

# *Design and Implementation of Smart Distribution System in India - Benefits*

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**Abstract:** With increase in the use of electricity, the expected demand of electricity in country like India has been tremendously increased in recent years. The demand is continuously increasing with the increasing population and hence it becomes very essential to monitor the usage of electricity by each consumer appropriately. The objective of this research proposal is to carry out a new smart system which could monitor the usage of each individual through a direct online system. Thus, for the said objective creating a Smart Distribution System will be very helpful. Smart distribution system can be very effective in a very densely populated area where metering the electrical usage of consumers becomes a tedious job. Also detecting fault location through Smart Distribution network will be of great advantage. The said proposal is primarily focused on to develop smart distribution system for city like Mumbai where the population in any specific locality is very dense.

**Keywords:** Smart Distribution system, metering, fault location

## **I. INTRODUCTION**

It has been forecasted that the Indian economy will set to reach a double digit figure in recent year, though it is about 7 to 8% [1] in 2014. But India is struggling from the power shortages which is about to get worse because the demand has been reached to its peak with a tremendous explosion of population in India. There are problems like the installed capacity is not adequate to cope up with the demand resulting into power cuts for several hours and also lack of transmission infrastructure has not even connected several villages to the national grid. 15-20% [1] power is lost in the process of transmission and distribution because of low level of voltage transmission. Almost 10-20% is itself lost to theft across the different utilities in India [1].

In India, after the passing of Electricity act '2003 [1] a drastic change is taking place in Indian Power sector and due to which the power distribution utilities are going through the phase of improvement to manage the regulatory changes in the field of power sector starting from customer satisfaction to reliability of supply [1].

It is also seen that in order to minimize the carbon content many countries have started to accelerate towards the smart grid technology. The smart grid has become a vital part of new growing network. The smart distribution grid is a part of the smart grid, differentiating the traditional grid and smart grid from each other as the distribution network, which is made direct user oriented [2]. This is an important factor to control and improve the quality of users main power supply. It was found that 95 percent of power cuts are seen in the distribution network itself [2]. Also a sufficient amount of loss in power is also seen. This loss can be almost 50 percent [2]. In order to cope up with such losses intelligent distribution network finds itself as an important sector of Smart Grid. Smart grid is a sophisticated and digitally improved power system in which new communication and advanced technologies leads to much greater advantages as compared to conventional systems [1]. According to Chenbing Wei [3] Smart grid is the new technology which utilises the sources of Information Technology in power systems in order to achieve some features like self healing, interactive, optimization and compatibility.

Therefore such situations lead us to develop and implement the Smart Grid Technology. A smart grid technology would help the distribution company to know about the consumer's information about the electricity use and required demand on an average required by the consumer. The smart distribution system will enable us to use the smart devices which can be beneficial for detecting faults and theft. These smart devices can be useful for the consumers also in order to know and manage the energy consumption properly. Such a twitchy intensification will need unique amount of energy that can be only achieved by efficient energy consumption through smart devices and smart distribution grid technology [1]. The distribution system is very complex network in which the fault detection, direction of current after fault occurrence, amplitude of current etc are some factors which has to be taken care off.

## **II. LITERATURE REVIEW**

According to Pang Q, Gao H and Xiang M [2] the conventional distribution grid differs from smart grid in every perspective. The smart distribution grid has basic need of a unit to realize the information communication and self healing technique. The traditional feeder end unit cannot fulfil such requirement of smart distribution grid and must be placed with more sophisticated terminal unit. The said researchers has proposed smart distribution grid as per the need and has designed intelligent terminal unit based on fault finding, protection, location, separation and reinstallation algorithms for smart distribution grid [2]. The research paper shows that the complete system has been composed of different elements such as "Sub-Station, Switching station, Ring main Unit, pole mounted switch, micro grid, distributed generation, intelligent terminal unit, Global Positioning system and communication network" [2].

The structure so designed for such smart distribution grid by these researchers is as shown in the diagram below,

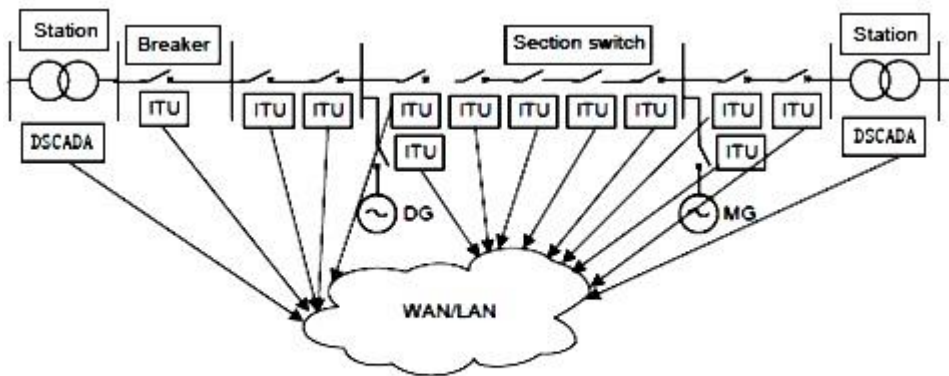


Figure 2.1 : - Structure of Smart Distribution grid [2]

As per the above sketch, a typical system was designed for simulation process and it was found that the ITU ( Intelligent terminal Unit ) was capable of achieving relay protection, fault location, fault isolation, power restoration and fault diagnosis of the feeders. In such innovation, ITU played an vital role of, interaction of information. The ITU had following components as shown in the figure below,

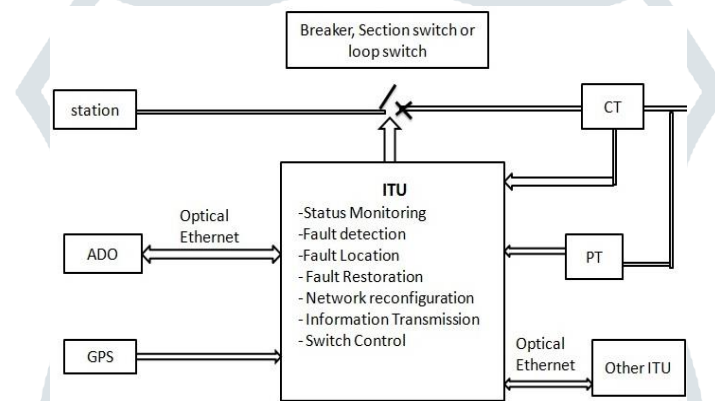


Figure 2.2: - ITU basic components [2]

Depura S, Wang L, Devabhaktuni V and Gudi N [4] has suggested use of smart meters in order to make the distribution network more advance. As suggested by these researchers, the smart meter is an unique device which is used for providing added information to the utility companies as compared to conventional meters. The smart meter so designed had the advantages such as real time energy consumption information, value of voltage, phase angle and frequency which can be securely communicated with the server. These meters are capable of communicating and executing the control commands as instructed remotely or locally [4]. At customer's premises this meters could help the customer in monitoring and controlling the home appliances. They were capable of measuring electricity consumption from grid, decentralization of generation sources and energy storage devices and charge the customer as per usage [4].

The author explains how still in many developing countries, the conventional energy meter are still being used for charging the customers. For the sake of better operation of home appliances, monitoring of grid, reduction in load shading, power quality improvement, better sharing of load, identifying non-technical losses smart meters can be used in developing countries in order to improve the distribution system [4].

As suggested by above authors in their research paper, efficient management of grid can be a better perspective then revamping the existing grid. The design, maintenance and deployment of such meters involve number of technical issues and challenges and require a billion dollar investment in it [4].

As per the theory suggested by Lasseter R.H in 2011, the smart distribution system should have the integration of Distributed Energy Resources (DER) [5] along with the concept of microgrids. Also the author explains that the DER method is beneficial in distribution system in order to reduce the distance (physical and electrical) between the generation and the loads. The DER method focuses more on reducing the losses that occur in transmission and distribution. It was seen that about 6% of transmission and distribution losses occurred in Portugal [5] in the same year the overall consumption was about 18 TWh. With the help of DER, 20% of load would have resulted into reduction in losses which would be 216 GWh [5]. The author also suggests that smarter distribution can be achieved by implementing hundreds of individual DER units.

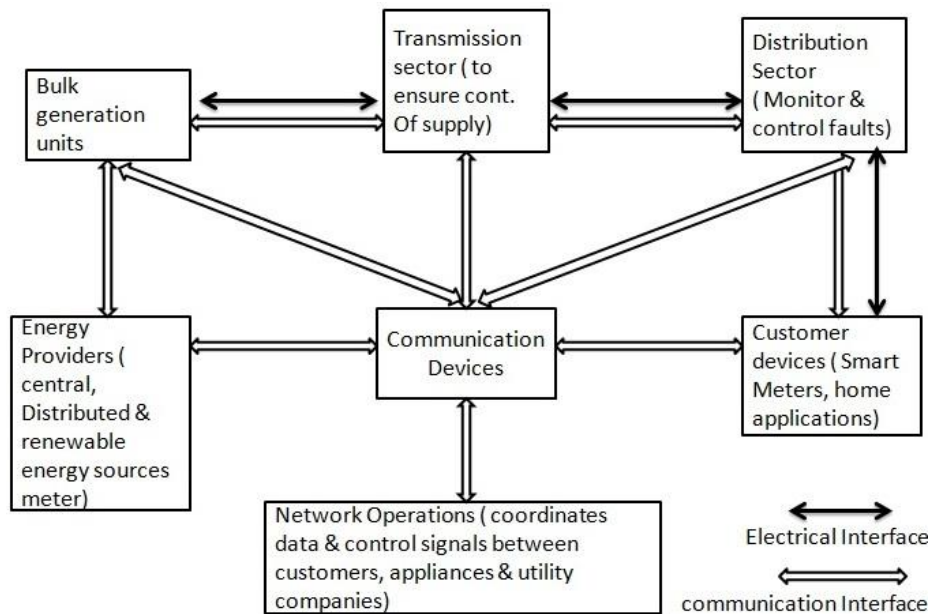


Figure 2.3: - communication network for smart meter [4]

As suggested by Sinha. A, Neogi. S, Lahiri. R.N, Chowdhury. S.P. and Chakraborty. N [1] for improving the distribution grid system in India, the focus should be made more on “*Advance Metering Infrastructure, Meter Data Management, Geographical Information system*” [1]. This will lead to the opportunity to increase the level of customer service and improve the operational efficiency [1]. The author also suggest that implementation of Meter Data Management is a new technology in Indian power utility. The above said sets of elements are found to be important as per the author in order to improve the stability, reliability of a smart grid.

Richard E Brown [10] has also explained above mentioned methods of improving the distribution system in his research paper. In his paper he has focused on different methods such as Advanced Metering Infrastructure (AMI), Distribution Automation (DA) and Distributed Energy resource (DER). He states that the above mentioned methods are some of the unique methods which can be integrated in smart Grid.

Different methods for improving the distribution system are been suggested, and are implemented in real world, though there is scope for improving the distribution network and make it smart in order to overcome difficulties that are faced by the consumers at the end.

### III. CONCEPT

In city like Mumbai, the population density per square km is almost 65,000 on an average [6]. Take for example, from the statistic it is believed that Mumbai suburbs which has area of 386 sq km has a population of 28, 00,000 which is served by the distribution company RInfra [7]. From such statistics it is clear that the distribution network for such populated cities becomes very tedious. A large number of employees are required to carry out the process of fault detection, tallying power consumption, energy meter reading etc. It does become time consuming process in order to serve such a huge population. Thus the main objective of carrying out such an important project is to implement a method for improving the practices that are carried out in the distribution sector. This can be improved by implementing the Smart Distribution system.

The objective would be to design such a smart device of distribution which could reduce the time of fault detection, reduce the load shading occurrences, increase power systems reliability, and improve the operational efficiency. Also such objective will also tend to reduce the distribution capital investments, reduce the failure of equipment at distribution side, reduction in the distribution maintenance cost, reduction in distribution operation cost, reduction and detection of electricity theft and electrical losses and reduction in SO<sub>x</sub> and NO<sub>x</sub> emissions. The overall said idea for improving the distribution sector in India will play a vital role and will be beneficial for the future because the demand of electrical usage will keep on increasing day by day and being a utility in the competitive world, managing such a huge amount of customers become equally important.

IV. ANALYSIS

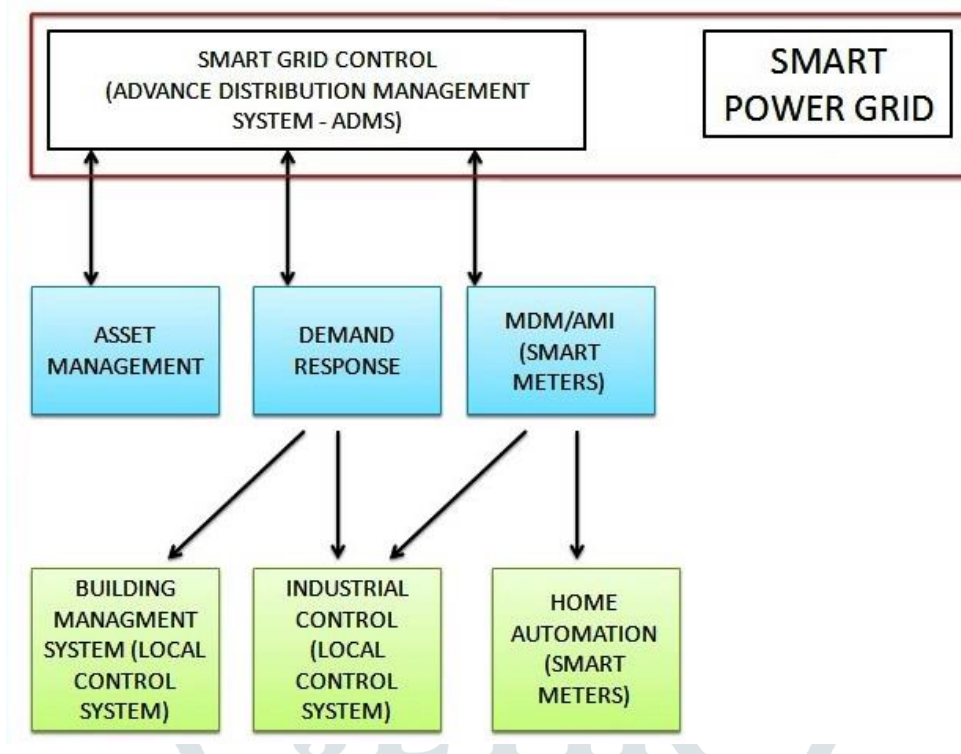


Figure 4.1: Proposed system

The above concept could be beneficial in making the distribution system in India mainly in much populated cities like Mumbai & Delhi in which the smart grid control (mainly consisting of Advance Distribution Management system) and Smart Power Grid work in coordination to overcome the difficulties which arises in conventional methods. The Local control system in Industries, buildings and houses share the information on their control unit and smart meters with the ADMS. The ADMS in coordination with the Power grid make required changes in order to inculcate the requirement or any other error.

Thus it could be a matter of concern that a lot of changes would be required for setting up a complete new arrangement. When talking Smart power grid, a lot of automation will be required, similarly each consumer would have to change the metering setups or the distribution set up's would have to be improved in order to make the system more smart which would be beneficial at the end of the day. The table below shows the cost effectiveness or the amount that we can save after the initial investment of the system.

TYPE OF BENEFITS	DISTRIBUTION AUTOMATION MANAGEMENT SYSTEM TOOL	SAVING PER YEAR(% OF ANNUAL INJECTED ELECTRICAL ENERGY)	SAVING PER YEAR (RS/METER/YEAR)
REDUCTION OF ENERGY LOSSES	OPTIMAL FEEDER RECONFIGURATION, VOLT/VAR CONTROL	1%	120-180
REDUCTION OF NETWORK OPERATION COST	FAULT MANAGEMENT AUTOMATION	1.25%	195
REDUCTION OF NETWORK CONSTRUCTION COST	NETWORK CONSTRUCTION, PLANNING & LOAD FORECAST	2%	240-360
IMPROVED POWER QUALITY	VOLT/VAR OPTIMIZATION	1%	150-180
<b>TOTAL BENEFITS</b>		<b>5.25%</b>	<b>915 (APPROX)</b>

Table 4.1: Benefits of DAMS tool in INDIA

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