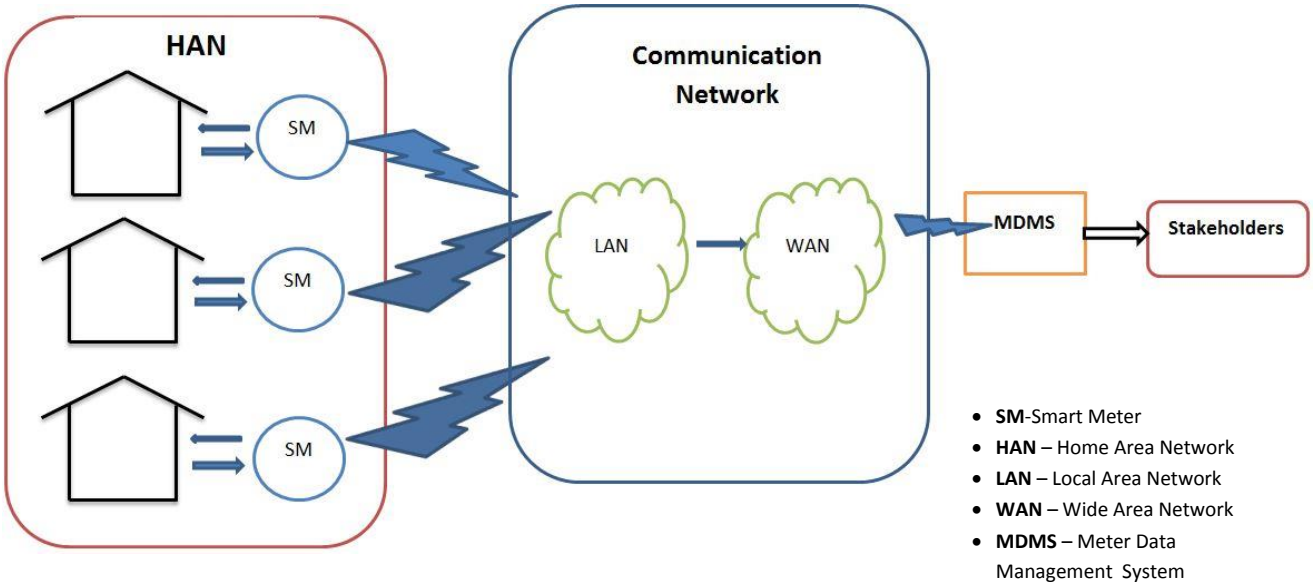

Figure 3. *Overview of AMI*

★ **Home Area Network (HAN)**

Home Area Network is deployed at consumer's premises which interface with a consumer portal to link smart meter to controllable electrical devices and hence enable a local control of loads by consumer. Controlling of loads without continuing consumer involvement is one of the major energy management functions of HAN.

★ **Wide Area Network (WAN)**

The medium over which the bidirectional communication between smart meters and remote data management system occur is Wide Area Network. The WAN is sometimes also referred to as the backhaul network. Communication on the WAN link is mostly Internet protocol (IP) based and does commonly rely on standard information technology media and technology stacks such as fiber optic cables (FOC), digital subscriber line (DSL), general packet radio service (GPRS), multi-protocol label switching (MPLS) or power line carrier (PLC).

★ **Meter Data Management (MDM) System**

MDM is the host system which receives, stores and analyzes the metering information. An MDM system is a single repository capable of storing the vast quantities of meter readings and other data associated with smart meters. It typically gathers data from one or more head-end systems.

4. Functions of Smart Meters

- Real-time registration of electricity import and export
- Enabling remote accessibility of consumption data
- Allowing changing of tariff in response to price changes
- Ability to change of payment method (Eg. Prepaid or Postpaid)
- Allowing load limiting/shedding for demand response purposes
- Detecting and notifying tamper alerts
- Receiving service messages (Eg. Power cut notifications)
- Power quality monitoring
- Communications with other intelligent devices in the home

5. Necessity of introducing Smart Meters to Sri Lanka

During the first half of year 2012, 64% out of total electricity generation in Sri Lanka has been catered by expensive fossil fuel oil power plants. Most of these plants have been operated only to meet the steep night peak. Sri Lanka has a daily load curve with a steep peak in the night, where starting from about 6.00 pm the load grows to about 2,000 MW by 7.30 pm and starts falling off after about 08.30 pm. Therefore the system must be comprised a substantial additional generation capacity only to meet that abrupt sharp night peak which is a huge burden for Ceylon Electricity Board (CEB).

Therefore requirement has been aroused to control the demand by paying attention to demand side management (DSM) while exploring the possibilities of developing sustainable energy resources. CEB has already implemented number of energy conservation drives to curtail the overall electricity demand. Also to pull down the steep night peak by pushing some industrial activities to low demand hours, CEB has introduced a three tier tariff plan for the industrial electricity consumers in 2011 with low off peak rates and penal peak rates. But in order to introduce this time-of-day tariff scheme for the domestic consumers it is necessary to replace the existing electricity meters with advanced smart meters since the existing electricity meter does not support both demand side management and decentralized power generation. By introducing smart meters to all electricity consumers both consumers and suppliers (CEB and LECO) can be benefited in many ways.

Initiating pre-paid electricity service, creating efficient electricity consumption patterns, establishing an efficient electricity consumption system and power and energy management are some of the special benefits anticipated by smart meter installation.

6. Anticipated Benefits from Development of Smart Metering Technology in Sri Lanka

Following benefits can be enjoyed once smart meters are implemented. Some of these benefits will be felt immediately, others will build up over time and as the technology evolves.

- **Automatic Meter Reading (AMR) Facility**

  Currently in Sri Lanka, electricity consumption of customers is recorded manually by sending meter readers to the customer sites on monthly basis. But there are some issues with this stand-alone meter reading such as meter reading errors, poor accessibility of meters in rural, estimated bills and inability to monitor and control real-time usage.

  The above issues can be avoided by replacing the current conventional meters with advanced smart meters, where both supplier and consumer can be benefited in many ways. One of the advantages of enabling AMR facility is, allowing field operations such as meter reading and service disconnection without sending utility personnel to the customer site. And it ensures accurate bills based on the actual consumption, rather than estimated bills which are major source of complaints by many customers. This will result in physical privacy to the consumers and also a high reduction in the operational cost of the utility which will ultimately benefit the consumers with low energy charges. Similarly, many maintenance and customer service issues such as voltage drop downs can be resolved more quickly and cost-effectively through the use of remote diagnostics.

- **Outage Detection Ability**

  Currently with the mechanical energy meters, the detection of an outage and restoration of power are not possible, therefore supplier largely rely on the consumer calls to take an idea of how large a power outage might be and where the power outage is occurring. Smart meters provide faster outage detection once an outage occurs and make it easier and quicker to locate and fix the problem. It helps to identify location and extent of outages remotely via meter signals. With the aid of this ability electricity suppliers also can keep records of power quality performance measures at each individual by recording the number and duration of power interruptions. Similarly, smart meters equipped with power quality monitoring capabilities enable more rapid detection, diagnosis and resolution of power quality problems.

- **Permitting Prepayment Facility**

  After replacing the existing mechanical energy meters with smart meters, prepayment facility can be introduced to the customers facilitating shifting from credit mode to prepayment mode, and vice versa, without the need to physically change the meter. When facilitating the prepayment mode, energy suppliers should offer more convenient ways to top up, for example cash payments, online or over the phone. Normally prepaid meters are programmed to issues warnings when the credit reaches a threshold or zero. After the use of emergency credit, the

service gets automatically disconnected. Then customer needs to recharge the meter and eventually the prepaid meter to avail the services again. Prepaid consumption is generally a very good commercial option for electricity consumers since they can preplan the budget required for paying the electricity bill, and no additional charges are imposed on the customer upon reconnect, hence no need to keep even security deposit to avail the service. Prepaid system is also advantageous for the electricity suppliers since it reduces paper work, enhances the reduction of customer energy consumption, reduces financial risks and improves operational efficiencies.

- **Reducing theft of energy**

  The most common method of tampering the mechanical meter is attaching magnets to the outside of the meter to prevent forming eddy currents in the rotor by magnetically saturating the coils of current transformer. And in Sri Lanka, events of tapping electricity from energized power lines are reported often. Not only do energy thieves risk their own lives, but also the lives of those nearby. Deployment of smart meters is useful to stop this energy theft using its ability of detection of tampering and discovering energy theft. This allows the company, fast detection of any abnormal consumption due to tampering or by-passing of a meter and enables the company to take corrective action. Moreover, by using smart meters the supplier will be able to get detailed information about their region, which means they can examine any suspicious areas where energy usage is higher than expected, and thus smart metering will provide the supplier with a tool to detect fraud. In addition to that since these devices remove the human factor from the equation, customers can no longer collude with dishonest meter readers to cheat the power company.

- **Financial benefits through efficient use of energy**

  Currently, electricity customers are informed of their energy usage via a bill that arrives months after they've used the electricity. The existing meters do not provide details of the real time energy usage, which could help consumers to understand their energy consumption in order to make intelligent decisions about it. However, Smart meters comprise the option of displaying the real time consumption including the energy usage in a previous period, hence consumers can keep track of their energy usage with a better understanding and make informed decisions on how to manage and control their electricity consumption according to the budget. Smart meters also provide detailed information and historical comparison reports to help the consumers to identify when they are using more or less energy during the day, the week or the month, which ultimately will help them to make changes that let them take control of their energy bills by changing their habits.

  Smart meters will also be beneficial for electric utilities since the individual consumption data could be useful to do surveys of energy use. Similarly, more detailed consumption data will ultimately enable distributors to measure energy lost during distribution rather than estimating losses using complex models.

- **Encouraging Micro Generation**

  Sometimes, electricity customers install their own electricity generating equipment, due to reasons of economy, redundancy or environmental concerns. In a case of a customer is generating more electricity than required for his own use, the surplus may be exported back to the power grid. In Sri Lanka also, electricity consumers are facilitated to export electricity to the national grid under "Net Metering" scheme. Since conventional domestic meters only record consumption, advanced meters should be deployed to accurately measure electricity exporting from domestic micro generation plants (Eg. Solar Panels). This enables householders to be fairly rewarded for their contribution, which makes smart meters one of the key enablers for the widespread adoption of micro generation. Similarly, it can accelerate the use of distributed generation, which can in turn encourage the use of green energy sources.

- **Promoting TOU Tariff**

  As in most countries, even in Sri Lanka, low voltage customers pay a flat, time-independent electricity tariff, which does not incentivize the customers to reduce demand at peak times and it leads to inefficient use of network assets. Once the smart meters are deployed, electricity suppliers will get the opportunity to offer and communicate time-dependent rates to the consumers through the meter, which eventually facilitate enabling Time of Use (TOU) based tariff system for the customers, rewarding low rates for energy usage at off peak times of day. Through the meter, customers can see how their consumption varies during the day and respond to the TOU based tariffs that encourage them to use cheaper energy. These price differences will help to encourage consumers to reduce their consumption in peaks times by pushing some heavy power activities to low demand hours and is known as load shifting or peak lopping. If this pricing method is applied in Sri Lanka, especially for domestic consumers, it will be a great support to pull down the steep night peak and flatten the demand curve, which, in turn, reduce the generation cost by shifting to low cost base load generation, as well as reduce the need for additional expensive, carbon-polluting peaking power plants to cater the night peak. Ultimately the electricity customers become an integral and active part of the overall electric power system by helping to balance electrical demand with supply, easing the stress on the distribution network.

- **Supporting to reduce the demand growth throw DSM**

  Since smart meters are capable of providing all information about electricity customers' energy consumption, it increases demand side management by enabling the consumers to modify their consumption behavior, could slow down the growth in the energy demand. An overall reduction in energy consumption will reduce the impending gap between forecast demand and generation and help to assure security of supply.

- **Reducing Carbon foot print**

  The smart meters not only can give detailed information about the consumption of electricity but also provides the measurement of carbon emission due to the usage of electricity. This means the people who are environmental friendly could actually make an informed decision about their carbon footprints and control it by limiting their electricity consumption. This is eventually a positive measure against global warming.

7. Disadvantages of Smart Meters

Health Concerns

Smart metering system cannot carry out its all tasks stand alone. The infrastructure should be comprised with a communication module to transmit and receive the data through commonly available fixed networks such as Broadband over Power Line (BPL), Power Line Communications (PLC) or Fixed Radio Frequency (RF) networks. Out of them most health concerns about the meters arise from the pulsed radiofrequency (RF) radiation emitted by wireless smart meters. Also some concerns have been raised about the long term impact of electromagnetic field emissions on customers' health.

Security Concerns

Most security concerns center on the inherent hack-ability of wireless technology. The introduction of smart meters in residential areas could produce additional privacy issues that may affect customers. Since these meters are often capable of recording energy usage every 15, 30 or 60 minutes, it can be used for surveillance, revealing information about customers' possessions and behavior and it can show when the customer is away for extended periods.

Other Issues

Since smart meters can be controlled remotely, it is easier for suppliers to disconnect the supply in case of non-payments. Although this is an ease for utility people, it is a disadvantage in the customers' side, since the service disconnection could be done being at a distance, without visiting the customer site without permitting additional time for the customers to make their payments.

Early notification of network faults following a power cut enables network faults to be located and resolved more quickly. However, this functionality may have an adverse effect on a distributor's performance measures (Eg. Customer Minutes Lost, SAIDI), because the clock will start running at the time of the fault rather than the time that the fault is first reported by a customer)

8. Smart Meter Deployment Approaches - Worldwide Best Practice Lessons

Implementation and deployments of smart meters is being actively considered in many jurisdictions across the world as a solution for number of issues occurred in power sectors around the world. The following cases describe the experience of some nations in the process of smart metering implementation.

Pakistan

Pakistan has been troubled with energy crises for more than five years. Through an estimate, Pakistan had a power shortage of 5300 MW in 2010 and this shortage has been increasing due to rapid growth in demand and a rather slow or no development work on the supply side. This energy crisis has put the whole country and economy in a distress and each and every person in the country is tired of the continuous load shedding which sometimes exceeds 16 hours per day. The second problem, which essentially is the major reason of slow development of energy sector of Pakistan, is electricity theft. It is estimated that Pakistan is losing billions of rupees annually on account of electricity theft.

As the most potential solution to tackle the above mentioned problems, introducing smart metering in Pakistan has been identified. Pakistan electricity companies Pakistan Electric Power Company (Pepco) and Lahore Electric Supply Company (Lesco) have already announced plans to install smart meters around the country.

As the first step of deploying smart meters in Pakistan, LESCO has launched a pilot project in certain areas, and has been able to save tens of millions of rupees just by the investment of 6.2 million rupees only. Similarly, theft and losses has been felt sharply from 11% to 2.9% in Shadbagh and Shadman, and from 13.2% to 4.4% in Dehli gate, after installation of smart metering.

Italy

The world largest smart meters deployment took place in Italy by Ente Nazionale per l'energia ELettrica (Enel) which is the largest power company in Italy with more than 32 million customer base. It has achieved the target of deploying smart meters to its entire customer base between 2001 and 2005. These meters are fully electronic and smart, with integrated bi-directional communications; advanced power measurement and management capabilities, software-controllable disconnect switch, and an all solid-state design. An annual saving of €2.1 billion is projected by this implementation.

Brazil

Brazil's government has mandated installation of more than 60 million smart meters by 2020. In this context utilities in Rio de Janeiro are taking advantage of preparations for the 2014 World Cup soccer championship and 2016 Olympic Games to deploy the meters.

Netherland

In Netherland all residential customers are being provided a smart energy meter starting from 2008. The proposed time frame for the whole project is 6 years. In the meantime, some pilot projects are also being developed.

UK

In December 2009, The United Kingdom Department of Energy and Climate Change announced their intention of installing smart meters all around UK by year 2020 and the rollout has officially started in 2012. The United Kingdom rollout is considered to be the largest program ever undertaken involving visits to more than 27 million homes to replace electricity meters.

Australia

In 2009, the Essential Service Commission (ESC) of Victoria commenced installing smart meters all around Victoria. It is projected to install about one million smart meters by the end of 2013. Meters installed in Victoria have been deployed with limited smart functionality that is being increased over time. This program is expected to cost $ 1.6 billion.

France

In France 300,000 meters were launched as a large experiment in 2008. Consequently, after return of experience, a target of compulsory deployment of smart meters for 95% of citizens by 2016 has been assigned. The general deployment phase, involving replacement of 35 million meters, was started in 2012 and continues through 2017.

Ontario - Canada

In Ontario, the Government passed legislation in 2006 establishing a new smart metering entity to implement the smart metering program. The Government of Ontario had set a target of deploying smart meters to 800,000 homes and small businesses, by the end of 2007.

Pennsylvania -USA

Six electric distribution companies have fully deployed advanced metering facilities with various levels of smart functionality, in Pennsylvania State.

Texas - USA

In Texas a project of implementing 2.4 million smart meters is being carried out and will be completed by 2014. A saving of $120.6 million is expected by the project during the surcharge period of 12 years.

Oregon - USA

In Oregon a project of deploying 850,000 meters was carried out from 2008 to 2010 enabling two-way RF AMI, remote connect/disconnect and etc. A saving of $18.2 million was expected during 2011 following the implementation.

The following table shows the capital expenditure incurred for each category of smart meter implementation in North America.

US$ million	2009	2010	2011	2012	2013	2014	2015	
Metering equipment	498	716	848	1,008	642	722	736	35%
Communication	356	511	606	720	458	516	526	25%
Installation and services	142	205	242	288	183	206	210	10%
IT integration and MDM	427	614	727	864	550	619	631	30%
Total	1,423	2,046	2,424	2,880	1,834	2,064	2,103	

Figure 4. *Smart Metering capital expenditure by category (North America 2009-2015)*

9. Key Challenges to Implementation of Smart Meters in Sri Lanka

Technical Challenges

The existing electricity system in Sri Lanka does not support both demand side management and decentralized power generation, since much of the transmission and distribution infrastructure we have today, is more than 50 years old. This aging grid infrastructure is a huge barrier to deploy smart meters in Sri Lanka, since it doesn't support handling large amount of data. Therefore the existing system must be upgraded, as well as a communication infrastructure also must be in place to support successful deployment of smart meters.

Workforce Resistance

Once the smart metering technology is deployed, a skilled workforce is required to handle the operations of the software based online systems as well as the data management system. Current workforce may be inefficient in this aspect, since new technology may be difficult to understand for the current workforce at the utilities, who may not have much experience working with data management systems and other software. Similarly, once the automatic meter reading facility and other remote operations are deployed, most of the current utility employees', specially meter readers' occupation will fall in risk, since their duties are covered by the new technology itself. Therefore a heavy resistance from the current workforce could be expected towards moving on to the smart meters. This will be the biggest challenge for the utilities to replace their employees once the new technology is deployed. Therefore the better approach is, training the current employees and making them expertise to handle the data management operations instead of recruiting new workers.

High Capital Cost

Although smart meters are definitely one of the tools being considered to fight many issues in electricity networks, it is still an expensive alternative. An advanced smart meter might cost $250 in United States, but in a developing country the same device could cost $1,500 because of low volumes and necessary rewiring. A full scale deployment of AMI requires expenditures on not only smart meters, but also all the other hardware and software components, network infrastructure and network management software, along with cost associated with the installation and maintenance of meters and information technology systems. Therefore implementing a mass smart meter rollout, especially in a developing country, would represent an enormous capital investment.

In this context, recovering the capital investment would be one of the biggest challenges, for a developing country like Sri Lanka. Therefore a cost recovery arrangement should be organized prior to commence meter rollout. The cost of meter rollout could be passed to the consumers or incurred by the utility. But, since the initial capital cost is extremely high, most successful method of recovering the cost is, including the cost of the meters in customers' bills through regulated network tariffs. And the best way is including regulated incentive arrangements designed to facilitate the efficient roll out of meters.

Consumer Resistance

Due to lack of understanding and knowledge among the public about the benefits over deploying smart meters and because of negative perceptions, initial resistance to the adoption of smart meter technology can be expected by consumers, as it represents a forced change in consumer life style. Also the consumers will be highly reluctant to offer their monetary contribution towards recovering the cost of meters. Therefore consumer awareness regarding the merits of using smart meters and societal benefits is needed very much, in order to meet this challenge and encourage consumers through mitigating resistance of public towards rolling out. Also consumer education is needed about the value of consumers' active involvement in electricity market, and the potential benefits for consumers.

10. Where are we now?

Sri Lanka has already declared its ambitions of introducing smart meters to Sri Lanka within a short time period. The Minister of Power and Energy has recently given instructions to CEB and LECO to explore the possibilities of up scaling the existing electricity grid to a Smarter Grid and of introducing electronic smart meters. And as the initial approach, even a pilot project has been embarked last year at the MPs official residences in Madiwela, which can be controlled through satellite technology from the parliament complex.

In Sri Lanka, most of the bulk consumers already use advance electronic meters, since the electricity tariff scheme introduced in 2011 has included the Time of Use (TOU) tariff for the industries. These meters are comprised with only few smart functions, which are; energy usage recording & storage facility accordance with the defined time slots and remote reading facility. Nevertheless, the remote reading facility of these meters is still used only in Colombo City region, where the other meters are

visited by the CEB officials to take down the monthly usage. The approximate cost of this type of electronic meter with remote reading facility is Rs.25,000 and without the remote reading facility the cost is around Rs.15,000.

Moreover, in 2010 the net metering was introduced, which has enabled the consumers to generate their own electricity and sell the excess to either the national grid. The electronic meter used under this scheme is capable of recording bi –directional energy flows as well as comprises the facility of storing the energy data.

11. Smart Meter Deployment Approach

A smart metering rollout won't happen overnight. Even the most aggressive rollout models would take a decade or more, since it takes time to establish the consumers' vision on the new concept. During the transition period, suppliers will have to face numerous challenges as explained by the previous section, as well as a lot of regulatory and standardization issues also have to be worked out.

The smart meter deployment approaches will depend upon the utility's starting point, geography, regulatory situation and long-term vision. Since the implementation of smart meters is a complex task with many difficult decisions and choices, a clear decision is needed at the early stage on which organization is leading on smart metering policy. The lead body could be government, utility company, a regulatory authority, or a state organization. In case of Sri Lanka, this could be carried out by Ministry of Power and Energy (MOPE), Ceylon Electricity Board (CEB), Public Utilities Commission of Sri Lanka (PUCSL) or Sustainable Energy Authority (SEA). And that leading body must undertake overall responsibility of rollout, and will need to act to ensure that the smart metering model developed a sound legal and regulatory framework. Similarly the regulatory authorities should review those regulations that hinder the development of smart metering and should actively promote demand response.

As the first phase of a smart meter rollout program, a pilot project should be launched in order to explore the performance of smart meter solution and to demonstrate the technology. Also, it is reasonable to say that smart metering should be started in the industrial sector and urban areas first. After the success of the project in those areas, it should be deployed intensively in the rural areas. Since smart meter rollout is a heavy investment, embarking a pilot exercise is very important to make sure that the system is effective and productive. At the same time a cost benefit analysis and an impact assessment including an analysis of the potential positive and negative effects of smart meter implementation, should be carried out. Impact assessment will be helpful to identify the measures required to protect consumers from the potentially negative impact as well as to take future decisions of smart meter implementation.

After reviewing the results of the pilot project, the leading authority can decide whether to go for a rollout or not. Prior to rollout is commenced, the minimum functionality and standards to ensure the interoperability of the smarts meters to be installed and specified, since functionality of smart meters is an important factor in determining the services that can be provided to customers through the smart meter, as well as the capacity of the smart metering system to serve the needs of market participants. Sometimes all the functions of the smart meters may not be able to deploy at the initial

stage. The better approach is dividing the function deployments in to two phases. In the earlier part, basic functions such as AMI and interval demand reading could be enabled to happen, and in the latter part the advanced features could be implemented as a run up to the smart grids vision. Moreover, a proper mechanism to recover the cost of meter implementation should be organized prior to the rollout.

The following chart is more pertinent for markets where there is an active AMI technology evolution.

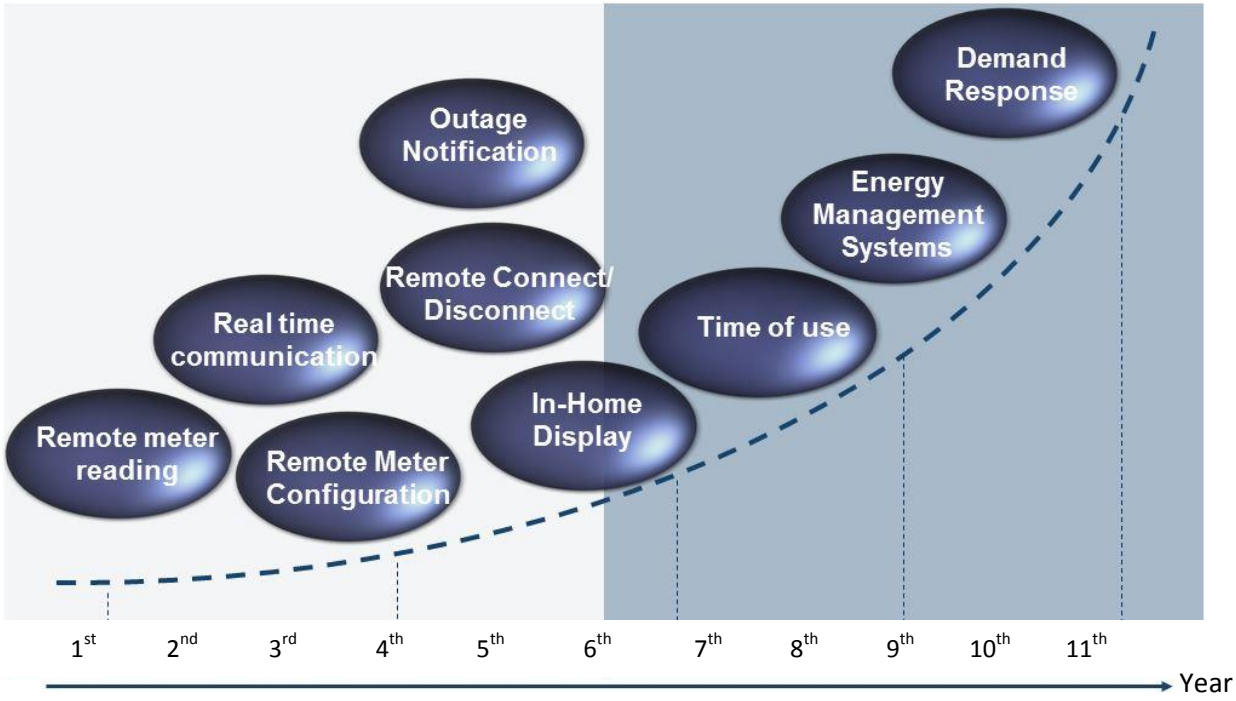

Figure 5. *AMI Technology Evolution*

12. Smart Meters - The First Wave of Smart Grid

Smart meters and their corresponding communications networks are the first wave of converting the existing grid to Smart Grid. Deployment of AMI is a crucial and fundamental first milestone in the development of the Smart Grid. Smart Grid is a transformed electricity transmission and distribution network, that uses robust two way communications, advanced sensors, and distributed computers to improve the efficiency, reliability, and safety of power delivery and use. Once the grid is made smart, power suppliers will be capable of managing the network more effectively while delivering the power quality necessary free of sags, spikes, disturbances and interruptions. Utility companies should keep their insight to move beyond smart metering and eventually to implement smarter grid, as their experience grows.

13. Conclusion

A key objective of smart metering is, to make customers more energy savvy, since the success of smart metering projects is largely dependent on the consumers, who choose in the first place to make an efficient use of energy and save their money. Energy savings and an increased security of supply will be main drivers, and believe in smart metering as a means to reach these goals is indispensable. Therefore, the consumer awareness of this equipment and know-how is very important in order to reap full benefits from it.

Deploying smart meters is the most potential applicable solution to cope with the energy crisis problem around the world. The main target of smart meter deployment could be different from country to country. Generally, smart meters help to enhance the flexibility of the relationship between the electricity supplier and the end user. And they are able to increase power system operational efficiency and to support power system control. Smart metering is not an energy specific phenomenon. It is part of a global trend towards the digital economy and the information society, which would provide a win-win proposition to the utility, regulators and the customer. From the wide acceptance of this concept around the world shows that, with no doubt this technology is mature and can be implemented on a large scale.

However investing in smart meters could be risky for consumers since the benefits of smart metering may accrue to other parties involved, than the ones that bear the cost. Therefore future of smart metering will depend heavily on the energy policy and decisiveness of the governmental bodies involved.

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