

SMART METERING SYSTEM FOR ELECTRICAL POWER DISTRIBUTION

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INTRODUCTION

In the present scenario, the use of advanced technologies such as digital metering, use of IT in metering etc. has become extremely necessary to achieve greater efficiency, theft reduction to reduce AT & C losses and to improve revenue collection. The utilities and planners should now focus on best use of IT Technology to develop a full 'smart' system, which is capable of offering long term benefits and comprehensive solutions in addition to theft reduction.

Table 1 compares different metering/IT technology in terms of their capabilities. Digital meters have now become the norm for India. These improve accuracy, but still a lot is required to be done to make best use of these meters by switching over to Automatic meter reading for instantaneous bill generation and quick revenue realization. In the next phase the concept of load control/management according to power availability can be implemented by using these meters.

Fundamentally Information Technology is a means of creating, transmitting, analyzing and storing information. The use of IT in Metering started with the advent of Static (Electronic) Energy meters. These meters are microprocessors based. The programmability of microprocessor has enabled the meter manufacturers to incorporate various features like Tamper data, Import-Export metering, Time of day metering, load pattern analysis in these meters. The meters were made communicable. Various data can be gathered through communication Port (Optical Port) by a hand held device known as M.R.I.(Meter Reading Instrument). These data could be transported to the base computers at the utilities for onward processing and interpretation.

The advancement in Electronics and IT have enabled the utilities in transmitting information over the power lines themselves using Power line carrier communications (PLCC). Further the other networking options such as low power or high power radio links (Presently used in DTR metering in MP MK VV Co. Ltd.), telephone lines, mobile

communication, (GSM) along with modems for telemetering (Remote Metering) have also been used (The remote metering through GSM modems is done for 9 Nos. HT consumers at Mandideep, Industrial Area of M.P.M.K.V.V. Co. Ltd. Bhopal). The latest development which is under consideration for implementation is installation of Prepaid Meters for LT consumers.

In addition to above as per the present requirement with the introduction of New Availability based tariff, now the Company's aim will be to get developed a low cost fully intelligent smart meter, through which in addition to Automatic meter reading other monitoring such as load and voltage monitoring in the consumer's premises could also be done, remotely, from the control room of the utility. It is proposed that the latest IT technology in meters, for metering, billing and payment for such remotely scattered large number of retail customers, like the communication towers, repeater stations, branches of Banks, railway stations etc. may be employed by using the required modem and by using the proper communication links. This will reduce the problems of metering, reading, bill distribution and consequent payments by generating all the bills at one place and timely sending them to concerned organization's paying centres. This arrangement will benefit the utility as well as the concerned institutions. With the implementation of these IT interventions wide ranging benefits may be availed even in a BIMARU State like Madhya Pradesh.

1.0 Automatic Meter Reading (AMR)

It is a process of digitally "noting" the energy meter readings. This process eliminates the traditional "paper and pen" and the errors associated with manual reading/ recording/ processing of the meter data. Automatic Meter reading also makes the data recording fast and saves on time and hence complies with the definition of automation.

The AMR can be further classified based on the distance between the meter reading station

and the target meter. Firstly the local-AMR wherein a meter man goes to read the meter with a hand held device (MRI) for collecting the readings. Secondly, Remote AMR in which the meter is dialed from the central office using appropriate Modems to collect the meter reading from a distance. The pre-qualifier to both the AMR's is the communication ability of the energy meter.

2.0 Meter reading, a retro spection

Meter readings is the feedback loop for the utility's efficient operation and besides completing the revenue cycle, the meter reading provides vital data for the following utility operations.

- i. Billing
- ii. Energy Audit
- iii. Tariff formulation
- iv. Electricity regulator
- v. Load research
- vi. Grouping of feeder

We have switched over to intelligent electronic meters to avail its benefits. Now it is needed to change the meter reading process.

2.1 Benefits of A.M.R. to the utility:

- a) The time to access the site & time to read the meter manually will be curtailed.
- b) Meter readings will be accurate and human errors while reading, recording and data entry are eliminated.
- c) The accessibility obstacles to meter on account of location (Rural/Indoor) will be eliminated.
- d) Meter reading cost i.e. Number of Meter readers and transportation/travel related cost will be reduced.
- e) Risk/otherwise the insurance cost will be minimized.
- f) There will be a saving on seals and stationeries.
- g) The cash flow will be improved due to faster meter reading, bill preparation and distribution. There will be faster meter reading to cash realization.

- h) There will be improved vigilance as demand/overdrawl of the consumer will be readily available and any tamper recording will immediately come into notice.
- i) There will be quick detection of any defect in the meter.
- j) Consumers complaints on A/C of Meter reading/billing will be avoided.

2.2 Benefits of AMR to the consumers:

- a) Consumers can budget their expenditure on electricity by regularly keeping a watch on it.
- b) The reading date for each month can be fixed. The consumption period will neither expand nor shrink on a/c of variation of size of calendar month or due to any other reason.
- c) Total transparancy in Meter reading/billing is ensured.
- d) The bills through e.mail are available to the consumers for their connections which is not possible in manual bill distribution.
- e) Improved service quality,more choices and faster response time will eliminate consumer complaints and result in customer satisfaction.

2.3 Cost associated with manual meter reading

The cost headings associated with meter readings are indicated in Table-2.

2.4 Problems with AMR:

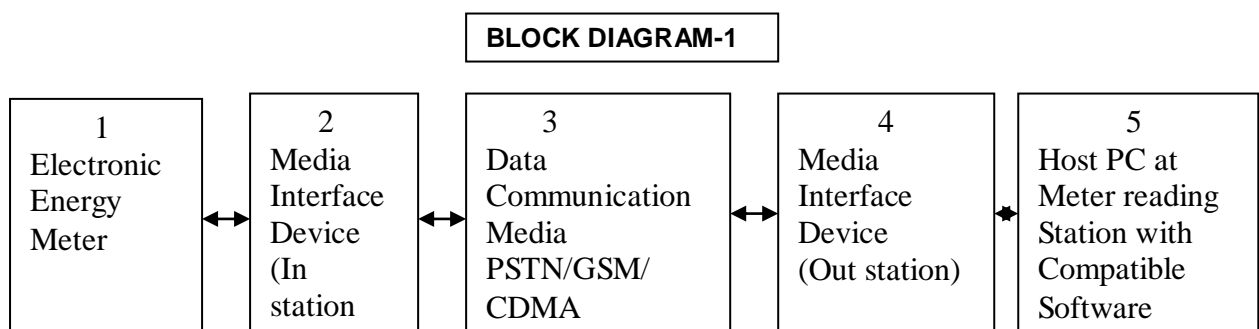
- i. Adoption of new technology may take time.
- ii. Physical site checking will be reduced.

These problems are meagre as compared to the huge benefits those are likely to occur.

3.0 The Remote Meter reading set up

3.1 R M R Block Diagram :

A typical Remote Meter Reading (RMR) set-up can be conceptualized using the following block diagram.



3.2 Electronic Energy Meter :

The basic pre requisite for RMR is the ability of the Electronic Energy Meter to communicate electronically. For mission specific applications it is advisable to have the energy meter which power from auxiliary power and would also communicate during power outages.

3.3 Media Interface Device (In-Station)

Media Interface device is a two port intelligent device which processes; stores and communicate the data stream, based on individual network needs connected at either ends of it. The selection of this block depend upon the communication media selected.

3.4 Data Communication Media :

Communication media consists of complex sub-elements like the local-loops on either side, series of intelligent switches, trunk-lines based on varieties of components like micro-wave, fiber optics or VSATS. There are two broad classifications of communication media as circuit switch communication network and packet switch communication network. While most of legacy applications work on the circuit switch network, the packet switch network is emerging rapidly, which is where the communication technology is heading towards.

3.5 Media Interface Device (Out station)

It is functionally same as explained in 3.3 above. It may be possible that in typical RMR setup the "instation" media interface device, may be PSTN and the "Outstation" side being GSM compatible, based on choice. It is advisable to power the media interface device from the meter voltage circuit (110V or 240Volts). For suspected customers it is also suggested to have a battery back up for the Media interface device.

3.6 Host PC with RMR Software :

The heart of the meter reading station is the software installed in the host PC for RMR. The software has facility to dial the target number, establish a data call, collect the meter reading and close the session. The modern version of software can be programmed for a meter reading schedule to dial and collect the target meter reading at the specified date and time. The aforesaid capability fully automates the meter reading process.

3.7 Various communication media available for RMR: The various communication media those can be used for RMR are :

3.7.1 Public Switch Telephone Network (PSTN) .

3.7.2 Wireless in local loop (WLL), which includes Global system for Mobile communication (GSM) or code division Multiple access or CDMA .

3.7.3 Dedicated radio link which includes Low Power Radio (L.P.R.) and High Power Radio (H.P.R.) based AMR.

3.7.4 Fibre optic/coaxial cable.

3.7.5 Power line communication and VSats.

The communication media is chosen after analysis of its :

- i. Cost
- ii. Availability
- iii. Reliability
- iv. Immunity to environmental/ man made disturbances
- v. Secrecy and ease of interface.

4.0 Financial Modelling and justification of RMR :

The utilities should also consider consumer value, life cycle costs and balance sheet issues in addition to current cost of labor while working out benefits of AMR. They should also analyse how consumer's view modernization and what they are willing to pay for it. Most financial modal today computes either the payback period or return on investment of RMR scheme. Both of these approaches are inappropriate. Pay back period is not proper because it takes a long time to install RMR System throughout to get the initial feeler. The aim of the utilities are normally not to earn more profit than allowed rate of return on investment. Few of financial models for AMR/RMR which are considered are detailed below.

4.1 Current Cost Model: In this to workout Payback-period, the increment at cost of RMR is divided by the annual cost of manual reading. If it is assumed that the annual Meter reading cost of a consumer is Rs.2000.00 and incremental cost for implementing RMR is Rs. 10,000/- then the payback period will workout to be 5 years.

A more accurate current cost model is difficult to work out as in it all the utilities functions are to be analysed for finding the real values which can be delivered by RMR. The data collection and inferring real benefits in Rupees is the real challenge. This figure again differs from one utility to other.

4.2 Life Cycle Cost Model: The underlying assumption is that AMR must have more value than stated in the current cost model. The reason being, the fixed investment on RMR equipment in today's Rupee is offsetting recurring labor cost which will inflate over the life of the equipment. It is argued that labor rate will not remain constant over the Next few years. This model requires detailed analysis showing relative costs of manual and AMR over the life of the program.

With all the assumptions modelled and appropriate factors included, a number of decision criteria are computed in a life cycle cost analysis. Break even period and ROI are some of the common parameters calculated.

4.3 Revenue Based Model :

RMR not only affects operating cost but also has the capability to increase revenue. It is even possible to use RMR to promote variable pricing or seasonal tariffs. There are several possible sources of revenue earning as follows, the combinations of which are expected to have a positive impact on the total revenue collected.

- i. Elimination of billing errors, reduced estimation and regular bills would improve cash flow.
- ii. Electronic monitoring will reduce the rate of theft rate due to meter tempering.
- iii. Detailed network flow data analysis would serve to identify other non-metered points on the network.
- iv. Automatic meter reading would quickly identify and locate meters which have gone defective, enabling the utility for their early replacement.
- v. Variable pricing may be used to increase consumption in off-peak periods, raising overall demand. RMR can be used for dynamic selling of power at opportunistic prices.

The modeling based on revenue, requires either heavy reliance on assumptions or an increase in rates.

4.4 Cash Flow Model:

Cash flow model considers the timing of money flowing from the consumer to the utility. In a macro view, crores of Rupees of the utility cash remains in the pocket of the consumers, until payments are sent. Key parameters in a cash flow model are ready to bill cycle, receivables and days-sales outstanding besides unbilled revenue. For weeks the utilities money remains with the consumers after delivering services, increase the capital cost and also poses a limit on investment and restricts the utility's operation. Cash is no less important to utilities as to any other entrepreneur. If cash is not collected from one group of consumers in a timely fashion, the burden be borne by the remaining which is socially not correct.

4.5 The Combined business model for RMR: The proposed model is realistic and simple to provide straight forward explanation to technocrats. The model tries to picture out distinct relationship between level of investment and level of value. A simple cause and effect diagram provides one word describing each of the attributes. The present benefits over a

period of 10 years are computed for RMR alternative, using telephone, GSM, CDMA or other commercial network.

The input and output diagram has no numeric value in Rupees, yet it provides the snapshot of increased value of with increased investment which is important for technocrats to understand.

Value Output	RMR
	Automation
	Speed
	Accuracy
	Access
	Electronic database connectivity
Equipment/ Cost (Input)	Saving on transportation and other travel expenses
	Network
	Software
	Network recurring cost

4.5.1 The model requires four annualized inputs and three fixed cost inputs which are easy to obtain rationally.

4.5.2 Annual Costs:

Annual input includes annual revenue and annual meter reading cost averaged over the number of consumers being moved to RMR. The real cost should include the entire meter reading expenses directly or indirectly associated with meter reading divided by total number of meters.

Annual cost is:

Annual Cost heading	Discription
Read Cost	Average yearly cost per consumer
Average Revenue	Average yearly revenue yielded per consumer
Inflation	Average inflation rate
Interest rate	Average interest rate

4.5.3 Fixed Cost

Fixed Cost	Description
Installation Cost	Average installation cost of RMR options E.g. modems, upfront money for telecom company etc.

4.5.4 Decision to Install R.M.R.

The above inputs can be fed to a spreadsheet to derive the business case. The final outcome i.e. if ratio of MMR/RMR is >1.0 ; one should immediately go for installation of the system. For cases $MMR/RMR=1.0$, it is balance bias, which can be made to tilt on the side "Go" should the utility believe in automation.

SCOPE AHEAD - PREPAYMENT AND SMART METERING

The recently developed prepaid meters for LT consumers are under consideration for installation in, some selected LT consumers. These meters have advantage of better revenue Management by increased cash flow, reduction/elimination of billing cycle. The customer satisfaction will also increase owing to budget control and ease of bill payment. Flexible tariff, Load monitoring, Load limiting and load management can be implemented by using these keyboard based meters. These meters can also ensure future proof integrated solution, enabling telephone, Internet and Web based vending.

Further now with the introduction of Power availability based tariff, the utilities should aim to develop and install fully intelligent smart meters which are capable to micro monitor and control every KWH across the system, in addition to automated remote meter reading. These meters should be made capable of monitoring load, voltage profile with additional capabilities like remote connect/disconnect and local level feedback for grid disturbances and accounting discrepancies, by using latest IT technology. In addition, such a system could offer consumers higher availability and quality of power, increasing their satisfaction and willingness to pay. If a full IT system is employed then instead of merely theft reduction, we could expect significant operational and cost improvements, in the power sector, especially if coupled to consumption equipment (appliances and Heating / Ventilation/ Air conditioning-HVAC systems). The demand side management could also be done through such a system by shifting the loads to off peak periods and there could be significant savings for the utility (who could avoid new peak capacity, especially from newer plants those are more

expensive) and to consumers, who might be receiving specialized pricing or might simply be able to receive more reliable and better quality power. To summarize an IT vision for India's power sector needs to be considered carefully with long term goals. The biggest requirement for long term benefits is a vision for how such a system would allow consumer demand management.

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TABLE-1					
Accuracy	Theft Detection	Communications	Control	Capabilities	
Electro-Mechanical Meter	Low(has threshold issues for low usage)	Poor	Expensive add-on	nil	Historical usages reads only Real-Time control; DSM
Digital(Solid State)	High	Node only	External Built in (on-chip)	Limited	
Next Gen. Meter (Proposed)	Arbitrarily high	High (network level)	* Can do much more than Automated Meter Reading (AMR)	Full (connect/disconnect); Extending signaling to appliances	

TABLE - 2	
Meter Reading : Cost drivers	
Cost heading	Sub cost headings
Man Power Cost	Salaries
	Risk and insurance
Bill Generation and distribution Cost	Data punching,distribution of bills, consequent delay.
Transportation cost	Cost of ownership (Vehicle)
	Variable cost (Fuel)
Opportunity Cost	Better deployment else where
	Vigilance compromised
	Customer service