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Distribution Automation System: India's Prospects

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ABSTRACT: The restructured and deregulated power sector in India has been reconstituted into Generation Company, Transmission Company, Distribution Company and Power Trading Company. All the restructured components in the deregulated power sector as primary objectives namely reliability improvement, high efficiency, revenue generation and operational cost optimization which benefit both customers as well as utility. One such sector of power sector which directly benefits customer as well as Utility by reaching their primary objectives is Distribution System. Distribution System has been automated with adaptation of information technology enabled communication system based technology with derived advantages such as minimum human machine interface for reliable, quality and safer distribution of power supply to the consumers from the utility, these technological enabled initiative is termed as Distribution Automation System [DAS]. This research paper illustrates India's position towards adaptability and implementability of Distribution Automation System for its future energy management and customer satisfaction.

KEYWORDS: Distribution Automation System [DAS]

I.INTRODUCTION

INDIA country with 1.21 billion population with rising middle class households and forward looking youngsters hungry for technologically driven initiatives alongside with all the categories of power consumers, demanding for high quality reliable uninterrupted power supply for their daily basic needs and business. India consists of more than 100 metropolitan cities housed in 28 States and 7 Union Territories which has population ranging from 0.4 million to 12 million based on their geographical area and age of these cities. These metropolitan cities are hubs of all the commercial, industrial and business activities of the country which generates enormous employment, revenue and foreign direct investments making a path for increase in GDP growth rate of the country [1]. Thus providing quality reliable uninterrupted power supply for the citizens in these metropolitan cities are been treated as primary objective and responsibility of power distribution companies.

Power sector in India is facing severe generation and demand gap during normal and peak hour operations by its utility. Thus Indian power industry is facing reliability crisis in the domain of customer satisfaction. Reliability can be defined as the how probable that a power system operates without any failure or interruption of power under normal mode of operation. Reliability Indices such as Customer Average Interruption Index [CAIDI], System Average Interruption Duration Index [SAIDI], and Momentary Average Interruption Duration Index [MAIDI] are the actable part of index's which demonstrates Utilities capabilities to satisfy their customers in terms duration per interruptions and frequency of these interruption occurring in a feeder or complete Utility. Reliability of utility varies from utility to utility because of factors such as weather, terrain of utility, load density, voltage levels, age of the utility and its circuits, and also methods adopted for reliability analysis calculation Reliability indices are benchmark indicators of system health, customer satisfaction and technical preparedness of the utility to counter any system operational obstruction. Reliability indices namely CAIDI and SAIDI are the parameter of interest in terms of customer

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satisfaction and Utility operational health status.[2][3][4]. Distribution Automation System can be defined as computer aided integrated system which includes monitoring, controlling, protecting and metering of various distribution system equipments and their parameters at one control center using application such as Supervisory control and data acquisition system [SCADA]. Distribution Automation Systems operation involves real time monitoring, data acquisition and state estimation of each components in the field. Distribution Automation System involving automation of distribution outgoing feeder from the distribution substation connected to the load terminal. Distribution Automation System [DAS] involves components namely Distribution Feeder Reconfiguration, Feeder Reconductorizing and Fault Detection, Isolation and Restoration [5][6][7].

II. INDIA'S POWER SCENARIO

India with rapid rise in population with decadal growth rate of 17.64% with population of 1.21 Billion (as per census 2011) having per capita consumption of electricity at 778.71 kwh which makes our country to stand at 14th place in the world per capita electricity consumption, where USA stands first with 17053 kwh as per 2009-10. Per Capita Electricity Consumption and Per Capita Steel Consumption of any country are the measure of actual growth of that country in terms of per capita consumption per head. At present India stands fifth in the world in terms of installed capacity for power generation at 223.625 GW and generates 876.887 Billion Units [BU] at end of fiscal 2011-12, which can be broken down into Hydro-electrical power generation is 130.510 BU, Thermal power generation is 708.806 BU, Nuclear power generation is 32.286 BU and imports from Bhutan stands at 5.285 BU which has been demonstrated in figure 1.

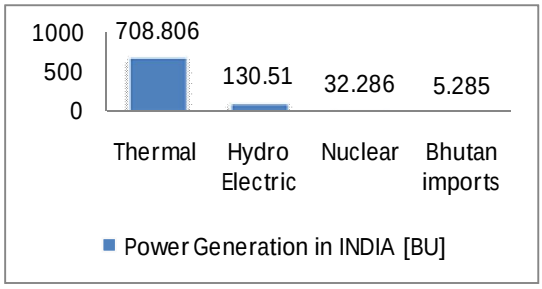

Fig 1 Power Generation in India [Billion Units]

In India power is generated by utilizing various sources of energies such as coal, diesel, and Gas which constitutes Thermal source of energy, India is the country with as thousands of rivers where power can be generated by proper channelizing of water such mode of power generated is knows as Hydro Power. India with rich thorium base possessed in its coastal area and member of nuclear supplier group added its power generation by acquiring Nuclear Energy for its energy needs and Renewable Energy Sources in India are very rich and abundantly naturally available at large scale and hence generating power by using renewable energy sources as taken momentum in the country. Table 1 below as demonstrated total installed power generating capacity of the country with their respective shares and sources of energy.

Installed Power Generation Units	***Installed Capacity [MW]***	***Percentage (%)***
Thermal	124730.98	65.4
Hydro	38848.40	20.4
Nuclear	4780	2.5
Renewable Energy Sources	22233.17	11.7
Grand Total	190592.55	100%

Table 1 Installed Generation Units in India as on 29-2-2012

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India's main thrust area of power management is to reduce the peak demand [MW] and energy consumption [MU]. Central Electricity Authority of India as brought forwards its annual report on "Load Generation Balance Report" for 2013-14 in which it as stated the energy management data for the year 2012-13, illustrated in the table 2 below which demonstrates power generation-demand deficit/surplus management dynamics of India [8]

Power in India	*Energy [MU]*	*Peak [MW]*
Requirement	9,98,114	1.35,453
Availability	9,11,209	1,23,294
Surplus / Deficit	-86,905	-12,159
Percentage	-8.7	-9.0

Table 2 Dynamics of Power Generation- Demand of India

III. DISTRIBUTION AUTOMATION SYSTEM

Distribution System Automation is the technological module which involves automating entire distribution system for the purpose of monitoring, controlling and data acquisition of entire distribution system to maintain stability in the grid through DAS Master Control Center which receives and sends data via communication network involving microwave signal mediated through satellite by sensing data's from the Remote Terminal Units [RTU] at the field via Very Small Aperature Terminals [VSAT] from each section as demonstrated in the figure 2 below involving Distribution Automation System Module for two parallel Distribution Feeders.

Distribution Automation System involves Substation Automation, Distribution Feeder Automation and Customer End Automation. The figure above demonstrates Distribution Feeder Automation which involves concepts such as Distribution Feeder Reconfiguration, Feeder Reconductoring and Fault Detection, Isolation and Restoration [FDIR] modules embedded in it. Distribution Feeder Reconfiguration and Reconductoring are the agents of DAS for distribution loss minimization occurring due to configuration errors or mismatch while drawing cables and due to the unpredictable loading aspects. FDIR is the heart and soul of DAS module which brings down the interruption outage time and area just to the momentary time by eliminating fault portion of the feeder from operation and simultaneously keeping healthy portion of distribution feeder operational [9][10][11].

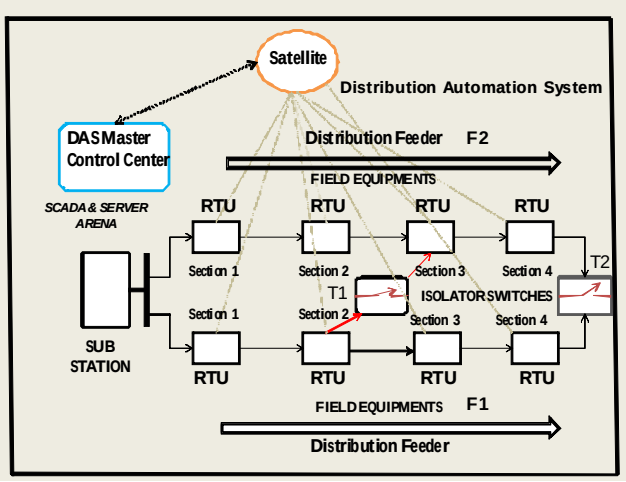

Fig 2 DAS Module for Distribution feeder Automation

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IV. DISTRIBUTION SYSTEM OPERATIONS IN CONVENTIONAL MODE

Table 3 below illustrates the operations of the distribution System operations in Conventional mode which can be regarded as pre-DAS implementation Stage. In the figure 2 above consists of two feeders namely F1 and F2 both containing four sections namely S1, S2, S3 and S4 along two isolator switches T1 &T2. In the conventional mode of operation during normal operation of feeders all switches in sections will remained Closed "C" and isolators remains Opened "O", since power will be flowing normally through all the four sections of either feeders. But during the fault stages in Cases mentioned in the table, if fault occurs in Feeder 1 then all the switches of Sections gets "O" opened thus causing black out for entire feeder F1. Similarly in case of Fault in feeder F2, here also all switches of sections gets "O" opened and keeps other feeder switch "C" closed. In conventional Mode of operation, detection of faulty part of the feeder will remain unknown, since all the switches in that section gets "O" Opened simultaneously. Here Isolator switches T1&T2are just used for emergency services and operated manually.

	Normal		Fault Stage		Fault Stage	
	F 1	F 2	F 1	F 2	F 1	F 2
S1	C	C	O	C	C	O
S2	C	C	O	C	C	O
S3	C	C	O	C	C	O
S4	C	C	O	C	C	O
T1	O	O	O	O	O	O
T2	O	O	O	O	O	O
Status	**Normal Mode**		**FI Feeder Fault Mode**		**F2 Feeder Fault Mode**	

Table 3 Status of Isolator Switches in Conventional Mode

In the conventional mode of operation of distribution system, international standard time for fault detection, isolation and restoration stands at 58 minutes per permanent contingency fault which constitutes detection of faulty part of feeder, patrolling time and restoration time. Hence conventional mode causes interruptions to healthy part of the feeder due to activation of relays in substation suspending entire feeder from operation.

V. DISTRIBUTION SYSTEM OPERATIONS AFTER DAS IMPLEMENTATION

Table 4 below illustrates the Distribution System Operations after DAS implementation through the status of Isolator Switches in the network. In the DAS mode of operation during normal operation of feeders all switches in sections will remained Closed "C" and isolators remains Opened "O", since power will be flowing normally through all the four sections of either feeders. But during the fault stage in Cases mentioned in the table, if fault occurs in Feeder 1 at S2 location, the switch at S2 gets "O" Opened automatically and gets isolated from rest of the feeder sections not interrupting any other sections. Here as soon as occurrence of fault at S2 Location will generate automatic path for flow of power by "C" closing isolator switches T1 and T2 automatically with in momentary time due to technological capabilities of DAS. Thus DAS will prevent interruption to healthy part of the feeder and so notify the section at which fault occurrence eliminating patrolling time for detection of fault section in the feeder. Similarly if fault occurs at Feeder F2 at section S3 same process of fault detection, isolation and restoration operations explained in Feeder F1 procedure will follow automatically.

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DAS	Normal		Fault Stage		Fault Stage	
	F 1	F 2	F 1	F 2	F 1	F 2
S1	C	C	C	C	C	C
S2	C	C	O	C	C	C
S3	C	C	C	C	C	O
S4	C	C	C	C	C	C
T1	O	O	C	C	C	C
T2	O	O	C	C	C	C
Status	**Normal Mode**		**FI Feeder S2 Fault Mode**		**F2 Feeder S3 Fault Mode**	

Table 4 Status of Isolator Switches after DAS implementation

Necessity of DAS

- To have Real time monitoring, control and supervision of entire operations of distribution network
- To have reliable uninterrupted power supply to the consumers
- To minimize outage area and time during occurrence of fault in the system
- To improve reliability of the Utility
- To lower operational cost of the system
- To reduce power loss both in terms of Transmission and Distribution losses and Aggregated Technical and Commercial Losses.
- To have higher efficiency in the system
- To mitigate power theft in the distribution network.

VI .AUGMENTATION FOR DAS IN INDIA

Outage Time Management

The measure of quality power supplied by the utility to the consumers also includes uninterrupted power supply as most important factor. In the figure 3 below illustrates the power outage time in the developed country in terms of minutes /year mainly USA, UK, France, and Japan where power outage duration stands at 90, 72, 58 and 11 minutes / year. But in India minimum outage duration of single utility such as Bangalore Electricity Supply Company [BESCOM] stands at 86.2 hrs / year and average outage duration of entire country stands more than 200 hours / year [12]. Very High outage time indicates the need for adaptation of fast response technological modules in the system to reduce outage time to the International Standards in par with the developed countries standards.

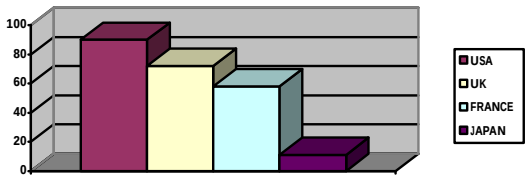

Fig 3 Outage Time (Mins per year)

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Minimization of System Losses

High Transmission and Distribution Losses in the Indian System are posing serious threat to Indian Power Market which needed to be addressed in large scale to scale down the losses to International Standards. In the figure 4 below illustrates All India Transmission and Distribution [T&D] losses and Aggregated Technical and Commercial [AT&C] losses for the period mentioned [13]. The gap between T&D losses and AT&C losses stands at 2%. International standard of losses in the system shall be around 7% but in the context of India it stands ranging from 25 to 32 % in past one decade. These losses have come down by few percent due to Government initiatives in the area of Transmission losses. Even after such initiatives losses are very high marking an urgent need to implement many technological measures to reduce losses, one such measure is Distribution Automation System, which plays vital role in reducing Technical and Commercial losses in the distribution network.

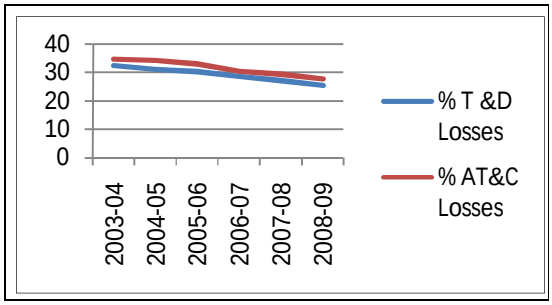

Fig 4 All India T&D and AT&C losses [%]

Distribution Automation System is a Multi-agent Communication based system which monitors, controls and regulates entire distribution system for optimal distribution losses. DAS will be instrumental in optimizing system losses, system reliability improvement, customer satisfaction, mitigation of theft, avoidance of metering errors and sinking power in the system. Electricity Act 2003 has entitled and entrusted lots of responsibility to State Electricity Boards [SEB] for system optimization which includes DAS, Smart Grid, Automating Meter Reading, and SCADA system.

Optimization of Cost of Power in India

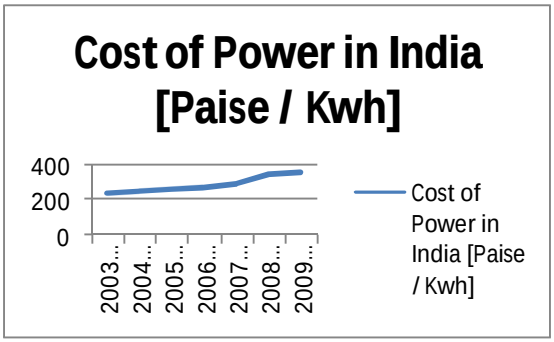

Fig 5 Cost of Power in India [Paise /Unit]

Widening gap of Current Account Deficit and Balance of Trade in India is one of indicator that indicates India is country with large imports than compared to exports. One such component that Indian import receipts reaches 70 percent of total imports is Oil and Power Component such as oil, High Quality Coal and Liquefied Petroleum Products. Figure 5 above shows the graph of cost of power in India which is increasing every year by a large margin. Due to the unaccounted theft of power, high system losses and very high cost of operations is major component which fueling

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increase of cost of power every year. Increasing cost of power in India has become major share holder for high rate of inflation in the country and increases all the products which are manufactured and serviced in India.

Automation of entire distribution system in India will be instrumental in decreasing system losses in distribution feeder as well as negates unmetered and unrecognized flow of power in the system, which benefits Utility in scaling down the operational costs as well as generating cost of power in India. Efficient Utilization of power and Best practice of energy management can be only solution to reduction cost of power in India, these can be achieved only through planned and adaptation of high end technology which is their in the form of Distribution Automation System. This will surely bring down our system losses to International Standard and benefit both utility as well as valued customers.

VII .CONCLUSION

Distribution Automation System is the technology of today which will become technology for tomorrow for any developing nation to sustain and maintain their energy needs for their future. Distribution Automation System will enable Utility to know their system condition, system parameters, Customer energy needs, and status of field equipments. Distribution Automation System for India is not the Myth but the truth which will enable Indian Utilities to scale down their Transmission and Distribution [T&D]losses, And Aggregated Technical and Commercial [AT&C]losses to International Standards. The implementation and adaptation of Distribution Automation System in India will increase operational efficiency of Utility, High Reliability, Customer Satisfaction, Optimization of cost of power, revenue generation, trapping of sinking revenues, availability of operational data's, safer operation of system, Utilization of skilled manpower and low operational cost of utility.

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