AMR DATA FOR PLANNING

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ABSTRACT

Tata Power has deployed Automatic Meter Reading (AMR), Distribution Automation (DA), Customer Relationship Management (CRM), Geographic Information System (GIS) etc for effective and efficient operation and planning of its Distribution network. Tata Power has deployed Automatic Meter Reading System for Commercial & Industrial consumers. The data from meters is collected using Meter Data Acquisition System (MDAS) & stored in Meter Data Management System (MDMS). The MDMS is integrated with Business Analytics system, GIS & CRM to develop actionable reports for planning. This paper describes the use of AMR data for distribution planning and improving customer services.

INTRODUCTION

Tata Power is India's largest integrated power company with a significant international presence. The Company has an installed generation capacity of 8623 MW in India and a presence in all the segments of power sector, viz Fuel & Logistics, Generation (thermal, hydro, solar and wind), Transmission, Distribution and Trading. It has successful public-private partnerships in Generation, Transmission and Distribution in India namely "Tata Power Delhi Distribution Limited" with Delhi Vidyut Board for distribution in North Delhi, 'Powerlinks Transmission Ltd.' with Power Grid Corporation of India Ltd. for evacuation of Power from Tala hydro plant in Bhutan to Delhi and 'Maithon Power Ltd.' with Damodar Valley Corporation for a 1050 MW Mega Power Project at Jharkhand. It is one of the largest renewable energy players in India and has developed the country's first 4000 MW Ultra Mega Power Project at Mundra (Gujarat) based on super-critical technology.

Tata Power has a consumer base of 5.5 lakh in Mumbai and an average of about 6,500 million units (MU) is sold in a year. Some of its bulk consumers include Railways, Airport, Port Trust, BARC, Refineries and other important installations in Mumbai.

Tata Power has taken number of initiatives to improve the quality and reliability of its power supply and enhance customer services. The city of Mumbai is known for 24X7 reliable power supply. At the core of reliable power supply to the city is the unique 'Islanding System' pioneered by Tata Power. In case of a state grid failure, the Islanding System ensures uninterrupted power supply within Mumbai city.

AMR AND METER DATA ANALYSIS IN TATA POWER

Tata Power has installed AMR system covering high value industrial & commercial consumer meters, Distribution Transformers meters, boundary meters and feeder meters. Data from above meters is collected every month & stored in Meter data management system. The large volume of meter data captured in AMR system is analysed using a unique and customized Business Analytics software solution. The various applications of AMR data and its benefits are explained briefly in this paper.

Automation of meter reading and billing process

Billing data from the meters is collected automatically on the scheduled bill date & stored in Meter Data management System (MDMS). The AMR system is integrated with SAP billing system and the meter readings flow seamlessly from MDMS to SAP. Consumer Bills are thus generated automatically without any human intervention which has helped Tata Power to provide accurate monthly bills to consumers. Please refer fig-1 depicting automation of billing process through AMR.

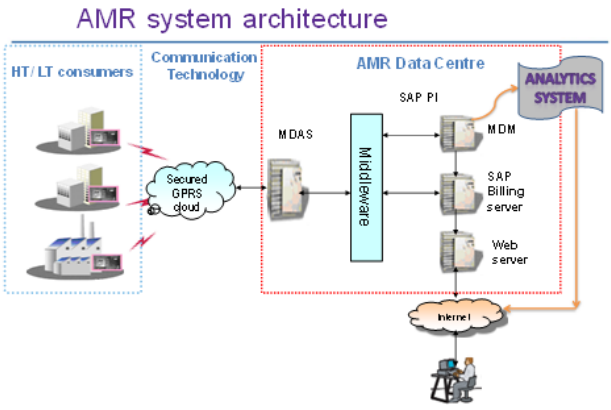

Fig-1: Automation of billing process through AMR

Load forecasting and Demand Response Initiatives

The meters installed at Transmission and Distribution boundary are covered under AMR system and their data

is collected in MDMS. This data is ported to Business analytics systems to plot daily demand curve of Tata Power Discom. The daily demand curve is tracked to forecast medium term and long term demands of Tata Power Discom. Fig. 2 depicts a typical daily demand curve of Tata Power Discom.

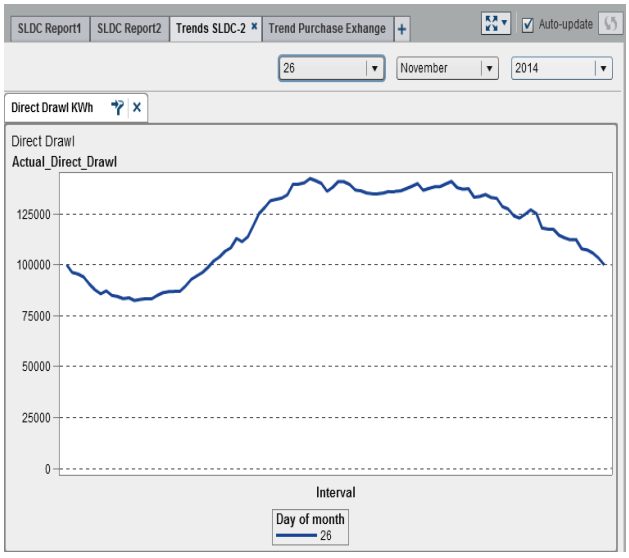

Fig. 2: Daily Demand Curve

The analysis of consumer load profile data captured in AMR system also helps to identify consumers having load profiles matching with the Tata Power – Distribution load profile. Please refer fig. 3 depicting consumer load profiles against Tata Power load profile.

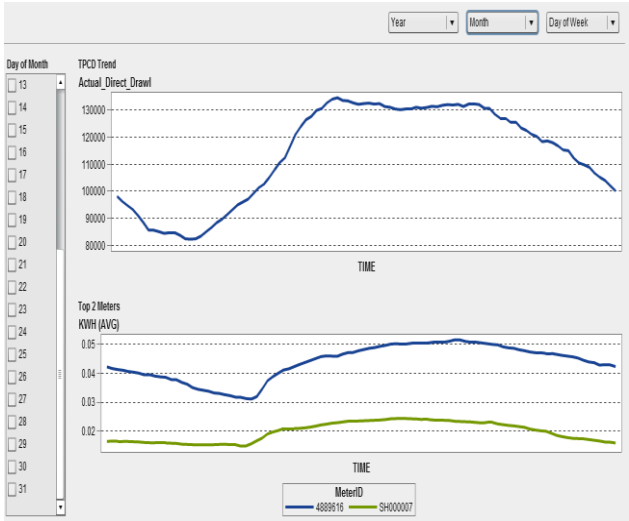

Fig. 3: Consumer profile matching Distribution profile

Consumer having load profile similar to that of Tata Power Discom are targeted for participation in Demand response program. The AMR system data is used to calculate the baseline, curtailment & applicable incentives for the consumers participating in Demand Response program.

Loss Monitoring

The energy injected in the Tata Power – Distribution network is obtained from boundary meters installed at T<>D periphery. This energy is compared with the energy billed to consumers to arrive at Distribution loss. Distribution loss is calculated for each individual Feeder & Distribution Transformer separately. The loss reports are configured in SAP & there is no manual intervention in calculation of loss. The Energy Audit reports are used for detecting metering abnormalities, theft, etc and arranging further investigation/site checks. This has helped in meeting the loss target set by regulatory commission. Fig. 4 shows the typical loss report for a Distribution Transformer.

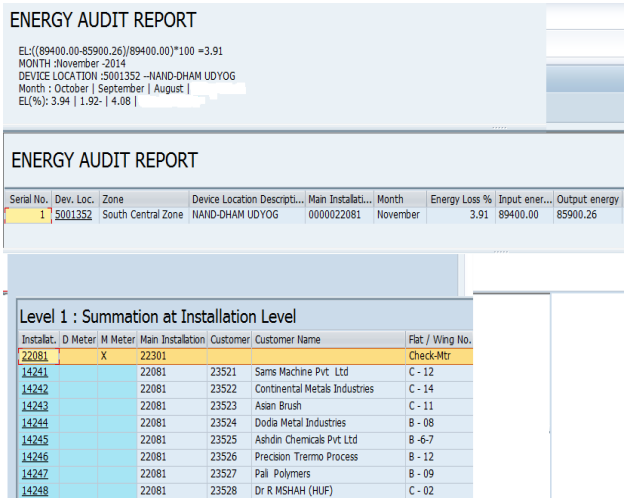

Fig. 4 Energy Audit report for a Distribution Transformer

Load Management

The daily load profiles of all Feeders and Distribution Transformers captured in AMR system are tracked to identify peak, off-peak & average loads vis-à-vis rated capacity of respective DT and feeder. This has helped Tata Power to manage loads on Distribution Transformers and Feeders optimally so as to minimize technical losses. Fig. 5 shows load profile of a typical Distribution Transformer (DT).

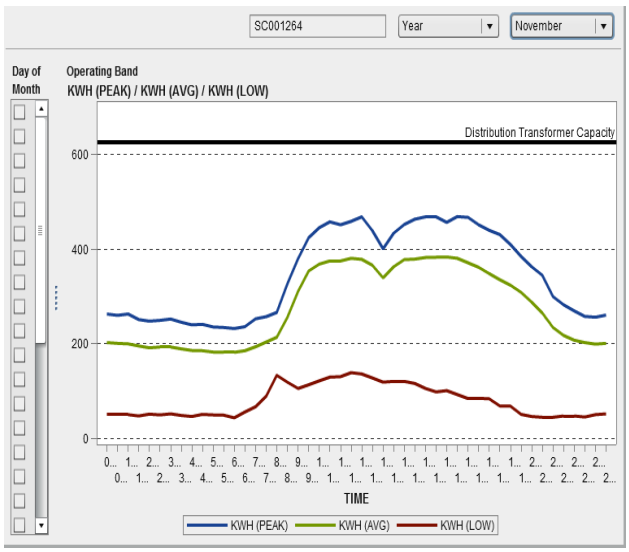

Fig. 5 Distribution Transformer loading

Faster detection of metering abnormalities/theft

Business Analytics solution is used to analyse AMR data and Check
1) If there is any inconsistency in load profile patterns of consumer meter and concerned Distribution Transformer/feeder.2) Abnormal Events have been recorded by consumer meter 3) Instantaneous parameter data captured in AMR system on hourly basis.
The fig. 6 shows a case where sudden deviation is observed in consumption pattern from the normal trend.

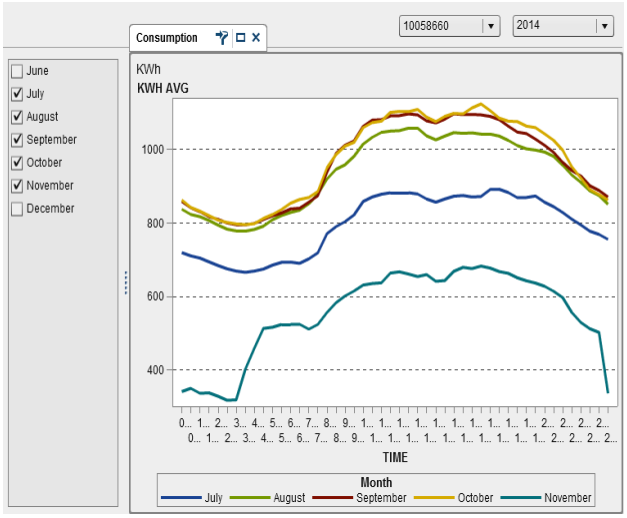

Fig. 6 Deviation in consumption pattern from normal trend

Analysis of tamper events recorded by consumer meters helps to identify suspected defective meters. The fig. 7 shows abnormal events observed in a consumer meter through Business Analytics solution. These abnormal tamper events are superimposed on load profile pattern of the consumer to identify if there is any theft/pilferage of energy.

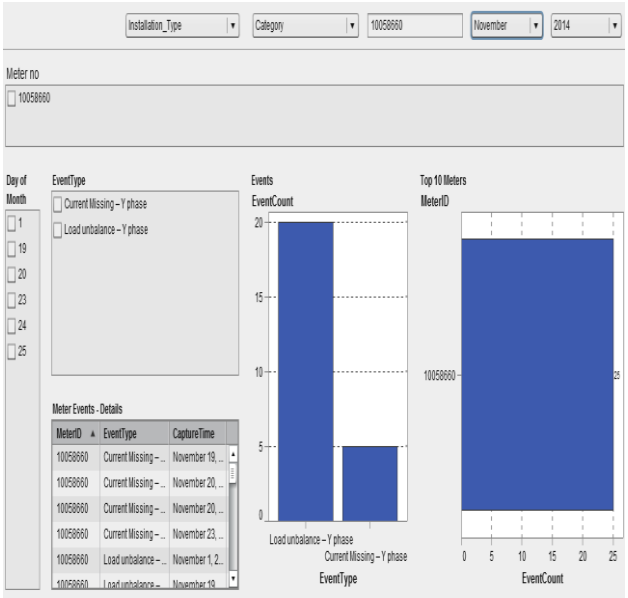

Fig. 7 Event data recorded by consumer meter

The fig. 8 shows a graph with events superimposed over load profile of a consumer which helps to check if any drop in consumption is observed on account of event.

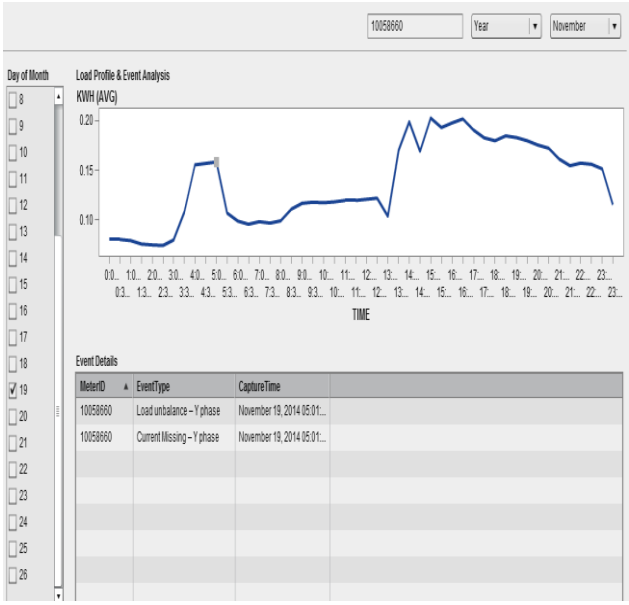

Fig. 8 Events superimposed over profile

The load profiles of consumers are compared with respective Distribution Transformer/Feeder profiles to check for any inconsistency. If sudden change is observed in any consumer profile but corresponding

change is not seen /reflected in the profile of concerned Distribution Transformer or Feeder for the same period, the same is forwarded for site visit/further investigation. The fig. 9 depicts comparison of consumer profile with corresponding Distribution Transformer & feeder profile.

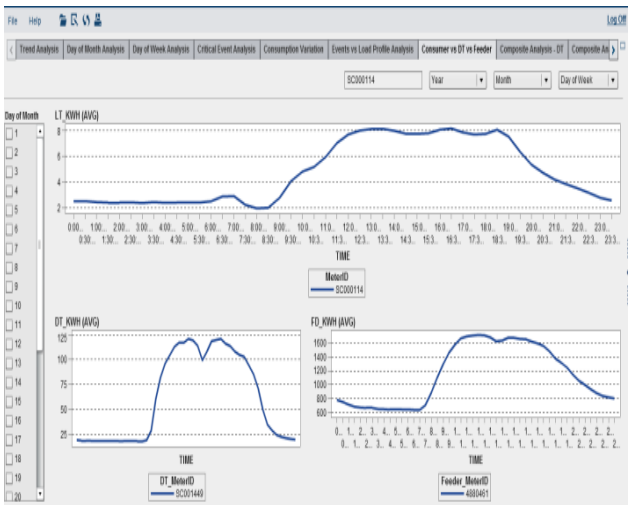

Fig. 9: Comparison of consumer profile with its Feeder & Distribution Transformer.

Consumer profile segmentation

Consumer meters are grouped as per Industry/Business segment and a standard load profile for various industry/Business segments is created. Actual load pattern obtained from a particular consumer meter is then compared with the standard profile of the concerned industry to check for any deviations. This helps in faster detection of abnormalities. The fig. 10 depicts comparison of consumer meter profile with standard industry profile.

Fig. 10: Comparison of consumer profile with standard industry profile.

Planning of Power Purchase from Energy Exchange

The data from boundary meters installed at interface between G<>T & T<>D is captured in AMR system. This data is analysed using Business Analytics solution to estimate the power available from own generation & balance requirement in each 15 minute interval. Also the availability of power & its cost at Energy exchange is captured in the system regularly from IEx Website. The above data is then used for firming up power purchase plan. Fig. 11 shows trends of Power purchase & balance requirement to be procured from IEx.

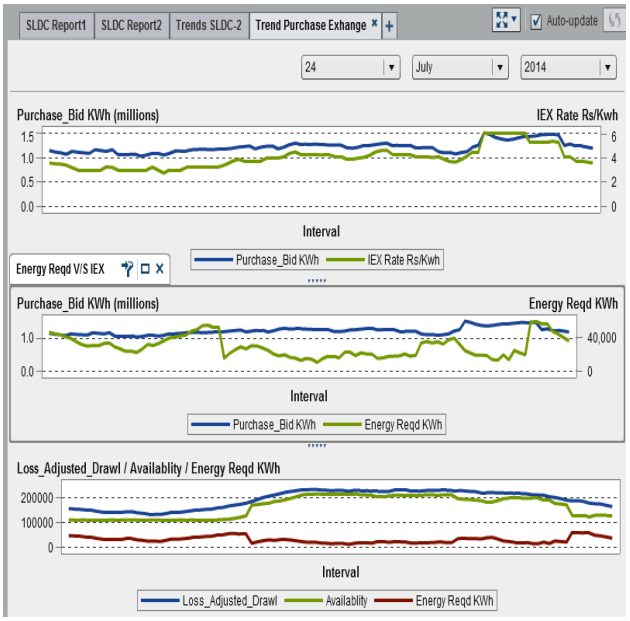

Fig. 11: Power purchase & balance requirement trend

Customer Services

Tata Power uses AMR system to provide energy usage information to key consumers which facilitates them to reduce cost of energy through energy efficiency measures/demand shifting.

A "bill-to-date" functionality is provided which enables consumer to estimate the bill to date any time in the month based on consumption trend till date. Refer fig. 12 which depicts bill-to-date functionality.

Data Summary:

Usage	Units	Quantity	Timestamp
>>ApparentConsumption<<	kVAh	53,893.77	
>>ApparentDemand<<	kVA	106.72	03/08/2013 08:30 PM
Consumption	kWh	53,453.05	
Max Demand	kW	105.94	03/08/2013 08:30 PM

Results:

Alternative	Rate Name	Rate Description	Bill Attribute Options	Cost (INR)	% Savings	Average Cost (INR/kWh)	Description
Current 1	LT2PCOM	Low Tension Two Part Comercial customer with load more than 50 kW	Default	457,266.69	0.00	8.55	04221274

Bill Charges Detail: LT2PCOM

Charge Type	Amount
Demand Charges	24,000.00
Energy Charges	368,612.56
Tax Charges	64,654.12

Fig. 12: Bill to date functionality

Rate Analysis feature allows the consumer to assess the impact of load shifting from one TOD slot to other on the bill amount. The fig. 13 depicts the impact of shifting consumer load from one TOD slot to other on bill amount.

Usage Change Summary:

Usage	Units	Before	After	Difference %	% Difference	Description
ApparentConsumption	kVAh	53,893.77	53,893.77	0.00	0.00	04221274
ApparentDemand	kVA	106.72	106.72	0.00	0.00	04221274
Consumption	kWh	53,453.05	52,264.66	-1,188.39	-2.22	04221274
MaximumDemand	kW	105.94	114.52	8.58	8.10	04221274

Load Change Applied:

Applied To	Season	Block	Energy (%)
Time Of Use	All Season	TOD - A	-10.00
Time Of Use	All Season	TOD - C	5.00
Time Of Use	All Season	TOD - B	-5.00
Time Of Use	All Season	TOD - D	10.00

Rates Used For Analysis:

Rate	Rate Currency	Distribution	Transmission	Commodity
LT2PCOM	INR			x

Fig. 13: Rate Analysis

Consumer can set threshold usage values in the system. When this threshold value is exceeded an E-mail alerts is received by the consumer. The above features are very well received by our consumers.

Proactive response to consumer complaints

In the event of power failure, field devices like modem send SMS to CRM system which is configured to automatically generate a service ticket on the fault duty team for power restoration. The consumer is not required to log any power failure in call center. This proactive approach has helped in faster restoration of power supply and improves consumer satisfaction.

CONCLUSION

1) The AMR system captures data from high value consumer meters, boundary meters, DT check meters and feeder meters.
2) The Meter Data management System acts as a meter data repository. This large volume of meter data is analysed using Business Analytics System. Also AMR system is integrated with other IT systems such as SAP, CRM, GIS, DMS etc.
3) The integration of AMR-MDM with Business Analytics System and Enterprise Systems has helped Tata Power to enhance consumer services and distribution planning as described below :
a) Consumers are provided their consumption data and the same can be used to get bill amount till date using bill to date feature. The feature also shows expected bill amount if the present consumption trend continues during the balance bill period.
b) Consumers can assess the impact on bill amount if consumption in one TOD slot is shifted to another slot by using Rate analysis feature.
c) The consumers can set threshold values for certain billing parameters and receive alerts through auto generated e-mails when the actual values exceed threshold values.
d) Further consumers are not required to log power failure complaint at call center as the service ticket generation in CRM has been automated.

4) AMR data and its analysis using Business analytics has helped us to improve distribution planning processes.
a) It is possible to identify consumers having load profiles similar to Tata Power Discom profile .These consumers are targeted for Demand response events.
b) Standard load profiles for different consumer categories can be created and consumers showing deviation from standard profile can be pinpointed.
c) The power purchase planning process uses AMR data for making plan of power purchase from power exchange.
d) AMR data analysis helps identify opportunities for improving asset utilisation and spot loss reduction opportunities through faster detection of metering abnormalities and meter tamper etc.