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Economic Benefits in Power Distribution through IT & OT Case Study of Tata Power Delhi Distribution Limited (TPDDL)

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Abstract: The Generation, Transmission and Distribution of Delhi were responsibilities of Delhi Vidut Board (DVB) and this entity was running in huge losses and thus was not able to provide the desirable services. Power Distribution requires efficient operations through latest technological interventions. Poor supply of power, pilferages through illegal connections, elongated outages and customer grievance were few important factors which led to the privatization of Transmission & Distribution (T&D) in National Capital.

In year 2002, the privatization was done for T&D in Delhi and various Delhi regional zones were awarded to three distribution companies – TPDDL, BRPL, and BYPL. BRPL and BYPL were the companies of Reliance Group and TPDDL was Group Company of Tata Group, the renowned business groups of India. Power distribution has now become a role model for public–private partnership (PPP) in India and this happened not only in the power sector but also in the other sectors. This achievement was mainly through winning the customer confidence involving techno commercial innovation.

Information and operational technology plays crucial role for improvement of efficiency, reliability and cost optimization in various functions across power sector. IT intervention like web enabled payment avenues, payment through e- commerce site, Automatic Meter Reading, Geographical Information System (GIS), and Enterprise Resource Planning (ERP) improves the commercial and business process. Similarly operational technology like Distributed Control System (DCS), Supervisory Control and Data Acquisition System (SCADA), Distribution Management System (DMS), Outage Management System (OMS) and Demand forecasting and Load Shedding / Scheduling improves reliability, customer satisfaction, error free operation and increase in un-served energy.

This case study is on TPDDL and is likely to be beneficial for all the electricity consumers, private and government power companies to understand the relevance of Information and Operational technology in Power distribution sector. This study is a showcase that how loss making entities can be turned into profitable ventures and how long blackouts are now approaching towards 24x7 uninterrupted power supplies in National Capital Region.

Keywords: Automation in Power Distribution, Smart Grid, SCADA, Distribution management System, Tata Power Delhi Distribution Limited (TPDDL)

INTRODUCTION

TPDDL is a JV company between State Government and Tata Power, with the majority stake owned by Tata Power. Total population in Delhi is around 15 million and it serves around one third i.e. five million. Peak Demand of Delhi is around 6000 MW which is sum total of Power demand of other metro cities i.e. Chennai, Kolkata and Mumbai.

Aggregate Technical and Commercial (AT&C) losses³ level in India are at an average level of 25%. The States like J&K, Uttar Pradesh, Bihar, Sikkim and North eastern states have 40-65% losses. In Delhi, the losses have fell down from 53 per cent to approximately 11 per cent beating the world average of 15 per cent along with major improvements in the reliability of network and consumer services. Thus Delhi is most efficient State w.r.t transmission and distribution network and this has been possible through IT&OT interventions.

Delhi per capita consumption of electricity is best amongst all States and Union Territories of India. TPDDL meets around 1600 MW of peak load and operations spanned across an area of 500 sq. km. The Delhi Electricity Regulatory Commission (DERC) has issued the license for the distribution and supply of electricity for a period of 25 years. The power regulations of the entire power sector of Delhi is done by DERC including the establishing of performance norms and tariff chargeable to all type of consumers. DERC also refers prevailing norms for other State utilities and the expectation of stakeholders (Society, Tata Group, regulatory norms, employees etc.) before finalizing the norms for State capital.

After a major and continuous improvement in performance, T&D privatization of Delhi State had become model for other regulators and utilities. TPDDL is mainly operating in North Delhi region and Power outages in this region are down from a regular five hours a day to near zero and revenues were up by 70 per cent. The company is continuously relying upon its high-tech automated systems and further improvements are required to be made in its distribution network to make Delhi as a smart city.

REVIEW OF LITERATURE

India in the 21st century has set a target to have many smart cities, phase –I list is out with around 33 cities spread across various States. Lot of infrastructure improvements will be required and huge expenditure has been kept aside from Central budget for making this dream a reality. Better Power distribution is going to one of the key requirement for all these cities. In India distribution is still controlled by manual and complicated processes, inadequate controls, less transparency, less customer focus and pilferages etc. IT & OT has enormous potential to transform T&D sector in India, if to be compared with many global distribution utilities (Ms. Vebhav Gupta, 2012, IJCBR).

Development and Introduction of best standards is required by close coordination of Government and industry groups. The work of National Institute of Standards and quality (NIST) and Associations like International Electro-Technical commission (IEC), Electric Power Research Institute (EPRI) and trade groups all contribute to establishing definitions and specifications for grid devices. The move to smart grid is not a revolution but an evaluation. (Jeff Meyers, 2013, Schneider Electric)

Elimination of defective meters, proper billing and better collection mechanisms are basic requirements for power distribution system to work efficiently. Recently in past, our State utilities have taken various steps for reduction in AT&C losses in the distribution system. We can only bring down AT&C losses to a

level of 7-10% and cannot eliminate in totality. The gap between generation and utilization should be less so that there is an improvement in our economy. (M. Kiran Kumar, Kadiyala Venkata Sairam and Rayavarapu, 2013, IJETT).

Automation in distribution provides ample benefits like getting maximum output and efficiency from all the equipment's working in the system, increased revenues, labor & material savings and reduction in O&M expenses etc. There is demand supply gap and it is increasing by 15-120% every year, if not much plants are coming on generating side, it becomes more important to give thrust on efficient power distribution to avoid the power crisis. (PV Chopade, BE kushare and Dr D.G Bhardwaj- Australian University Power Engineering conference, 2005).

Delhi government used to provide a subsidy/support to DVB to the tune of Rs 1500 Cr per annum, before the privatization took place (As on date terms, this support is equal to around Rs 3000 Cr). Thus State has saved around Rs 40000 Cr in last 10 years and the same would have used in other sectors like flyovers, hospitals, metro and stadiums etc. (Delhi Power Sector Reforms- A position paper).

There are many challenges that power discoms are facing as on date. The operations information system (OIS) helps in implementation of computer systems used as interface with power systems. Through this system real time monitoring for the distribution and generating assets can be done and there is a close coordination amongst operators. IT as tool allows the sharing of information through tabular charts, diagrams and easy management. (Anil Johri, WCECS-2007, San Francisco, USA).

In India we use AT&C losses but in the developed countries T&D losses are calculated as there are negligible commercial losses. T&D losses in %age for various countries in year 2008-2010 are as below;

Countries with losses less than 7%	Australia, Austria , Bangladesh, Belgium, Germany, Iceland , UAE, United Kingdom, United States of America , Japan, Korea , Israel and Italy
Countries with losses between 7%-15%	Bahrain, Belarus, Bolivia, Jordan, Ukraine, Turkmenistan, Uruguay , Uzbekistan, Georgia , Honking, Indonesia
Countries with losses between 15%-25%	Algeria, Azerbaijan, Kenya, Tunisia, Brazil, Iran and India
Countries with losses >25%	Iraq, Haiti, Botswana and Albania

Source: International journal of Scientific and Engineering research, Vol-4, Issue-9, Sep-2013

RESEARCH OBJECTIVES

To understand relevance of IT & OT in power distribution of National capital region Delhi

- a) In reducing the pilferage in electricity and the customer grievances.
- b) In providing reliable and affordable power round the clock to consumers of Delhi.
- c) In terms of commercial benefits

METHODOLOGY

The case study is a qualitative research methodology and is case base paper of TPDDL. Literature review was carried with study of around 20 papers on the subject matter. This was followed by personal interviews of employees of the TPDDL Company at senior, middle and ground level management officials.

BACKGROUND

The residents of New Delhi in 2002 were resistant towards the privatization of the power distribution and it was a barrier for the Delhi Government, as consumers were not willing to pay for electricity, considered as necessity and perceived to be borne by the State government.

The reform process in power distribution sector in New Delhi was the first of its kind in India and Tata Power had an opportunity to gain initiative advantage. To achieve the vision of supply of reliable power to consumers through reengineering and change management, TPDDL began its journey, considering that external forces were the only challenge. The power distribution sector of India had miles to go thus it was a huge challenge for the private companies to ensure supply of 24x7 quality electricity which in turn will improve the lifestyle of residents of New Delhi.

By early 2004, the State of Affairs of the Electricity Board in the North and North-West Delhi started turning round. TPDDL revamped the entire network through its run–repair–replace policy, upgraded the information technology (IT), reengineered the entire revenue cycle Management process, automation infrastructure and established a performance management system to make the employees accountable.

TPDDL also established its Center for Power Efficiency in Distribution to train its employees and upgrade their capabilities making them adaptable to the IT and automation initiatives undertaken post takeover.

The entry of a Tata group company in power distribution business was to turn around the image of the electricity business. It gave consumers the hope of reliable power. The IT & OT involvement in power distribution system through inclusion of Automation systems, SCADA, distribution & outage management systems and geographical information system (GIS) were the TPDDL initiatives for automation. Some other initiatives includes web based billing system, Automated meter reading and Automatic Demand Response Systems.

Tata Power Company took a lead in bringing and adopting latest technology in the power distribution systems. Together with the culture of consumer service excellence, continuous learning, performance orientation, innovation, and empowerment, it was able to set benchmarks of the accelerated reduction of AT&C losses and enhance consumer satisfaction. The workforce of TPDDL was an amalgamation of employees from erstwhile DVB (under Delhi Government) and new employees recruited after takeover.

TPDDL had its own Government of India accredited training center – Centre for Power Efficiency in Distribution (CENPEID) – for in-house training as well as training of the personnel of other distribution utilities. Over the years, CENPEID became the ‘mecca’ of TPDDL because of rigorous training provided to unskilled and non-qualified workforce after takeover from DVB in spite of resistance from these employees for training due to lack of work culture.

TPDDL had many firsts to its credit for innovative and successful adaptation of advanced technologies to upgrade from a conventional power system to a modern smart power system. These included SCADA and GIS applications, automatic meter reading (AMR), global system for mobile (GSM) switching, geographical information systems (GIS) and SAP-integrated asset management, CAP on TAP project, distribution management system (DMS)/ distribution automation (DA), outage management system (OMS), Secondary Data Centre, and many more. As the power distribution companies in New Delhi were allocated

distribution licenses to operate in different geographical regions so there was no direct competition for capturing the business of each other rather there was a competition on performance aspects. There was an additional pressure on the leading branded business groups of India i.e. Tata and Reliance to perform better in New Delhi. Further, better performance helps the extension of license period in future.

RELEVANCE OF IT & OT

A) Role of Supervisory Control and Data Acquisition System (SCADA)

SCADA revolutionized the way electricity was distributed in New Delhi and had streamlined the process of Power Distribution. There were evident positive outcomes in the first few years of SCADA functioning. TPDDL needed to sustain the momentum and improve its revenues on an ongoing basis. The government needed more focused efforts in order to replicate this model in other states across the country. Other Public private projects (PPPs) were looking at TPDDL as successful example. As far as the various stakeholders of setting up SCADA were concerned, these included regulatory authorities, employees, Tata management leadership team, civil society, consumers, and other utilities. SCADA helped in understanding the importance of technology in an organization and how it could help companies to improve functioning. TPDD highlighted the PPP model and its increasing popularity as a success strategy, thereby achieving the effective management of aspirations of multiple stakeholders. In addition, the importance of employee training programs and the effective deployment of resources under a changing environment was also emphasized adequately. Sustainability through triple bottom line i.e. Economic, Social and Environment aspects were emphasized in the management philosophy of TPDDL. There was an improvement in the business model with the IT working as an enabler to serve the needs of a large population. There was also a visible impact on the overall effectiveness as well as efficiency levels of TPDD as a result of this initiative. The successful implementation of SCADA was due to effective utilization of manpower, ease of use and interaction with the consumers.

B) Usage of IT for Business Process Transformation

Business process redesign is a critical aspect of change management which lies at the heart of organizational transformation. Managing change is never easy and TPDD sought to remove redundancy for consumers as well as DERC by setting up SCADA. Use of technology as a strategic tool to revolutionize power distribution in India has a number of social implications for society in addition to the achievement of the primary objective of increasing efficiency for TPDD. Prompt correction of power-related issues also creates the perception of an honest and efficient electricity distribution system which morally discourages the unauthorized use of electricity. The PPP model with TPDD as a private partner enabled the Delhi government to utilize world-class services of a highly intensive IT company. The major benefits of SCADA are lower cost of distribution, reliable and affordable supply of electricity. SCADA functioned as a centralized automated facility for the distribution of power. It was based on the ideology of the strategic use of IT to facilitate the business process. TPDDL also undertook business process restructuring exercises to establish industry benchmarks in service delivery to customers along with ensuring revenue improvements for the company. This, in turn, enabled the social welfare expenditure programs of the Tata group to function in an appropriate manner. It was based on an intelligent use of IT to facilitate the process. Usage of IT& OT had played an important role in terms of achieving consumer satisfaction, quality and safety and increased

revenue. Automation and redeployment of the workforce in different operational and commercial sections led to effective and efficient operations and accurate billing and collections. In the pre-takeover stage, during power outage, consumers switched to diesel generator (DG) sets which ran on petroleum fuel with a very high cost in India; hence, consumers found a cost-effective substitute for electricity. Due to reliable power, consumers were indirectly benefitted by saving on petroleum fuel costs or inverter-installation costs.

(C) Technological Innovation

TPDDL analyzed the existing IT assets during its inception and to its amazement, found only two personal computers being used immediately after takeover. At the same time, consumer base with high per capita consumption provided a ray of hope to improve the future revenue. Commitment from the central and state governments in terms of Accelerated Power Distribution Reform Program (APDRP) supported TPDDL to invest in new technological development projects.

In order to win the confidence of consumers, TPDDL initiated a number of customer-centric initiatives and extensively used IT for building a smart distribution network. It led to its technology innovation along with its business/strategic objectives. TPDDL investment in technology has been driven with a road-map to serve better and system improvements. The company laid down a separate IT budget for each year.

(D) Geographic Information System (GIS)

GIS integrates software and hardware, collects, manage and analyze data, displaying geographically referenced information. GIS helps and allows to view, get knowledge, ask questions, analyze and visualize data in several ways that gives relationships and trends in the form of shapes, figures, reports and maps. Power discoms are required to keep a comprehensive list of inventory of assets, both as a part of normal service provision and their obligation to inform third parties. Complexity involved in distribution power system requires introduction of information technology - GIS that carries out various complex power system analyses in a short time (ex - load forecasting, fault analysis, networks optimization). With the usage of GIS along with company system software's helps in design and to analyze power distribution network. The objective of the distribution network design process can be divided into three independent parts.

- Load Forecasting
- Design of Secondary Design of Primary System Load Forecasting System
- Design of Primary System Load Forecasting System

(E) Distribution Automation System

The quantities like voltage, current, temperature and oil level etc. in a distribution automation (DA) system, are recorded in the field at transformers and feeders using a data acquisition device called Remote Terminal Units (RTU). Through a variety of communication media, these system quantities are transmitted on-line to the base station. The media can be wireless or wired. The field data are processed at the base station and is displayed through Graphic User Interface. An alarm is automatically generated for operator intervention in the event of a system quantity crossing a pre-defined threshold. Any control action like opening or closing of the circuit breaker is initiated transmitted from the base station through the communication

mode to the remote terminal unit associated with the corresponding circuit breaker. The desired switching action then takes place and the action is acknowledged back to operator for information.

Implementation of distribution automation system improve reliability, reduce outage time to customer and reduce man made error.

Flow of IT related intervention in TPDDL in last 15 years

TPDDL has used IT extensively for ensuring O&M in its area of operation. The various IT interventions, introduced in chronological order, have been detailed below:

- I. FY 2002–03 :** Implementation of homegrown online Decentralized Energy Billing System (DEBS) connected from its central server to all consumer care centers and cash collection centers with central server. The companies own website (www.tatapower-ddl.com) was introduced and billing and consumption data of all its consumers was made available on its website.
- II. FY 2004–06:** SCADA compatible Grid Substation Automation System (GSAS) for 66/33/11 kV grid stations was implemented. Implementation of GIS was initiated for sub-transmission network along with mapping of the entire asset base. DEBS was modified for development of Bulk Billing Software (BBS) and AMR for consumers having load greater than 100 kW on HT network. In-house software Automatic Meter Reading Data Analysis (AMRDA) was developed to analyze the data downloaded through AMR. Primary Data Centre (PDC) was established. For smooth functioning at the back office and strengthening the revenue management system, software applications SAKSHAT and RMS were rolled out along with offline collection modules at cash collection centers. Also, SAP ERP system was implemented for other business functions including Finance and Controlling (FICO), Material Management (MM), Project System, etc.
- III. FY 2007–09:** In the year 2007, SCADA was implemented across all grid stations with control facility at Centre for Network Management (CENNET). The control of entire grids system was centralized and remote monitored. Subsequently, GIS was implemented with an aim to make arrangement for the implementation of Distribution Management System (DMS). GIS was also integrated with SAP to have effective maintenance management. The same year a home-grown work flow based CRM application SAMBANDH (Building Relationship) was implemented. The software was, based on business process reengineering and integrated all modules/ commercial processes, with the provision of auto escalation of parameters and performance assurance. The software was integrated with all major applications such as DEBS, GIS, SAP-R/3 and SAP BW. The software and modules were enumerated in table below:

<i>Module name</i>	<i>Abbreviation</i>	<i>Usage</i>
Customer Care	CCM	Complaint/ request registering/ tracking with provision of informing the customer about the status through SMS/ call center/ Interactive Voice Response System (IVRS)/ website
Connection Management	CMM	Maintaining record related to new connection, reconnection/ disconnection requests
Meter Management	MM	For meter installation/ removal/ replacement/shifting/ testing

Revenue Collection	RCM	Payment-related complaints handling, payment collection, and enforcement bill
Revenue Recovery	RRM	Disconnection advices for payment defaulters
Revenue Discipline	RDM	Enforcement cases , misuse of electricity cases, legal cases, and compliance to court orders
Record Management		Stores documents and images during processing of request

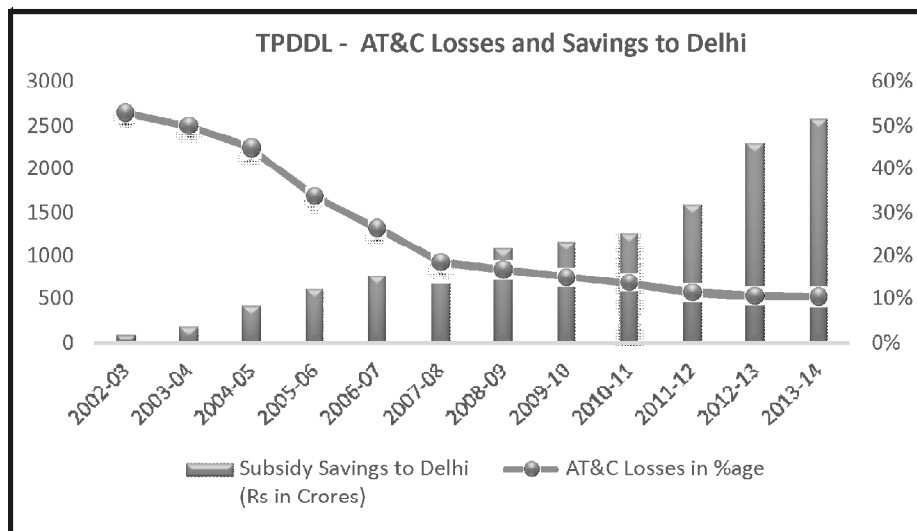
IV. FY 2010 till 2017: Automation of the last mile of distribution network has been major focus area of TPDDL during this period. DMS (in 9 out of 12 districts wherein all 700 points have been automated) was introduced for optimal handling of any network contingency and ensure faster restoration of network. Implementation of DA system aimed to identify and isolate the faulty section and restore network from SCADA center in minimum possible time. OMS has been interfaced with various systems in utility so that the availability of accurate historical data on outages faced by the customers in the past shall help to ensure prompt restoration of outages.

In April 2011, SAP Industry Solution for Utilities (ISU) was implemented. This has facilitated online accounting of sales and collection without any manual intervention. The application has been seamlessly integrated with other applications like OMS, GIS, AMR, HHD, Spot Billing, IVRS, Payment Gateway, Lab testing M/c, etc., and with other ERP modules.

TPDDL has also been able to establish a Unified Call Centre (UCC) for attending to ‘No Supply’ and ‘Commercial Complaints’. Further, with the increased dependence on IT, it became necessary to ensure 100 per cent system availability. Thus, a Secondary Data Centre (SDC) has been established to ensure smooth operation of business critical applications in case of any hardware failure.

Results and Continuous Improvement

- The introduction of all these measures has helped to decrease the overall AT&C losses of TPDDL from around 53 per cent in FY 2002 down to around 11 per cent in FY 2013 of which technical losses may be considered to be approximately 8 per cent.



- Success of the power distribution in various States across India will largely depend upon the inclusion of more and more automation. A well planned approach with skill development initiatives for human resource are likely to yield better results i.e. reduction in AT&C losses.
- For the sustainable improvement in the sector local community and social aspects are equally important. Social Aspects includes the healthy and safe working and operating environment of transmission and distribution.

CONCLUSIONS AND WAY FORWARD

It is amply clear that there are numerous benefits of IT & OT in power distribution sector and all leads to economic benefits in the long run. Some of the benefits are a) Optimization of manpower resources b) Reduction in theft and pilferage c) Peak saving and grid stabilization d) Reduction in human error and increase in safety e) Increased customer satisfaction. Total Savings to State Government is to the tune Rs 30000 Crores.

In our country though the above said technologies are used by the major IPPs, Power Distribution Company and power transmission companies, the fruits of implementation is not materialized fully. This is due to the fact that the IT and Automation (Operational Technologies) remain as standalone system and not integrated with each other as per the operational requirement. Though the Govt of India has initiated lot of scheme like R-APDRP (Part –A), IPDS and Smart city initiatives, Indian power Sector has to go lot of miles to get the fruits of these technologies.

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NOTE

1. AT&C losses are sum total of commercial losses, technical losses and shortages due non realization of billing amount.

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