APPLICATION OF AMI FOR UNSCHEDULED INTERCHANGE PRICING AND FAULT LOCATION

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ABSTRACT

Abstract: Advanced metering infrastructure (AMI) is an integrated system of smart meters, communications networks, and data management systems that enables two-way communication between utilities and customers. By incorporating AMI into the conventional grid, we get benefited by effective two-way communication between the user and the utility, and improved energy efficiency. Unscheduled Interchange charges can be reduced by controlling frequency. Under Smart Grid Environment Using Advanced Metering Infrastructure UI charges can be controlled or reduced. This paper describes application of Advanced Metering Infrastructure for Unscheduled Interchange Pricing and Fault location in smart grid.

Keyword: *Advanced metering Infrastructure, Two-way communication, Fault location*

1. INTRODUCTION

Power sector of India is trying to overcome issues like increase in energy demand, mismatch of supply and demand, issues of transmission and distribution losses, voltage and frequency stability problems. Intelligent component like Advanced Metering Infrastructure (AMI) of smart grid technology makes it possible to work traditional grid in smarter way by better utilization of information and communication technology.

Maintaining grid dripline is utmost importance for secure operation of any power system. There are penalties for deviating from limits of scheduled generation and demand. [1] To maintain grid discipline, Central Electricity Regulatory Commission (CERC) has introduced Availability based tariff (ABT) mechanism, based on the financial principals, wherein all the central sector generators and beneficiaries must declare a schedule for dispatch and drawl for every 15 minutes one day in advance. Any deviation from the schedule is charged at UI rates, which are frequency dependent. First component of ABT, the fixed cost consists of installation cost, interest on loan and working capital, equity returns, operation and maintenance cost, insurance and tax. Fixed cost depends on availability of plant. Second component of ABT comprises of variable cost, cost for fuel which is dependent on consumption of fuel and actual generation of plant. When there is a deviation from actual generation and deviation of frequency the third component of ABT comes into the picture. Third component is Unscheduled Interchange (UI). If frequency is above 50 Hz UI rate will be small and if frequency is less than 50 Hz UI rate will be high. ABT metering gives real-time monitoring of control of frequency. Another important application of AMI is fault location. Electrical transmission and distribution network is exposed to random and uncertain events like lightning, bridging by birds, failure equipment, ageing, etc. Protective relays located at both the ends of transmission line will sense the fault and immediately give the signal to the circuit breaker. Faults can be categorized as temporary (which is cleared by recloser operation) and permanent (which is not cleared after auto recloser operation). Majority of faults are single line to ground and occasionally double line or three phase faults. The traditional method of fault location in the transmission system is based on manual outage mapping using consumer's calls and customer's outage reports. It is time consuming and

requires manual intervention. Due to the developments in communication and the measurement field, number of new techniques for fault location has been proposed which are applicable to transmission and distribution network. These developments include, bidirectional communication between the utility and the consumer, access to real time data corresponding to the fault event. Methods proposed till now for fault location in electrical transmission network are not applicable to distribution network [7]. This paper is organized as; first section covers UI pricing in India, working of UI Mechanism, and ABT meter and second section covers Distribution Automation Scheme, fault location automation in electrical distribution system.

2. UNSCHEDULED INTERCHANGE

ABT comprises of following three components

1)Capacity charge 2) Energy Charge 3) UI charge

Before implementation of Availability Based Tariff, it was two parts tariff namely capacity cost and fixed cost. Apart from above two charges third charge is included by CERC, India in ABT for unscheduled interchange of power. [2] Frequency allowable limit is 49.5 Hz to 50.5 Hz. Deviation from schedule are determined in 15 min time block (96 blocks in day).

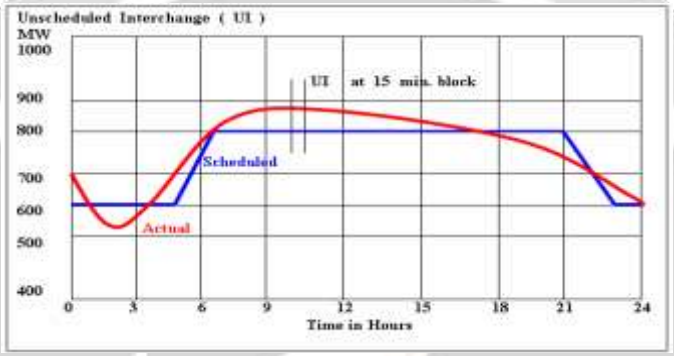

Fig-1 Unscheduled Interchange for 15 min time block

The UI mechanism is embedded with the availability based tariff mechanism. In this method, all the percipients need to monitor the frequency signals for drawl or dispatch purpose in real part. Any deviation from the schedule prepared by load dispatch centers has been charged with frequency linked UI charges as prescribed by CERC, Central Electricity Regulatory Commission.

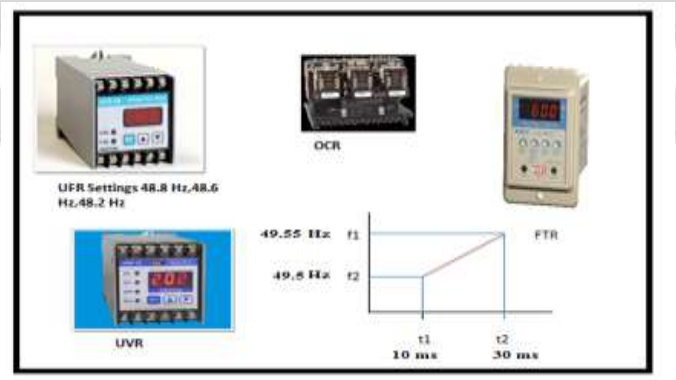

Fig -2 Traditional way of monitoring frequency and voltage.

CERC of India has been making amendments to these rates from time to time through its orders. [3] Deviations from Schedules are determined in 15 min time blocks through ABT metering. And these deviations are charged depending upon frequency. The corresponding UI rate is determined by taking average frequency for the same 15 min time block into account. The mechanism is working efficiently since 2003.One of the major drawback of UI mechanism is it does not take losses into account.

The relationship between the above UI rate and grid frequency, for the interstate system, is specified by CERC. When the frequency 50 Hz or higher, the UI rate is zero, which means that the generating station would not get any payment for the extra energy supplied. It would burn fuel for producing this extra energy, but would not get reimbursed for it at all. Conversely, if the actual energy supplied were less than scheduled energy, the generating station would still be paid for the scheduled energy (at its energy charge rate) without having to pay back anything for the energy shortfall. It would thus be able to save on fuel cost (for the energy not generated) and retain the energy charge as net saving. There is thus a strong commercial incentive to back down generation during high frequency situations, and help in containing the frequency rise.

3. ABT METERING

To maintain grid discipline, Central Electricity Regulatory Commission (CERC) has introduced Availability based tariff (ABT) mechanism, based on the financial principals, wherein all the central sector generators and beneficiaries must declare a schedule for dispatch and drawl for every 15 minutes one day in advance [10]

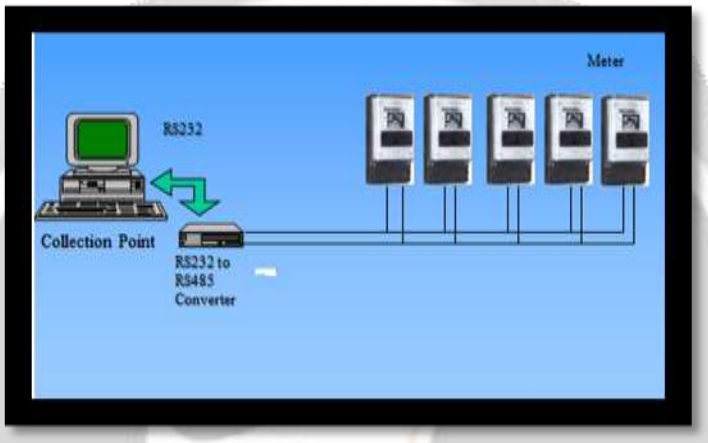

Fig-3 Availability Based Tariff Metering

Any deviation from the schedule is charged as penalty. ABT meter is smart meter which notifies change in frequency in real-time. following diagram shows ABT metering for state electricity

3.1 ABT and UI

Fig 4 shows ABT metering use for UI control and multifunction meter working. Using GSM technology all display parameters of ABT meter can be transfer to smart phone or other output devices like SCADA, LCD, RAM etc.

schedules are given by LDC, Load Dispatch Center which is used for the amounts payable as energy charges Deviations from schedules are determined in 15-minute time blocks using ABT metering, and these deviations are priced depending on frequency. If the actual generation/drawl is equal to the given schedule, payment because of the third component of Availability Tariff is zero. If under-drawl, a central authority is paid back to state utility for the frequency dependent rate specified for deviations from schedule.

3.2 Prioritization of load and its effect on economy of overall system:

Load A: High priority load. Load B: Medium priority load. Load C: Low priority load.

Total Load can be done by dividing load in three categories based on reliability, requirement Frequency change will be detected in ABT meter and third component of ABT can be controlled accordingly to apply UI rates given by CERC.At the same time engineer in control room will receive details on his smart phone about change in frequency

and control of load pattern required. Loads can be divided as per priority. load A is on top priority (Load of hospital emergency room, airport etc.) and it will never get cut whatever the frequency level

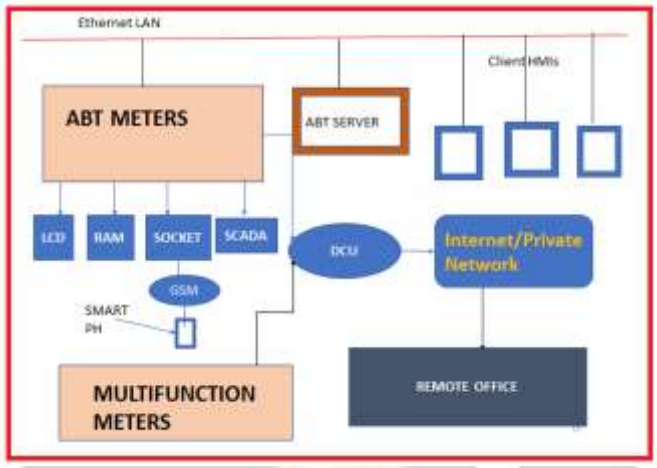

Fig -4 ABT metering

4. DISTRIBUTION AUTOMATION SCHEME(DAS)

Fault Management and System Restoration (FMSR) is one of the important function of Supervisory Control and Data Acquisition System (SCADA) or distribution Management Systems (DMS). Components of DAS are mentioned in [9]

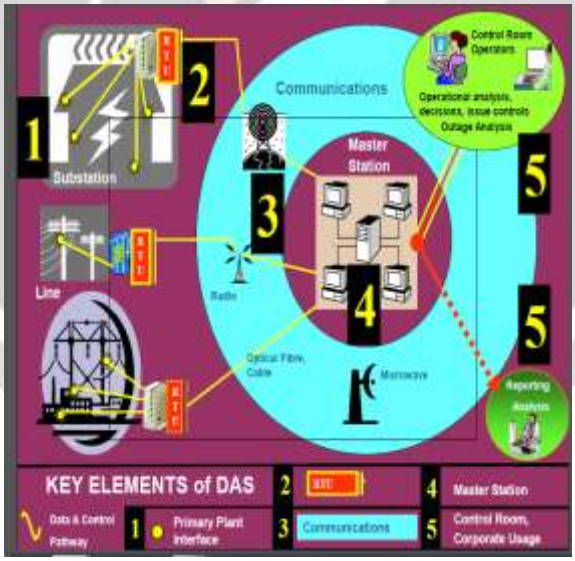

Fig -5 Key elements of DAS

4.1 Key elements

Communication: Multiple communication options used in DAS are as follows:

A. Between Substation to Control Centre

–Wired

•Optical Fiber

•Leased Line

•Power Line Carrier Communication (PLCC)

Wireless
•Radio
•Code Division Multiple Access (CDMA)
•General Packet Radio Service (GPRS)
•Very Small Aperture Terminal (VSAT)

1. Between Substation to Distribution Transformers

Wireless (Dialup)
•Public Switch Telephone Network (PSTN)
•Global System for Mobile Communication (GSM)

Wireless (always on)
•CDMA
•GPRS
•Radio

5. REMOTE TERMINAL UNIT (RTU) [2]

RTU is a microprocessor based electronic device. It interfaces objects in the physical world to a Distributed Control System or SCADA system by transmitting telemetry data to the system and/or altering the state of connected objects based on control messages received from the system. RTUs are more suitable for wide geographical telemetry, mostly it uses wireless communications, on the other hand, Programmable Logic controller (PLCs) are more suitable for local area control (plants, production lines, etc.) where the system utilizes physical media for control. [8] RTU monitors the digital and analog parameters in the field and transmits all the data to the Central Monitoring Station. It can be interfaced with the Central Station with various communication media (serial (RS232, RS485, RS422) or Ethernet).
RTU can support standard protocols (Modbus, IEC 60870-5-101/103/104, DNP3, etc.) to interface any third-party software

6. ISSUES IN EXISTING DISTRIBUTION NETWORK

Continuity and security of supply, Occurrence of outage are the major issues which can impact the revenue loss of the utility. Customers are suffered loss of production time. Implementation of network automation (Substation Automation, Feeder Automation) will overcome these issues. Government of India is working on it through Restructured Accelerated Power Development & Reforms Program (RAPDRP). The efforts are being taken to obtain best power quality and to reduce outage time and cost to the utility as well as its customers. There are two approaches for reducing the outage time, I. By improving Medium Voltage (MV) network, which can be done by dividing it in large number of short sections and by installing reliable components. II. By improving MV network management, which can be done through installation of Fault Passage Indicators (FPI) or, remote controlled load break switches, or fully automated reclosures and sectionalizes.

6.1 Reclosing and Sectionalizing:

An Automatic Circuit Recloser (ACR) is a pole mounted circuit breaker which is used to protect overhead distribution lines. It is effective at restoring the supply after the occurrence of a transient fault. Approximately 70% of faults that occur on medium voltage overhead lines are transient. A Load Break Switch can be used in conjunction with an ACR to sectionalize a faulted section of line and allow the ACR to restore supply to healthy sections in the case of a permanent fault.

6.2 **Fault Passage Indicator (FPI):** FPI identifies the passage of fault current. Identification of a faulty region becomes easy by using it. It makes fast fault location possible. It is suitable for distribution cable network.

7. CONCLUSIONS

The mechanism adopted for provision of frequency regulation using control of third parameter of ABT can be automated using Advanced Metering Infrastructure. In this paper frequency regulation issues based on pricing linked to UI has been discussed. In second half of paper various components of DAS has been mentioned. Issues in existing distribution network and means through which those can be minimized. Using AMI into the conventional grid, effective two-way communication between the user and the utility is possible, AMI with android platform provides real time data, remote monitoring and information about any equipment failure in the system, natural accidents etc.

8. ACKNOWLEDGEMENT

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