

## ADVANCE METERING INFRASTRUCTURE TECHNOLOGY AND CHALLENGES IN PAKISTAN

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### Abstract

In recent year's smart grid have become a very important topic of research. Smart grid is combination of different technologies working together with grid to provide better communication, efficiency and reliability. Smart grid technology is implemented all over the world in developed countries. Pakistan still uses the outdated technology for grids which needs upgrade to the smart grid. Smart grid can provide solution to the power crises that are faced at the present time. AMI is considered as the first step towards the building of smart grid as it serves the purpose of communication link between the utility and user. The information shared by AMI helps performing different functions like times based pricing, energy management, control of energy theft. This paper presents idea about AMI technology, challenges it faces, present situation of this technology and ongoing projects related to AMI in Pakistan. This study will be helpful in understanding how this technology can be used to solve the power crises problem present in Pakistan. Smart meters which are one of the component of the AMI infrastructure can be very helpful against the problem of power theft that is one of major issue in remote and tribal areas of Pakistan

**Keywords:** smart grid; AMI; AMI technologies; power theft.

### 1. INTRODUCTION

The 19th century is regarded as the century of inventions. The first half of the 19th brought brilliant discoveries in the field of electromagnetism. Electrodynamics interaction between currents was discovered by André-Marie Ampère in 1820. In 1827

the German Simon Ohm revealed the relation between current and voltage in conductor. In the year 1831 British Micheal Fraday discovered the law of induction which is the basic working principle of motors generators and transformers [1].

By the second half of the 19th century there were much inventions in the field of electrical field. However it was still not clear what should the bills of the units and the measuring principles of electrical energy. The earliest meter was made by Samuel Gardiner in 1872. This meter only measured the time during which the energy was supplied to the load. In 1882 Thomas Alva Edison constructed his electric meter which used the electrochemical effect of the current to measure the electricity called electrolytic meters. In 1884 Hermann Aron constructed pendulum meter using the rotation. Then as the discoveries came in field of electricity different scientists invented different meters. The American Elihu Thomsan prepared his meter using the motors in 1889 for General Electric. In 1889, the Hungarian Otto Titzsz Bláthy patented his electricity meter known as induction meter. In the upcoming years many improvements were made in the metering process. By the start of the 20th century three phase meters were made. In the year 1934 Landis and Gyr prepared the Trivector meter which could measure the active energy, reactive energy and apparent energy. Some standards and codes were made by IEC metering standards, the first metering standard was developed in 1910. In 1960 the remote metering come into existence [1].

In 1977 Paraskevako Metretek, Inc, which developed and produced the first fully automated, commercially available remote meter reading and load management system [2]. Smart metering is an

excellent way to provide solutions to the problems which were present in old metering system. One of the main advantage of this is the human errors that were made during the time of taking readings. The smart meter is similar to the traditional meter in many ways but the basic differences between the two meters is, smart meter can give us the reading at any instant of time and major benefit is that there is two way communication between the consumer and the utility.[3]

## 2. INTRODUCING THE CONCEPT OF AMI

AMI is the implementation of solution to the metering problems, which provides a two communication between the utility and the consumers. AMI is not a single technology, in fact it is a combination of different technologies intertwined into the present grid to transform into a smart grid. AMI proves to be an important link between the generation, transmission, distribution and load. AMI provides the benefits to the customers which they don't enjoy presently. AMI has gain much importance commercially and industrially because of its accuracy. [4]

## 3. SMART GRID

Smart grid can be thought of as the integration of the communication networks with grids thus improving the efficiency, security, reliability and safety of the system. It also includes the addition of the renewable energy sources such as wind energy, solar energy, bio mass and tidal energy into to the existing system. In SG the consumers not only use the electricity but also provides surplus power back to the grid, the smart meter calculate and measure the power. AMI is the first to step to the realization of the smart grid. The steps towards the smart grid shown in table no 1 [5].

## 4. TECHNOLOGIES USED FOR AMI

AMI system consist of number of technologies that work together as a system

**4.1 Smart meters** Conventional energy meters electromechanical devices which are placed at the user end mostly serve the purpose of calculating the energy used over a time period, which is usually a month. Smart

meters are electronic devices which can be programed. A smart meter should perform the following tasks [6]

Table 1. Steps towards the Smart Grid

<b>Advance metering infrastructure (AMI)</b>	Established the communication to the load side
	Provides information for the past event
<b>Advance distribution operation (ADO)</b>	Use AMI to collect the information about distribution
	Use AMI to improve the operations
<b>Advance transmission operations (ATO)</b>	Use the information provided by ADO to improve the operation and management of the transmission system
<b>Advance asset Management (AAM)</b>	Use the information provided by AMI, ADO, ATO to improve the efficiency and the utilization of the assets

**4.2 Communication infrastructure** Smart meters send information collected at the end user and send it to the operational center for analyzation and also receive of operation. Communication plays vital role in AMI. A highly reliable communication system is required for transferring the data. Different type of technologies can be used for the communication. Following are some examples

- Broadband power lines
- Copper of optical fiber
- Internet
- ZigBee
- Power line cables
- General packet radio service

#### 4.3 Meter Data management system MDMS

can be considered as a database with analytical tools that can perform interaction with other information systems. MDMS should also perform validation, editing and estimation on the data received from AMI to ensure the flow of the data [7]. MDMS interfaces with the following systems [6]

- Consumer information system
- Billing system
- Outage management system
- Power quality management and load forecasting system
- Transformer load management system.

The data collected by MDMS contains critical personal as well as business information, so the storage facility should be able to support any disaster and all required data should have a backup contingency plan and the facility should be designed according to it [8]

### 5. CHALLENGES IN INSTALLATION OF THE SMART METERS IN PAKISTAN

The industrial as well domestic demand of Pakistan is increasing day by day. With this growing demand there is much need to switch to new technologies. It is very hard as there are much challenges such as old transmission & distribution system, power theft, transmission losses, monopoly of the local manufacturers. To make the working of the home appliances easy, monitoring the grid, detecting non-technical losses smart meters have to be introduced

**5.1 Power theft** Electricity theft is not only the problem of underdeveloped countries but it is worldwide problem. Electricity theft of 6 billion US dollar was reported in 2012-2013. In 2013 its been reported to the senate of Pakistan that in last 5 years Pakistan have lost RS 90 billion to electricity theft and line losses [9]. Power theft can be reduced by installing overhead insulated transmission lines and installing smart temper proof meters. Efforts are being made to solve these

issues. In 2014 Pakistan issued orders to take strict actions against the electricity thieves [10]. K-Electric have introduced aerial bundle cable system to reduce the electricity theft [9].

**5.2 Financial issues** Huge amount of investment is required to build this structure. These funds are very hard to acquire and it is hard even for the utility companies to invest in AMI as there is no direct return of investment. AMI can provide solution to the problems of the underdeveloped countries but this would require a large amount of investment

**5.3 Monopoly of local manufacturer** Smart meters are not manufactured in Pakistan and the local manufacturing companies are not so much well equipped and advanced to manufacture the smart meters. As the introduction of smart meter would be big problem for them so they would not want this to happen.

**5.4 Lack of Interest by Government and Authorities** In 2015 Asian Development bank approved loan of 1.4 billion dollars for two year to solve the key problems in power sector. 990 million dollars were to use to build AMI structure for distribution companies across the country [11]. Ministry of power and planning commission canceled the bidding for installation for smart meters because they had concerns over the project design. Despite of fact that the local stakeholders gave negative response the finance minister went ahead acquired 400 million dollars in first phase in 2015. Since then two years have gone and there is not much progress to much issue and hesitation from power companies. The project is yet to be initiated but the 400 million dollar loan is already putting a load of 0.25% commitment charges on treasury [12].

**5.5 Ongoing projects in Pakistan** There approximately 23 million power consumers present in Pakistan, out of which 47% domestic, 30% industrial, 11.4% agriculture and 7% are commercial consumers. USAID have installed over 80 thousand smart meters in the country. USAID installed smart meter

in the 12 feeders of Niaz baig (Lahore) which reduced the distribution losses to 2%. Similarly GSM based smart meters are installed by USAID in some for areas of vehari for tube well users. They have also installed 84 thousand static meters and 42 thousand RF based AMR meters in PESCO which helped in increasing their revenue to 50%. USAID is working in the region of Faisalabad and Hyderabad to produce similar results. [13]

## 6. CONCLUSION

Pakistan faces problem in the energy sector related to billing, line losses and circular debt. All these problems can only be solved by upgradation of the present system. Efforts are being made by the Pakistan Government to solve the energy crises and few initiatives have been taken in this regard. AMI is considered as the first step for the building of Smart Grid. AMI enhances the recovery of money and reduces the circular debt of the distribution companies. Furthermore, it increases the system efficiency, reliability, control the power theft and reduce the line losses. This technology is still in its early stages and faces problems as financial issues, lack of interest by government and monopoly of local manufacturer. This paper helps to understand the importance of AMI technology, its structure and the ongoing projects.

## NOMENCLATURE

### Abbreviations

AMI	Advance Metering Infrastructure
SG	Smart Grid
ADO	Advance Distribution Operation
ATO	Advance Transmission Operations
AAM	Advance Asset Management
MDMS	Meter Data management system

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