Project Report on

Virtual Power Plant through Consumer Participation

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Certificate of Originality

This is to certify that the project report entitled **"Virtual Power Plant through Consumer Participation"** submitted to Delhi Technological University in partial fulfillment of the requirement for the award of the degree of Master of Business Administration is an original work carried out under the guidance of Dr. Rajan Yadav. The matter embodied in this project is a genuine work done by Sanjeev Kumar Rana to the best of my knowledge and belief and has been submitted neither to this University nor to any other University for the fulfillment of the requirement of the course of study.

Signature of the Student

Signature of the Guide

DECLARATION

I Sanjeev Kumar Rana student of EMBA 2015-2017 batch of Delhi School of Management, Delhi Technological University, Bawana road, Delhi-42 declare that term project **"Virtual Power Plant through Consumer Participation"** submitted in partial fulfilment of Executive MBA program is the original work conducted by me.

The information and data given in the report is authentic to the best of my knowledge.

This Report is not being submitted to any other University for award of any other Degree, Award and Fellowship.

Place: New Delhi Sanjeev Kumar Rana

Date:

ACKNOWLEDGEMENT

"The successful completion of any task would be incomplete without accomplishing the people who made it all possible and whose constant guidance and encouragement secured us the success."

I am grateful to Dr. Rajan Yadav in Delhi School of Management, Delhi Technological University, Delhi, for his astute guidance, constant encouragement and sincere support for this project work. The knowledge and values inculcated have proved to be of immense help at the very start of our career.

I feel proud and privileged in expressing my deep sense of gratitude to all those who have helped me in presenting this project.

Sanjeev Kumar Rana

Executive Summary

India's Power Sector has changed tremendously over the last few years in terms of generation capacity addition, transmission network augmentation, distribution network reforms, end-user consumption growth and the transition to open market trading of electricity over power exchanges.

India's electricity grid is aging, and the transmission and distribution (T&D) losses amount to 25%, with $5.7 billion financial losses to the utilities. In 2013-14, India had an average peak power deficit of 9% and an average energy deficit of 8.7% due to insufficient generation and transmission capacity, resulting in rolling blackouts.

India suffers from severe electricity shortages, particularly during peak demand hours, and often experiences shutdowns from several hours to days in certain locations. India faced an unprecedented blackout for two days in July 2012 that affected an estimated 680 million people, which is twice the population of the United States. This blackout highlights the increasing pressure on India's power system for infrastructure and market investments for peak load management and customer engagement. Certified Smart Grid products and technology solutions from the industry provide a robust Automated Demand Response (AutoDR) system to automatically manage demand when the grid is under stress.

Demand-side management technologies can improve electricity consumption by means of various measures, which in turn addresses the reliability related and other issues affecting power availability by managing consumption pattern. This further depends on consumer awareness, willingness and most importantly on change in consumer behaviour towards Energy conservation and importance of Electricity. Demand Response (DR), which is widely used by various power distribution utilities in (U.S.), modifies electricity consumption by end-use consumers, providing flexibility to meet network constraints. When combined with Smart Grid applications like Advanced

Metering Infrastructure, DR help minimizing power outage situations, improve grid reliability and avoid the need for expensive generation capacity and transmission. If adopted successfully in India, DR automation technologies can help utilities save money and prevent the grid from collapsing when demand rises exponentially, thus representing a market opportunity for technology providers and customers. India suffers serious power shortages, mainly during peak demand hours In Summer season. In India there is a shortage of 4.7 % in peak power and consumers often experiences shutdowns from several hours in certain locations. Further, this demand and supply gap is bound to increase if suitable steps are not taken mainly due to the fact that (1) almost 30% of population of India who does not even has access to electricity , are being electrified under various reform initiatives of the Government adding to the demand scenario ,(2) increasing population and (3) the fact that in metropolitan cities and other urban areas, increase in the consumers affordability to have more and more electrical appliances like geysers , microwave oven , air conditioners etc. As per report, in Delhi itself 2.5 Lakh ACs were sold during summer season.

To meet the gap scenario between Power supply and the Demand, just adding new generation capacities cannot be a viable solution; there is a strong need of bringing change in behaviour of consumers to manage their consumption pattern by means of DEMAND SIDE MANAGEMENT initiatives which may also be termed as virtual power plant.

There are means and initiatives by which consumer demand can be managed through Demand Side Management by taking initiatives for Energy conservation, usage of energy efficient devices and participating in utility initiated Demand Response program. In such initiatives, success of the program to a major extent depends upon the consumer knowledge, their willingness and behavioural change in managing their demand as utilities hardly have any control over consumer demand and consumption pattern.

As an initiative, to help consumers to plan and hence monitor their energy consumption pattern, manage their electricity bills and ensure reliable supply to consumers from utility end on sustained basis. TATA POWER Delhi Distribution Ltd proposed a solution for carrying out a pilot study and implementation of advanced Smart Grid

Technologies i.e. “Auto demand Response along with Advanced Metering Infrastructure” in collaboration with Technology providers, Technical experts and the Consumers. This would help consumers by ensuring supply for their critical load even during constraint scenario by participating in the Demand Response event & allowing TPDDL to curtail their non-critical load (identified based on consumer’s input) to match the desired demand supply gap. The pilot project is being carried out with 250 Nos. of High Revenue Commercial and Industrial Consumers. This was the first of its kind in the Indian electricity distribution sector. Auto Demand Response shall enable the participating customers to voluntarily shed their identified non-critical loads, thereby helping TPDDL in better management of peak demand supply imbalance by way of lowering peak demand during grid stress situations. This will ensure better reliability of supply to the customers.

Many techniques were used for gathering requirements, Use of secondary data for shorting potential customers, One-on-one interviews with Industry owners, Technical Managers and subject matter expert were carried out. Group interaction with RWA’s and Industry Association were carried out to have a consensus. Requirement gathering workshops were carried out and Questionnaires was shared with Technical Managers / Industry supervisor to gather basic details. And a joint energy audit was carried out to capture inputs and feasibility study. Key Learning of Pilot Project have been the voluntary participation of 165 no High End Commercial and Industrial consumers show interest of consumers to take lead role in TPDDL’s Smart Grid Initiatives by building awareness among consumers about efficient usage of energy. Need for policy of differential tariff or dynamic peak pricing to incentivize the consumers who are participating in Demand Response Program will encourage consumers as there is no direct monetary benefit at this moment. Incentivization will be indeed required for roll-out.

TPDDL is having 1.5 million registered consumer with 70, 000 consumers having sanctioned load of more than 10 kW and a potential of participating in Demand response program. A study shows consumers having more than 100 kW are having a DR potential of 40 MW equivalent to a 40 MW Virtual Power Plant at the time of crisis. Further it

will save TPDDL a capital investment of 160 Cr (commissioning a Gas Based Power plant of 40 MW).

As per CO2 Baseline Database for the Indian Power Sector, User Guide, Version 11.0 April 2016 published by Government of India, Ministry of Power, Central Electricity Authority, the average CO2 emission 0.96 t/MWh. A virtual Power Plant will save CO2 emission of 38 t/MWh.

This project shall not only help TPDDL and Technology partners to assess and understand the technological challenges & opportunities in Indian Scenario but also will provide sufficient inputs to TPDDL and the Regulator in understanding consumers behaviour , willingness for participation in such initiatives , Various type of industries , load eligible for curtailment (critical & non critical) during Grid constraint & plan future strategies accordingly to have win –win situation for both i.e. the Utility and the consumers. Success of the project shall pave the way for introduction of differential tariffs like critical and dynamic peak pricing, peak time rebate and financial incentives for participation in such Demand Response programs.

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1. POWER SECTOR SCENARIO IN INDIA

History of Power Sector

1910: First Indian Electricity Act Passed

1948: Electricity Supply Act Released after independence (Power Sector Development by SEB)

1975: Electricity Supply Act amended for Central Government's intervention to develop Power Generation - Inception of NTPC, NHPC

1991: Electricity Supply Act amended for private sector participation in Generation – Attractive ROI, Tax Exemptions, 100% Equity participation, incentives on high performance

1992: PGCIL formed out of NTPC to develop Transmission Lines & National Grid

1998: Regulatory Commission Act passed – CERC & RC for states formed

2003: Indian Electricity Act (1910), Electricity Supply Act (1948) & Regulatory Commission Act (1998) INTEGRATED with following are the major highlights

- Electricity Generation Free in Licensing
- Mandatory role of RC in granting license for T&D, tariff, competition promoting, dispute setting
- CEA Role redefined
- All Supplies are to be metered
- Progressive reduction in cross subsidy
- Stringent penalties against theft
- Reorganizing the SEB

1.1 Generation:

India is the sixth largest country in terms of power generation. About 65% of the electricity consumption in India is generated by thermal power plants, 22% by hydroelectric power plants and 3% by nuclear power plants and rest 10% from other alternate sources like solar, wind, biomass etc. 53.7% of India's commercial energy demand is met through the country's vast coal reserves. The country has in recent years also invested on renewable sources of energy such as wind energy. As of Aug 2016, India's installed wind power generation capacity stood at about 27,676.55 MW. India has committed massive amount of funds for the construction of various nuclear reactors which would generate at least 46,200 MW. In July 2013, India unveiled a $19 billion plan to produce 20,000 MW of solar power by 2020 under National Solar Mission.

At the end of October-2016, the energy generation from conventional sources 684.2 BU and the total number of consumers at over 46 million, while the per capita energy consumption stood at 1075 KWh (2015-16). The total demand for electricity in India is expected to cross 950,000 MW by 2030.

Actual achievement and growth in electricity generation in 2009-10 to 2016-17:-

Year	Energy Generation from Conventional Sources(BU)	% of growth
2009-10	771.551	6.6
2010-11	811.143	5.56
2011-12	876.887	8.11
2012-13	912.056	4.01
2013-14	967.150	6.04
2014-15	1048.673	8.43
2015-16	1107.822	5.64
2016-17*	684.200	4.52

Table 1.1 * Provisional (Up to October, 2016) Source CEA report

Per Capita Consumption

Per capita consumption in India is observed as shown in graphical representation below. It is clear that PCC in India increased drastically from 2011-12 to 2015-16 & same shall be 1500 kWh by 2018-19.

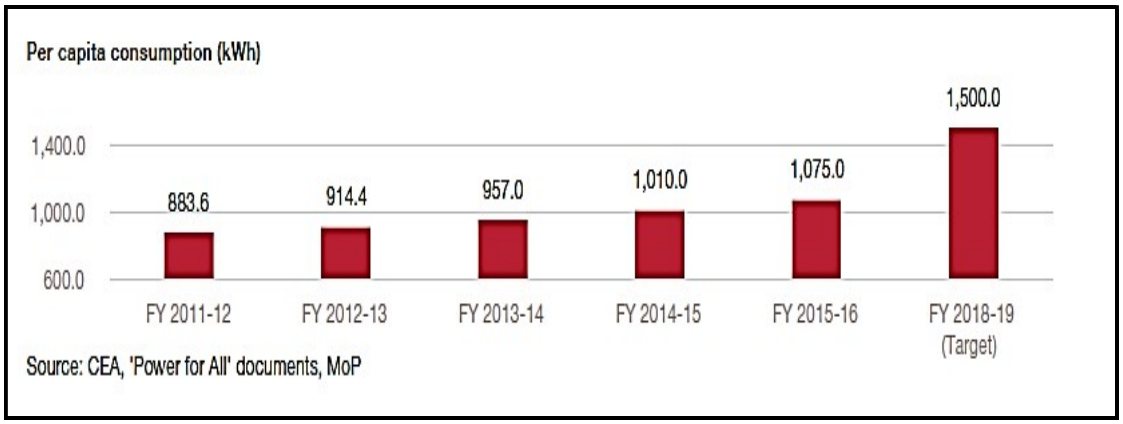

Fig 1.1 : Per Capita Cansumption

1.2 Transmission

Transmission of electricity is defined as the bulk transfer of power over a long distance at high voltage, generally of 132kV and above. In India bulk transmission has increased from 3,708 c.km in 1950 to more than 166000ckm today in which 1, 31, 728 ckt. is transmitted by Power Grid Corporation of India (as on 30 Aug. 2016). The country has been divided into five regions for transmission systems, namely, Northern Region, North Eastern Region, Eastern Region, Southern Region and Western Region. The Interconnected transmission system within each region is also called the regional grid. While the predominant technology for electricity transmission and distribution has been Alternating Current (AC) technology, High Voltage Direct Current (HVDC) technology has also been used for interconnection of all regional grids across the country and for bulk transmission of power over long distances.

Certain provisions in the Electricity Act 2003 has been placed such as open access to the transmission and distribution network, recognition of power trading has become a distinct activity and provision for supply in rural areas have introduced and encouraged

competition in the electricity sector. It is expected that all the above measures on the generation, transmission and distribution front shall further encourage development of a robust electricity grid in the country.

INSTALLED TRANSMISSION (CIRCUIT KM) AND CAPACITY (MVA) IN INDIA UP TO END OF AUG 2016			
Capacity	**Substations (MVA)**	**Transmission lines (c.km)**	**c.km / MVA ratio**
± 500 kV	13,500	9,432	0.699
765 kV	121,500	18,644	0.153
400 kV	192,422	135,949	0.707
200 kV	268,678	149,412	0.556

Table 1.2: Installed Transmission Circuits Up to Aug-2016

1.3 Distribution:

India is the world's 6th largest energy consumer, accounting for 3.4% of global energy consumption, with Maharashtra as the leading electricity generator among Indian states. Due to India's economic rise, the demand for energy has grown at an average of 3.6% per annum over the past 30 years. Indian electricity distribution caters nearly 200 million consumers with a connected load of about 400 GW that places the country among the largest electricity consumer bases in the world. The consumers are served by around 73 distribution utilities – 13 electricity departments, 17 private distribution companies, 41 corporatized distribution companies and 2 State Electricity Boards. In Delhi the regulatory board is the Delhi Electricity Regulatory Committee(DERC) while there are three utilities; Tata Power Delhi Distribution Ltd (TPDDL), BSES Yamuna Power Ltd (BYPL) & BSES Rajdhani Power Ltd (BRPL).

Problems in Power Sector

1. Power Generation:
    - Low average Plant Load Factor (PLF) – 75.07
    - High cost of Generation
    - Poor hydrothermal mix (3:1)
    - Excess reliability on fossil fuels
    - Few Technological Options
    - Environmental factors

2. Power Transmission:
    - Network constraints
    - High cost of transmission
    - High losses in STU networks

3. Power Distribution:
    - High AT & C losses
    - Non-rational Tariff structure
    - Old networks
    - Poor reliability
    - Inadequate investments
    - Govt. Monopoly
    - Political Unwillingness to reform

Transmission & distribution losses in India

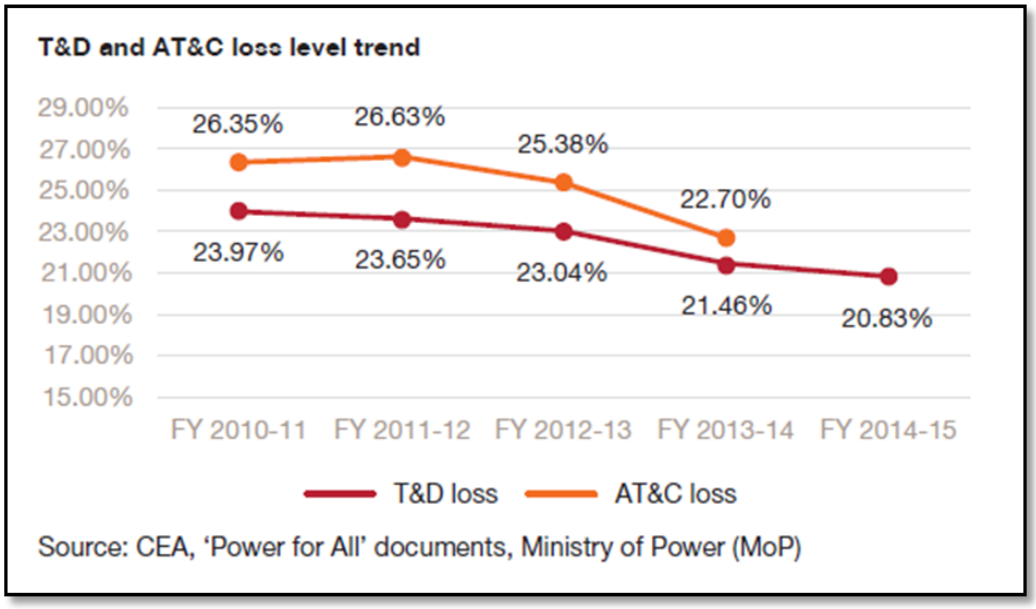

Figure 1.2: AT&C losses in India at distribution level

Requirement of power reforms required at distribution level

Although there are losses at all the three levels but AT&C losses at distribution level are very much dominated. Several loopholes have been identified in power distribution which cause highest losses in distribution among generation, transmission and distribution. Some major considerations are:

High AT&C Losses at distribution level

Aggregate Technical and Commercial Losses can be divided in to two parts i.e. Technical Losses and Commercial Losses. Reasons of these losses are as below.

- Technical Losses:
  - Overloading of existing lines and substation equipment's
  - Absence of up gradation of old lines and equipment's
  - Low HT: LT ratio
  - Poor repair and Maintenance of equipment's
  - Non-installation of sufficient capacitors

- Commercial Losses:
  - Low metering/billing/collection efficiency
  - Theft & Pilferage and tampering of meters
  - Low accountability of employees
  - Absence of Energy Accounting & Auditing

2. TPDDL LEGACY CHALLENGES & APPROACH

2.1 Power scenario in Delhi before TPDDL

The Delhi Vidyut Board (DVB) was set up as a statutory body under section 5 of the Electricity (Supply) Act, 1948 on February 24, 1997 and took over the business of generation, transmission and distribution of electricity in Delhi from the Delhi Electricity Supply Undertaking (DESU), a division of the Municipal Corporation of Delhi.

The power situation in the National Capital started deteriorating from 1998 onwards which the Government of National Capital Territory of Delhi initiated power sector reforms in Delhi with a view to improve the quality of service to the consumers, make electricity available at competitive prices, improve operational efficiencies through reduction in losses as also the need for reduction of Government funding in the electricity sector. The initiation of the reforms was found necessary in the backdrop of the following factors.

- **Demand for electricity grew** manifold in Delhi. For ex, in the period from 1994-95 to 2000-01, the demand met by DVB had increased from 1898 MW to 2670MW and energy supplied increased from 11987 MU to 17362 MU.
- Number **of consumers increased** from 19.3 lakhs to 24.5 lakhs
- Although there had been a substantial enhancement of the physical system to meet the power demand coupled with increase in the energy supply, a lot was required for improving the quality and efficiency of supply
- No generation capacity was added, as a result of which DVB and its consumers had to depend on other sources for purchase of power.

- Transmission and Distribution losses increased from around 26.5% in 1991-92 to 48.8% in 2000-01.

2.2 Reform in Delhi Power Sector:

Distribution sector in Delhi was in pathetic condition in 1998. So Delhi government decided for privatization of its power distribution sector.

As a part of the reform process Government of NCT of Delhi took the following steps:

- An independent regulatory commission, the Delhi Electricity Regulatory Commission (DERC) was created on March 3, 1999, under the Electricity Regulatory Commissions Act, 1998.
- In 1999, SBI Capital Markets Limited was appointed as financial advisor to assist in the unbundling of DVB and privatization of its distribution functions.
- For unbundling of DVB and privatization of its distribution functions, the necessary enabling legislation i.e. the Delhi Electricity Reform Act, 2000 (Reform Act) was passed by the Delhi legislature on Nov 23, 2000 and assented to by the President of India on March 6, 2001
- Based on the Inception Report submitted by SBI Capital Markets Ltd, the Govt. took a decision in Jan 2001 to go ahead with the restructuring of DVB and privatization of its distribution functions.
- It was proposed that the generation company (the GENCO), would take over the existing three generation stations of DVB the transmission company (the TRANSCO) would take over the transmission network and the distribution companies (Central East, South West, North-North West) shall take up over the distribution activities of DVB.
- The Govt. had qualified six bidders based on the bid submitted against the RFQ.
- The necessary instrument through which assets, liabilities, proceedings and personnel of DVB were transferred to the successor entities through a Transfer Scheme.
- The RFP was issued for the bids to acquire 51% equity stake in the distribution companies with the following methodologies.

- The bidders would bid on AT&C loss reductions in 5 years.
- The bidder who proposes maximum reduction in losses as measured by the net present values of the revenues from loss reductions.
- The bidders can bid for all the three distribution companies but one bidder can be selected maximum for two companies.

➢ Based on the RFP and evaluation , Tata Power & BSES were found selected for three distribution areas and Tata Power was given 51% stake in North-North West and BSES was given 51% stake in South West & Central East distribution Companies.

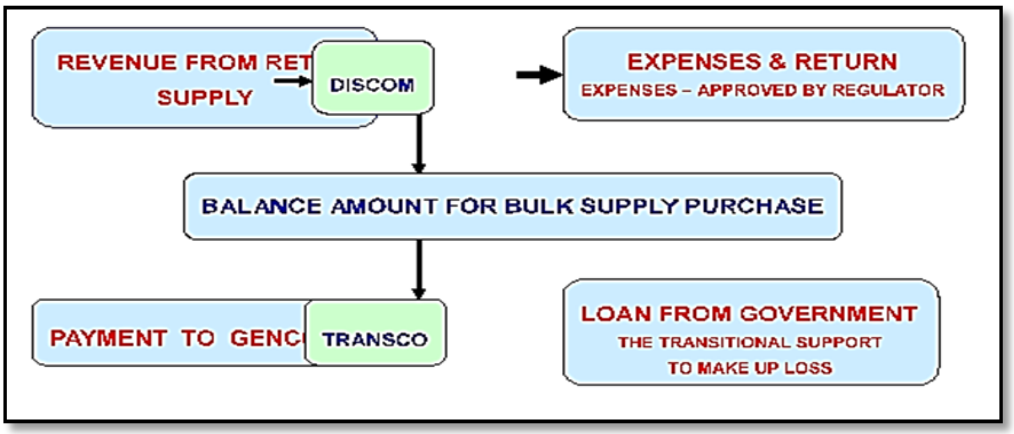

Figure 2.1: Delhi Power Sector Reform Model

Self-sustained Power Sector Reform Model was implemented in which financial support during transition period was assured by Delhi Government.

2.3 TPDDL – Profile

TATA POWER DELHI DISTRIBUTION LIMITED incorporated on 1 July 2002 is a joint venture of TATA Power and GoNCTD (TATA Power - 51%, GoNCTD - 49%) and is one of the few private power distribution utilities in India, in an otherwise Govt. owned industry. Delhi became the second state after Orissa to unleash Reforms in the Power Sector, which resulted in the unbundling of Delhi Vidyut Board into 5 entities – 3 Discoms (TPDDL, BYPL & BRPL), GENCO and TRANSCO (DTL). This was

institutionalized through a Transfer Scheme, which was preceded by a Tripartite Agreement (TPA) between employee representatives, GoNCTD and DVB. The stakes in Discoms were offered to private players through a competitive bidding process on the basis of their commitment to reduce AT&C Losses over the transition period of 5 years (2002-07). Tata Power's winning bid committed a loss reduction of 17% in five years (from an opening loss level of 48.1% in Jul 02 to 31.1% by FY 2006-07)

Some of the highlights of TPDDL profile are as below:

- Distribution of Power across a geographic spread of 510 sq. km with a consumer base of 15 Lakh and a population of 7 million approx.
- TPDDL's daily average energy requirement is about 23 to 24 MUs and Annual Energy Input of around 8800 MUs with Turnover of about INR 6700 Crores.
- Highest ever reduction of AT&C Losses - Losses have reduced by 84 % as compared to the loss levels at the time of take over. (53% in Jul 02 to 8.8 % in Mar 16)
- 26% of Revenue contribution from Express (>500 kW) and KCG (>100 kW) consumers which includes sensitive loads such as DMRC, Hospitals, Hotels, Shopping Malls etc.
- A team comprising of approximately 3218 dedicated & committed members.

2.4 TPDDL's Business Model:

- Distribution Companies privatized by Delhi Govt. under DERA 2000 through sale of majority stake in July, 2002.
- License-based Regulated business – license for 25 years
- Guaranteed 16% RoE on meeting AT&C Loss Reduction Targets
- AT&C target prefixed for initial 5 years as per bid/agreement. Tariff set by regulator on cost plus RoE. Power purchase payment by Discom's on residuary principles for initial 5 years i.e. till 2007after which ensuring sufficient power is Discom's responsibility.
- Overachievement gains shared equally with consumers.

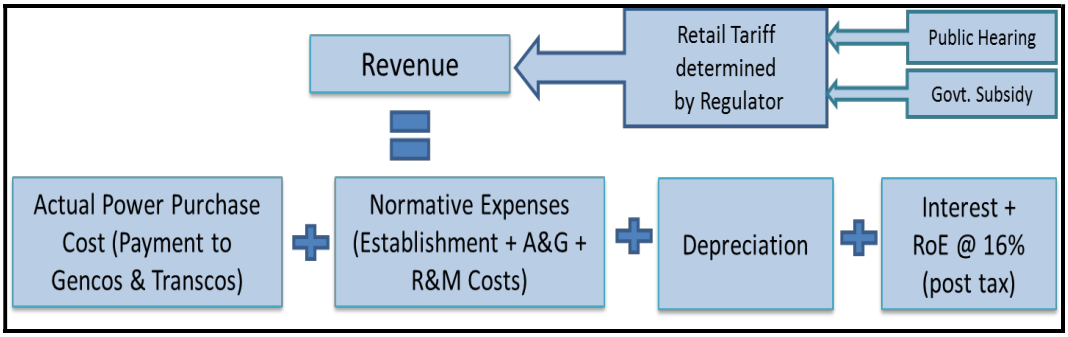

Figure 2.2 (A&G – Administrative & General, R&M – Repair & Maintenance Cost)

2.5 TPDDL - Challenges

Legacy Challenges: In July' 2002, when TPDDL came into existence, a number of organizational challenges were ahead doubting the success of privatization of Power Distribution Company as a part of reform activities. The working area of the company is Capital City of India and hub of Indian politics hence the most prestigious challenge to face. But Systematic approaches toward Capex Planning and effective implementation of the same played an important role along with Corporate Strategy in making reforms successful in TPDDL area.

It is very important to consider these challenges right in planning phase of Capital Budget formation to conceptualize the appropriate strategy to counter them. Let us go through Challenges of Legacy inherited by TPDDL in year 2002.

- AT&C Losses nearing to 54% with increasing trend.
- Dilapidated distribution network – couple of transformers and plenty of cables bursting every day.
- Reportedly harassed consumers with poor fault management system, wrong billing, inadequate payment channels – a back log of 1,00,000 billing complaints and 20,000 new connections.
- A work force of 5638 employees with very little skill sets available.

- Absence of key management functions like HR, Finance, and Governance etc.
- No administrative infrastructure and dilapidated / un-sanitary buildings / offices
- Old, outdated switchgears, RMU and other equipment's
- More stress on Manual Interventions in Operations
- Almost no IT interventions
- No use of advance technology in operations
- No processes in place for smooth and simple functioning
- More than 6 Lac slow electromechanical meters in the network.
- Poor quality supply at consumer end with very low reliability High duration & frequency of shut downs

Operational Performance Parameters

S.NO.	PARAMETER	Year 2002
1	AT&C Losses	54 %
2	Reliability Index (%)	70
3	Transformer Failures w.r.t. Installed Capacity (%)	11
4	Number Of No Supply Complaints received Per Day at Call Center	8000
5	Load Shedding Share In Delhi (%)	40
6	Street Lights In Working Condition (%)	< 50

Table 2.1: Operational performance parameters

Upcoming Challenges

Increasing electricity demand: Rising populations, growing affluence of nations and escalated demand for goods and services that require ever more electricity.

Global Warming: Electricity production is a major source of carbon emissions. The smart grid offers potential to conserve energy, both thru reducing demand at peak times and by its ability to deploy renewable energy sources

Rising electricity costs: Costs are spiraling due to increases prices for oil and gas and low plant factor for renewable energy resources

To meet the gap scenario between Power supply and the Demand, just adding new generation capacities cannot be a viable solution; there is a strong need of bringing change in behavior of consumers to manage their consumption pattern by means of DEMAND SIDE MANAGEMENT initiatives which may also be termed as virtual power plant.

There are means and initiatives by which consumer demand can be managed through Demand Side Management by taking initiatives for Energy conservation, usage of energy efficient devices and participating in utility initiated Demand Response program. In such initiatives, success of the program to a major extent depends upon the consumer knowledge, their willingness and behavioral change in managing their demand as utilities hardly have any control over consumer demand and consumption pattern.

As an initiative, to help consumers to plan and hence monitor their energy consumption pattern, manage their electricity bills and ensure reliable supply to consumers from utility end on sustained basis. TATA POWER Delhi Distribution Ltd is proposing a solution for carrying out a pilot study and implementation of advanced Smart Grid Technologies i.e. "Auto demand Response along with Advanced Metering Infrastructure" in collaboration with Technology providers, Technical experts and the Consumers. This would help consumers by ensuring supply for their critical load even during constraint scenario by participating in the Demand Response event & allowing TPDDL to curtail their non-critical load (identified based on consumer's input) to match the desired demand supply gap.

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load eligible for curtailment (critical & non critical) during Grid constraint & plan future strategies accordingly to have win –win situation for both i.e. the Utility and the consumers.

2.6 Regulatory Scenario:

TPDDL's utility business is governed by the provisions of license issued by DERC (Delhi Electricity Regulatory Commission) for distribution and retail supply of electricity in North & North West Delhi for a period of 25 years. DERC regulates the working of entire power sector of the Delhi state, including determination of tariff chargeable to end consumers and establishing performance norms (mainly related to loss reduction, reliability of power supply and consumer service delivery).The norms/targets are set by DERC after taking into account the past performance, existing levels and current operating environment, i.e., the ground realities and prevailing norms for other power distribution utilities across the country. Further, keeping the stakeholders' interests paramount, it captures the future expectations of the general Public/Govt./Utilities etc. through public hearing sessions

Emerging Market Factors Affecting Business

- Ever rising energy demand, CO2 emission and energy pricing due to major dependency on thermal and low plant load factor of renewable generators.
- Non-Cost reflective Tariff.
- Huge Capex requirement for network augmentation to meet the demand and serve electricity to consumers.
- Managing demand during peak loads and off peak hours – vide gap. Power outage resulting in lost economic opportunities for the end-customers.
- High Technical and Commercial losses
- High operation and Maintenance cost
- Lack of consumer participation / knowledge / awareness for consumption pattern management requirement and techniques.

3. PROBLEM DEFINITION: DEVELOPMENT OF VIRTUAL POWER PLANT

Problem Statement:

"Design a technology solution to bridge Demand Supply Gap during peak and Off-peaks by creating a Virtual Power Plant using non-essential, non-critical consumer loads"

3.1 Need for Virtual Power Plant:

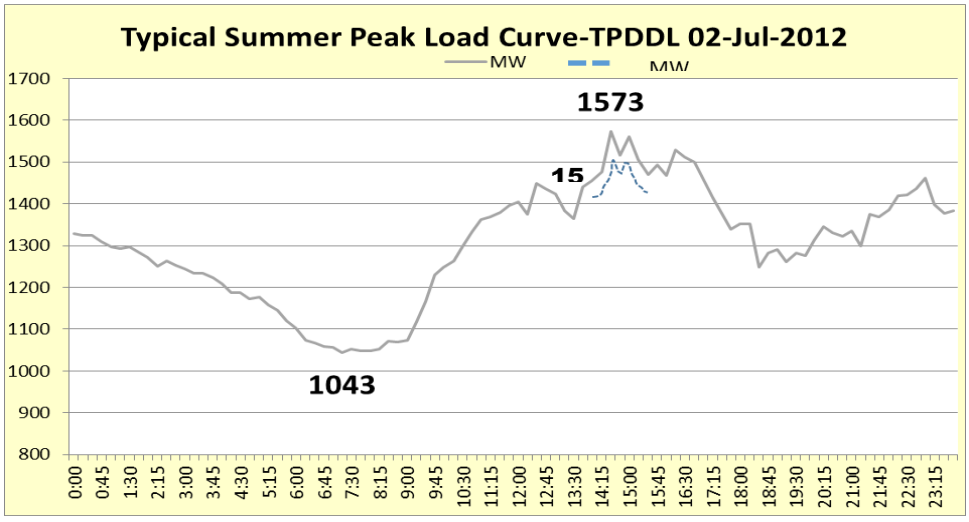

Fig:3.1 TPDDL Summer peak load July 2012

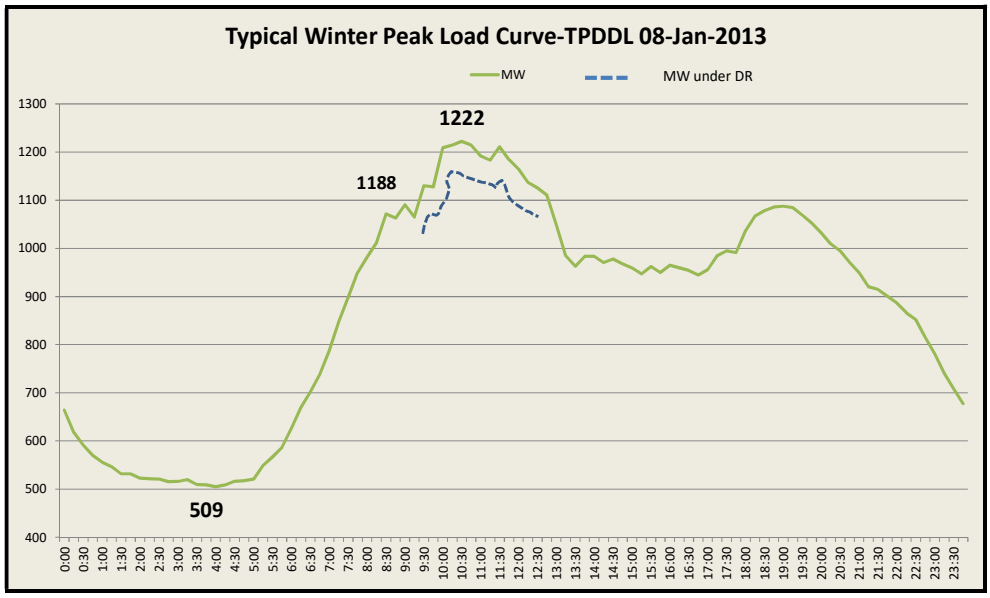

Fig 3.2: TPDDL Winter peak Load Jan 2013

3.2 Time of Day Billing Regulation:

A combination of the above two technologies would also help the consumers take the benefit of "Time Of Day" tariff which has been introduced by DERC in Delhi from 1st July 2012for all consumers (other than domestic) whose sanctioned load/MDI is 300 KVA and above. However, in the tariff applicable from 1st August 2013, ToD tariff has been made applicable for all consumers having sanctioned load above 100 KW. Better planning of the electricity usage will enable consumers to better manage/maintain their electricity bills. The TOD tariff introduced is as below:

Month	Peak Hours	Surcharge on Energy charges	Off Peak Hours	Rebate on Energy Charges
April- September	1500-2400 Hrs.	15%	0000-0600 Hrs.	15%
October-March	1700-2300 Hrs.	10%	2300-0600 Hrs.	15%

Table 3.2 Time of Day Billing

At TPDDL, an Auto Demand Response pilot project is being carried out with 250 Nos. of High Revenue Commercial and Industrial Consumers. For this, TPDDL will work closely with these commercial and industrial customers for active participation in this project. This will be the first of its kind in the Indian electricity distribution sector. Auto Demand Response shall enable the participating customers to voluntarily shed their identified non-critical loads, thereby helping TPDDL in better management of peak demand supply imbalance by way of lowering peak demand during grid stress situations. This will ensure better reliability of supply to the customers. Completion of the project shall pave the way for introduction of differential tariffs like critical and dynamic peak pricing, peak time rebate and financial incentives for participation in such Demand Response programs.

3.3 Demand for Power at time of crisis:

Below table shows unscheduled power purchased by TPDDL due to power shortage:

Type	FY-14-15 (MU's)	Fy15-16 (MU's)
Bilateral	0.4	0.01
Banking	562	620
Power exchange	62	43

4. RESEARCH DESIGN:

4.1 Data Collection Methodology

DATA SOURCES: Both secondary data and as well as primary data were required. Secondary data are data that were collected for another purpose and already exist somewhere. Primary data are data gathered for a specific purpose or a specific research project.

Secondary Data Source

Secondary data was examined to see whether the problem can be partly or wholly solved without collecting costlier primary data. The collection process of secondary data was rapid and easy, collection cost was relatively low and collection time was short.

Secondary data provided a starting point for research. Some of the data sources available were:

- SAP-ISU: Consumer details like sanctioned load, billing pattern are stored by consumer CA no.in SAP –ISU.
- GIS: All consumers are mapped in TPDDL which help in identification of consumer clusters. Lat/long detail of consumers for communication network designing.

Primary Data Source

Primary data for marketing research was collected by observation, focus groups, surveys and site audits. Surveys are best suited for descriptive research such as learning about people's knowledge, beliefs, preferences, and satisfaction, and measuring these magnitudes in the general population; thus supporting marketing decisions with information, intelligence and research.

RESEARCH INSTRUMENTS

Site audit format in the form of "Questionnaire and observation" was used as the research instrument in collecting the primary data. Because of its flexibility, this was by far the most common instrument used to collect primary data. It will uplift, motivate, and encourage the respondent to become involved in the interview, to cooperate, and to complete the interview.

SAMPLING PLAN

After deciding on the research approach and instruments, I have designed a sampling plan, based on three decisions:

1. Sampling unit: Who is to be surveyed? The target population to be sampled industrial, commercial or Institutional consumers. Sample size: How many people should be surveyed? Large samples give more reliable results than small samples. Thus we had a sample size of 165 respondents.
2. Sampling procedure: How should the respondents be chosen? To obtain a representative sample, a probability sample of the population should be drawn. Probability sampling allows the calculation of confidence limits for sampling error.

But the cost & time involved in probability sampling is too high, and thus I used non-probability sampling.

CONTACT METHODS

Once the sampling plan was determined, we had to decide how to contact subjects. Choices include mail, telephone, personal, or on-line interviews. Consumers were approached through client manager for briefing about the project. Consumer premises by experts from Technical team and commercial team of TPDDL and Honeywell.

DATA ANALYSIS

Excel was used for quantitative analysis to generate information by reducing accumulated data to a manageable size by developing summaries, graphs and looking for pattern.

4.1 Exploratory Approach:

In principle approval obtained from DERC to carry out Pilot Project "Automatic Metering infrastructure (AMI) based Auto Demand Response (ADR) Project" in joint partnership with equipment and solution providers on cost sharing basis.

Pilot Project to cover 250 nos. of high end Commercial & Industrial (C&I) consumers with sanctioned load of 300 KW and above with an objective to reduction of peak load on large C&I Customers identified by TPDDL and respective customer's potential and their agreement with TPDDL.

- Demonstrate the key features of AMI & Demand Response,

Win - Win situation for both Consumers and TPDDL by providing opportunity to:

- Facilitate the Customers for better Energy Management
- Potential Reduction of Expensive Power Purchases
- Achieve Grid Reliability.

In this project, TPDDL will build an Advanced Metering Infrastructure (AMI) with robust and secure data communication network for enabling two way communications with Smart Meters to Data Collection and Meter data Management servers. This will enable the customers to have better visualization and control of their energy consumption pattern and will also help the utility in achieving much higher degree of operational efficiencies. Further, customers will enjoy faster response in the event of outages and error free billing.

Given the nature of problem, exploratory research was conducted to determine the best research design, data-collection method based on following techniques:

- secondary research - reviewing available consumer data in SAP-ISU and GIS
- informal qualitative approaches, such as discussions with consumers, employees, management or competitors
- formal qualitative research through in-depth interviews, focus groups, projective methods, case studies or pilot studies.

4.2 SWOT analysis of the project?

Strengths	Weakness
• Background of Tata Image and further enhancement of the same. • TPDDL is among market leaders in innovative adoption of technology in power distribution utility domain • Selection of renowned & world class technology partners for project implementation on cost sharing basis • TPDDL's Smart Grid feasibility study and technology Road Map	• No Regulations binding consumers for mandatory participation in the DR program for further scalability. • No penalty to the consumers not ready to participate in the DR Project • Dependence on Technology Providers. • Non availability of standards for Smart Metering and communication protocols

for next year. • TPDDL is best test bench for advanced Smart Grid component / solution providers for demonstration of their product / technology. • Regulator's inclination towards Demand Side Management initiatives	• Project deployment on RF communication on unlicensed band i.e. 865-867 MHz for data communication. • Consumer participation in ADR project without any financial incentive • Lack of automated load at consumer premises for integration
Opportunities • India's First Smart Grid Pilot Project on "AMI based ADR" • Consumers sensitization for electricity consumption control mainly due to ToD tariffs • Selection of world class solution providers as partner by TPDDL for project implementation generates further faith. • Opportunity to the consumer to reduce their consumption, electricity bill and forced outages during network constraint through participation in the event at no cost to them. • Availability of Power for critical load even during constraint. • Enhanced customer satisfaction	**Threats** • Scalability of DR project without any binding on consumers for mandatory participation in DR program. • Government support for roll out - funds • Lack of policy and regulation for Maximized benefits • Consumer education / willingness for participation in absence of any financial incentive to them for participation in the DR event.

4.3 PEST analysis of the project

The PEST analysis of the project is as under –

Political

- The project is India's first smart grid project implementation project on adoption of Smart Grid components for addressing numerous challenges faced by the Consumers and the Utility and thus in line with the Centre Govt. initiative towards 100 Smart cities , MoP agenda regarding Smart Grid Pilot Project through ISGF etc.
- The project must work/ run within the ambits of Govt./ regulators defined guidelines and within the confined licensee area.

Economic

- By improved reliability and reduction in unwanted outages hampering the productions, C&I consumers will be able to increase their production, reduce cost and hence would contribute towards economy growth for the nation.
- Post implementation of Time of Day Tariff, by being able to monitoring their consumption pattern online, this project or the technology would provide enough insight to the consumers to plan their production plan in order to take maximum benefit of off peak hrs. and save money.
- By compensating demand – supply gap mainly during peak hrs. through Demand Response event, TPDDL will not have to buy that much extra power on real time basis, helping in having some control over Power Purchase Cost to the consumers.

Social

- This project would provide opportunity to minimize CO2 emission.

- This initiative of ADR project by joint participation of Utility, Technology partners and the consumers will help in reduction of power outages and thus improving the overall social scenario.

Technology

- This will provide enough opportunities to all the technology partners to demonstrate their solution in best possible way as TPDDL has all the other technologies already implemented to derive or demonstrate maximum benefit through integration
- This shall also help all the agencies to access pros and cons of the technology, challenges etc. for further improvisation in Indian Environment.

4.4 Methodology adopted for consumer engagement

4.4.1 Consumer Categorization:

Broad Categorization / Type of C&I consumers identified to conduct initial interaction and Site audit for identification of non- critical load.

- Commercial complexes (shopping Malls and Offices)
- Flour Mills
- Dal Mills
- Steel Industries
- Plastic Industries
- Printing Machine facilities
- Hospitals / Nursing Homes
- Schools and Colleges
- Rubber Industries
- Hotels
- Govt. Offices
- Cold Storage
- CNG Stations
- Food process Industries etc…

5. DESCRIPTIVE STUDY:

5.1 Consumer shortlisting for the project

5.1.1 Mapping of KCG consumers in GIS

a. Correction of GIS database for KCG consumers above 300 KW in consultation with all the 46 zones.
b. Objective of the exercise was to identify the exact geographical location of the consumers as well as identify cluster of consumers.
c. The activity also enabled identifying the distances between any two consumers and between any two consumer clusters.

Based on GIS mapping of the consumers, KLM for all the consumers was generated giving latitude and longitude of the consumers. The file was sent to RF vendors for the feasibility study of creation of a RF mesh network. The consumers which were not feasible (Narela and Bawana Districts) being covered through the network were excluded from the consumer consideration list. The broad classification of all consumers above 300 Kw industry wise is as follows:

Classification	Count
AIR	5
CNG Station	7
Cold Storage	12
Commercial	74
DJB	53
DMRC	4
Education Institute	28
Flour Mill	24
Food Processing Industry	14
Hospital	34
Hotel	7
Industry	33
Jail	1
Laboratory	20
Office	36

Plastic Industry	14
Printing Press	5
Railways	4
Residential	16
Stadium	3
Steel Industry	13
Grand Total	**407**

Table 5.1: Classification of consumers

The final consumer selection is as follows:

Consumer Type	GOVT	PRVT	Grand Total
DIFR	1		1
DJB	33		33
DMRC	3		3
INDUSTRIAL	3	80	83
COMMERCIAL	105	105	210
Grand Total	145	185	330

Table 5.2: Final Consumer List

5.1.2 Introduction of the concept for AMI & ADR to consumers

- ✓ **Meeting with DJB, meeting chaired by Member (Finance) and all the SEs and XENs of DJB units in TPDDL area.**

Based on the presentation and discussion Mr. Prashant Goyal (IAS), Member (Finance) DJB has given his consent to begin with the following sites and also expressed his willingness to extend the study to all connections in TPDDL area.

S. No	Supply Address	Sanctioned Load (kW)	Contract Demand (kVA)

1	Wazirabad Water Treatment Plant	15604	12338
2	Chandrawal Water Treatment Plant	6246	4550
3	Haiderpur Water Treatment Plant	10004	9700
4	Sewage Treatment Plant, Coronation Pillar	858	500
5	Lawrence Road Booster Pumping Station	530	350

- ✓ **Visiting sample DJB installation like Water Pumping Station, Sewage pumping station and Raw water pumping station and interaction with their SE's and XENs.**

Site visit with Honeywell technical team was done at the following DJB sites for identification of shed potential. The sites were:

1) Wazirabad Water Works
2) Sewage Treatment Plant, Coronation Pillar
3) Raw Water Pumping Station, Bawana

The reports of the visits were shared with DJB officials and based on their inputs and recommendations, Honeywell team worked on designing specific solution of for the DJB units.

- ✓ **Meeting with consumers in consumer interaction conducted by KCG held for explanation of TOD tariff**.

Salient observation points from the meeting were:

On 7th and 8th August 2012, KCG had organized sessions to educate the consumers on the impact of TOD tariff which has been introduced for the first time in Delhi and will impact consumers having contract demand or MDI >300 KVA.

As the target consumers for our AMR & ADR project are same, we used this opportunity to introduce the concept to our consumers and also use the same to capture the feedback /first hand reactions of the consumer.

During the 2 days 4 different sessions were conducted and the following groups of consumers attended:

- Commercial Complex Consumers
- Government Consumers
- Industrial Consumers of North
- Industrial Consumers of North West

Following were the salient points which emerged out of the discussions:
One consumer from Cold Storage industry (Jolly Ice and Cold Storage) was represented by his owner and he was very enthusiastic about the concept of AMI & ADR. He has proposed that we can hold a similar sort of session for the Cold Storage Association and explain the benefits to the association members as well. It was also agreed that there was non-critical load which can be shut down for some time.
Tirath Ram Hospital was represented by one its employees has also expressed desire to go in for the AMI & ADR, however, he also desired a separate session for Admin team.

DSIDC Infra Pvt Ltd which has been given responsibility of operation and maintenance for DSIDC Bawana Area for common utilities like Street Light, Effluent Treatment plants etc have also shown interest in participation of AMI &ADR.

Unity Buildwell – was represented by its VP and they also expressed desire that site visit to identify Critical/Non critical load can be done in their installations.
Rice processing industry represented by many consumers from Narela, expressed that there was very less possibility of finding Non critical load in their installations.

Flour Mill Industry represented by consumers like M/s Bankey Bihari and M/s Shakti Bhog also expressed that there was Non critical load in their processes which could be shut down for some time and also showed interest in AMI & ADR concept.

Delhi University also desired a detailed presentation for some of their officials.

- ✓ **Session on ToD tariff for consumers above 100 KW was held at Cenpeid on 30th August**.

Approx. 100 Consumers from various Industrial & Commercial establishments participated in a ToD & Smart Grid Awareness session. The consumers were explained the various offerings of the pilot project and response the apprehensions and questions of consumers were given.

✓ **One to one meeting with consumers**

Following consumers were met by representative from Smart Grid Group along with KCG Client Managers for explaining the concept of AMI & ADR and seeking consumer concurrence for participation in the program

S. No	Consumer Name	Date of Meeting
1	Khosla Ayudervedic hospital	13.12.12
		21.12.12
2	D. Mall Rohini	14.12.12
3	D. Mall _ NSP	14.12.12
4	Unitech Amusement park	14.12.12
		21.12.12
5	Rithala Sewage Treatment Plant	21.12.12
6	Moments Mall	19.12.12
		20.12.12
7	Bankey Bihari roller Flour Mill	20.12.12
8	Premeier Inn Shalimar bagh	4.1.13
9	Galleria Mall Shalimar Bagh	4.1.13
10	Anjania Cold Storage	9.1.13
11	New Nirankari Oil Mill	9.1.13

5.1.3 Challenges/ Consumer apprehensions in participation.

- Some consumers especially flour Mills are interested in the concept the owner wants the control of non-critical system with him.
- The sites like large Commercial Malls and complexes presented challenges in terms of the placement of controller and the control wiring as the design and location of LT panel rooms for different floors was different. DJB officials were

concerned about how the control system would integrate with the old switching equipment of the Jal board.

- Some consumers have expressed that there is no direct benefit of participating in the program as he would be forced to shed even when other are enjoying full electricity.
- Some consumers are who have already optimized their operations to consumer less energy don't see any direct benefit of participation in the program.
- Control required by consumers to 'OVER RIDE' the DR command given by TPDDL
- Consumers are apprehensive that their supervisors/operators shall be able to manage the DR infrastructure put in place in addition to the existing set up.

- Consumers want an option to opt out of the DR-Project at any time after go-live

2) **Sample site visit with the Honeywell design team for understanding the actual site conditions or deployment of controllers and control wiring**.

S.No	Consumer Name	Date of Visit
1	Moments Mall, Kirti Nagar	20/12/12
2	Bankey Bihari Exports, Keshavpuram	20/12/12
3	Unitech Amusement Park, Rohini	21/12/12
4	Maharishi Ayurvedic Hospital, Shalimar Bagh	21/12/12
5	DJB, Sewage Treatment Plant, Rithala	21/12/12

- Specific Inputs/ Observations for the Honeywell team while designing the site solution
- The control wiring and placement of controllers would vary greatly with every site, completion of a site could take anything between 3 days to a week depending upon the complexity. Hence the resource planning to take care of this.

- The controller design to take of consumer requirements like the one arising from Flour Mills – the entire production line would be shut down at once this will be the scenario in all the flour mills.
- The environment in which the controllers would be operating also vary greatly, i.e from proper control rooms to very dusty/acidic environment in the industries, hence proper IP protection should be taken care off.
- There could be situation wherein the consumer LT panels are spread across distances, like in the case of Amusement Park and DJB. While the controller would be placed in one of the rooms, control wiring would need to travel distances. Hence the system needs to be designed/tested for this

TPDDL has developed a unique Automatic Load Shedding module in SCADA (Supervisory Control and Data Acquisition System) to avoid contingencies like insufficient generation capacity or inadequate transmission infrastructure to deliver sufficient power, which causes drop in system frequency, overloading of tie-lines, overloading of transformers etc… Main feature of TPDDL's load shedding module is automatic load shedding carried out in a pre-planned, controlled way without requiring human intervention.

Here each load is prioritized and mapped for different system contingencies for different time of day, thus avoiding important loads or same load getting tripped each time. In Automatic Load Shedding module four different levels of under frequencies are defined i.e. under frequency stage1, 2, 3 & 4. For each level of under frequency, corresponding blocks are configured for respective time of day as per the predefined schedule. Automatic Load shedding module picks up the instantaneous frequency value from the field and the value of over drawl in MWs (Actual Drawl – Schedule Drawl) and based on "AND" conditions load shedding is carried out, to restrict over drawl.

Under circumstances when system frequency drops below defined low frequency levels, under frequency load shedding module automatically trips corresponding block scheduled for that time of day independent of OD/UD quantum.

However TPDDL is in the process of implementing these ADMS mechanisms incorporating new Deviation Settlement Mechanism (DSM).

Also to make Automatic Demand Management scheme more explicit to certain areas/ consumers and reducing the customer inconvenience due to untimely load shedding, an Auto Demand Response through Smart Metering pilot project is being carried out with 250 Nos. of High Revenue Commercial and Industrial Consumers. TPDDL worked closely with these commercial and industrial customers for active participation in this project. In this project, energy audits were carried out at consumer premises to identify non-critical loads, which were then connected with Automatic Demand Response controller. TPDDL build an Advanced Metering Infrastructure (AMI) with robust and secure data communication network for enabling two way communications with Smart Meters to Data Collection and Meter data Management servers.

Auto Demand Response shall enable the participating customers to voluntarily shed their identified non-critical loads, thereby helping Power System Control in better management of peak demand supply imbalance by way of lowering peak demand in times of critical grid stress or during times of peak power requirements which necessitate purchase of power at high costs.

TATA Power Delhi Distribution Ltd has always been on the forefront of implementing new technology to improve its operations and increase customer satisfaction. It has to its credit many firsts in implementation of technologies like Grid Sub Station Automation, Automated Meter Reading, Distribution Management System, Outage Management System and ERP etc. After completing the first phase of technology roadmap, TPDDL has now embarked upon its journey towards becoming a smarter utility of the future by launching its pilot project on Automated Demand Response and Advanced Metering Infrastructure which will result into reduction in peak demand at the time of critical grid stress.

At times during grid stress, the only option available with any utility is to SHED the load. We at TPDDL want that our consumers should be not be affected due to load shedding, hence to reduce grid stress we shall disconnect load which is non-essential and does not hamper your production/process. There would be primarily two strategies in which the Identified Non critical load would be shed:

High: In this only that load would be disconnected for which advance intimation is required by the consumer to manage their production processes.

Low: In case of emergency situations where TPDDL is not able to forecast the grid stress due to unforeseen conditions, the load connected in this category would be shed.

5.1.4 Techniques of Demand response

Demand response is reduction in peak demand simultaneously by many facilities creating virtual Power Plant. This ensures adequate supply during peak hours or any network constraint situation, bridging demand supply gap and reduction in energy pricing. Demand response is only needed occasionally and just for a few hours during critical time.

DR allows customers to reduce his /hers use of energy during these peak periods, lowering cost for the consumer and allowing the utility to re-route the electricity where it is needed – without having to rely on starting up its peakers. Demand Response is cheaper, faster, cleaner and more reliable.

To date, most DR solutions have been deployed by large commercial energy users. But with the widespread integration of Smart Meters, the practice can now begin to be rolled out for residential consumers as well.

There are three type of demand response:

• **Manual**. Actions involve labor-intensive approaches to manually turning equipment off and on, and changing set points of control parameters.

• **Semi-automatic**. Actions involve preprogrammed control strategies that are carried out by building operators, typically through centralized building automation and control systems.

• **Automatic**. Actions do not need human intervention but are executed automatically by building automation and control systems upon receipt of DR event signals. When used with the ADR application, a building automation and control system can automatically execute DR control strategies.

Automatic Demand Response (ADR) is an integrated system with energy management control systems to initiate customer approved actions to curtail loads automatically during requirement of Grid. An Auto-DR event can be triggered by either real-time prices or system reliability triggers. The communication is based on open standards like Internet protocols – Open ADR protocol.

5.2 Models of Demand Response (DR):

There are two different models of DR which are as under:

1. **Infrastructure Model:**

- Utility will have direct customer relationship, contract and pay incentives.
- Utility will design, develop, market and program manage the DR program.
- Utility will engage DR infrastructure provider to provide multiple services like Auto DR infrastructure, Facility Commissioning and Shed strategy, BMS programming and management, customer training and problem resolution.

2. **DR Aggregator Model:**

- Utility will not have direct customer relationship
- Utility will engage service provider to provide Turnkey DR services like Auto DR infrastructure, BMS programming and management, customer training and problem resolution, design and development of DR program, incentive payment, DR program marketing and management, customer web portal, delivery of peak demand reduction

5.3 Pilot project Scope and Components:

5.3.1 Advanced Metering Infrastructure (AMI)

- Meters
- Communication Networks
- Meter Data Acquisition System (MDAS /Head End)
- Meter Data Management System (MDMS)
- Application Integration
- Customer and Utility Portal
- Site Implementation Work

5.3.2 Auto Demand Response (ADR)

- ADR Solution and Server
- Software Development and Analytics
- Controllers
- Customer Agreement
- Consumer Site Audit for DR Potential
- Site Implementation

5.3.3 Consumer Engagement and Change Management

- Identification of Consumers
- Interaction with KCG Team
- Finalization of Consumer Behavior Sheet
- Interaction with Circles and Zones
- Interaction with Consumers
- Consumer Agreement

5.3.4 Application Integration

- Use Cases of Integration between various system
- Finalization of Standards and Protocol for integration of the above
- Integration of MDMS with ADR
- Integration of MDMS with Head end
- MDMS with CRM, OMS, SAP
- Unified Customer Portal linked to TPDDL Website

- Output Reports

5.3.5 Basis of Selection / Evaluation of Technology partners:

- Product Maturity in the international market including credentials
- Product Maturity in the Indian Market (e.g. Established, Leader or Entry)
- Solution Scalability
- Interoperability and Compliance to Industry Standards
- Ease of Integration, availability of ready adaptors
- Support for multiple integration standards for transport and message protocol.
- Partner Delivery & Technical/Service Support in India

5.3.6 Equipment's qualifying for Demand Response

- Lighting
- HVAC
- Motors
- Pumps
- Fans & air compressors
- Process equipment & audio/video equipment
- Appliances and vending machines capable of receiving curtailment signals

5.4 Challenges envisaged initially and Mitigation plan

Sr. No	Risk/Challenge	Probability of Occurrence	Impact on Project	Risk Level	Mitigation
1	No Standards for Metering and Communication Protocols. Lack of Product and Technology Maturity	H	Low	Low	Advocacy with OEM, Regulators and Advocacy Platforms, Advocacy through Demonstration
2	Communication with PLCC/RF on HT and	High	High	High	• Hybrid Concepts • POC

	Scattered Consumers				• GPRS Backup
3	Consumer Engagement for ADR for Participation without Incentive	High	High	High	Program to be Positioned as Energy Management Program and Provided Free of Cost. KCG Relationship to be Leveraged, Preparation of benefit proposition given the context.

5.5 Design and Implementation

5.5.1 Salient Feature of the Project:

- First utility initiated Auto DR program along with AMI for C&I customers
- First time Auto DR is being done without Shadow meter, the meter data for base lining shall be taken through integration with MDMS
- First time utility is attempting to enroll customers without any financial incentives for participation in Demand Response Program
- Direct load control through customized low cost controllers compliant with open ADR protocol.
- Setting up of RF Mesh based communication network covering around 200 + Sq. Km of licensed area for capturing widely segregated consumers.

5.5.2 System Architecture:

Demand Response: relates to any program which encourages shift of peak demand power by end consumers. The participation of the end customers is a response to factors such as incentive pricing, differential tariff schemes, greater awareness and an increased sense of responsibility. The end consumers agree to involvement, but their participation may involve either active behavioral changes or passive responses, through the use of automation

Proposed architecture for ADR with AMI Pilot Project:

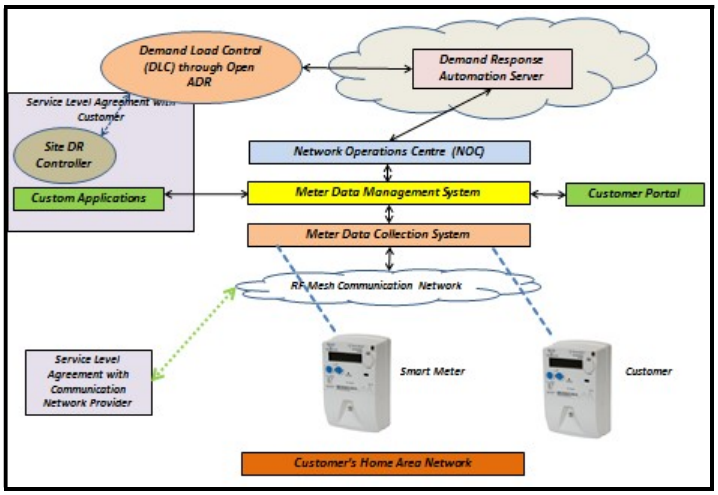

Fig 5.5.1: System architecture

Advanced metering infrastructure (AMI) is an integrated system comprising Smart Meters , communications networks , Head end system and Meter data management system over a two-way communication system for data exchange between utility and the consumers. Its main components are as follows:

- Smart meters: Smart meter is a recording device with many inbuilt intelligent features; it records consumption of electric energy in intervals of hours or minutes as configured and communicates that on real time basis or at least daily to the meter data acquisition system over a two-way communication system.

- Two- way Communication system- between meter and central control room for meter reading , temper data etc. and from central control room to Meter for say connect – disconnect , clock synchronization , load limit setting etc.

- Head end System: A set of Hardware and software for collecting information from meters (on specified intervals – scheduled or on demand) and sending it to the Meter Data Management (MDM) system.

- Meter Data Management System (MDMS) : Primary store for all metering data act as centralized meter data repository system , for performing control functions for meters All validation, estimation and editing (VEE) of meter readings; Determination / transmission of billing determinants and for integration with other IT-OT applications.

5.5.3 ADR Process:

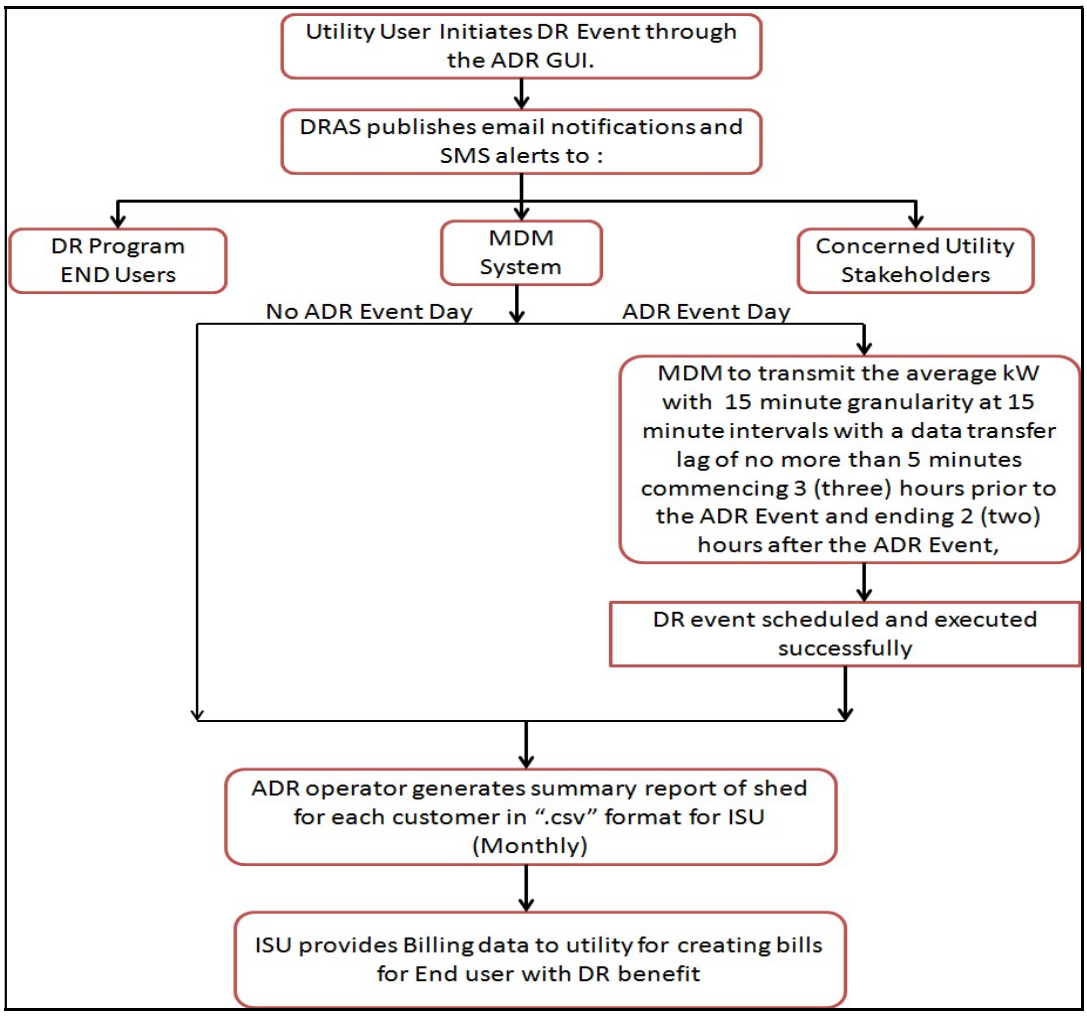

Fig 5.5.2 : ADR Process

5.5.4 Steps in Automated Demand Response

After taking due consent/agreement from the consumer, the following steps would be carried for the Automated Demand Response:

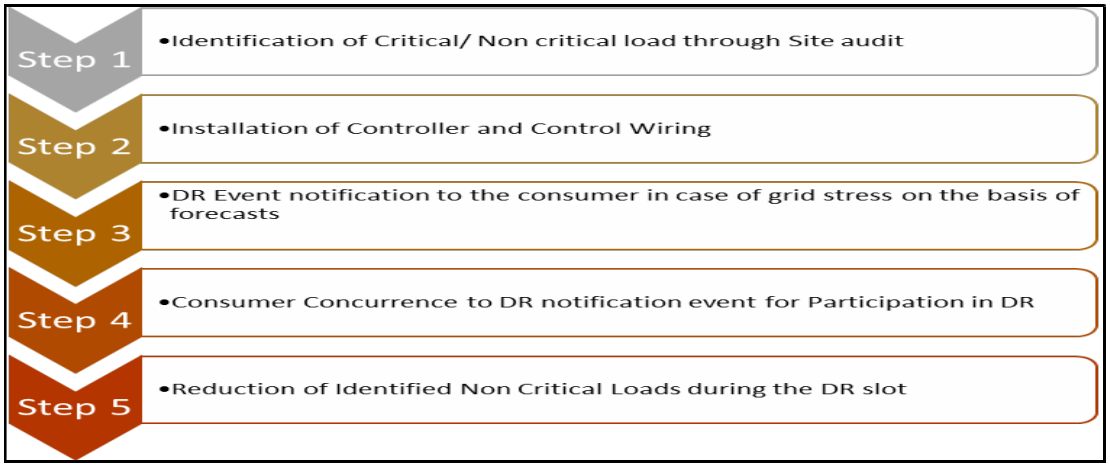

Fig 5.5.3 : Steps in ADR

5.5.5 AMI Based ADR Project Interfaces:-

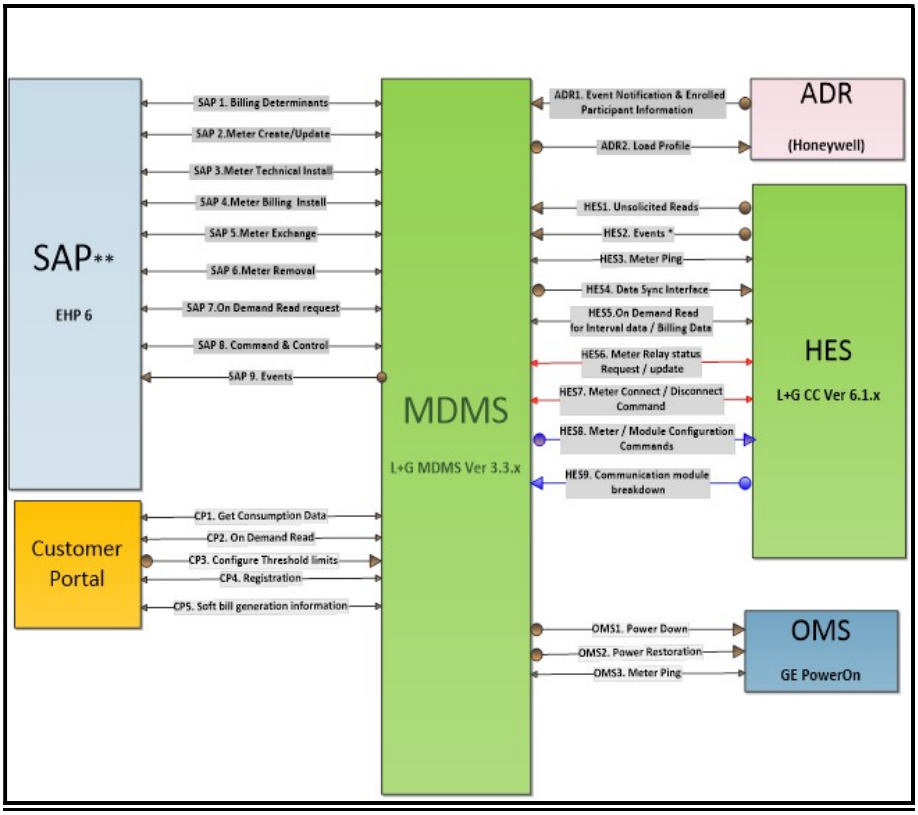

Fig 5.5.4: AMI and ADR Interfaces

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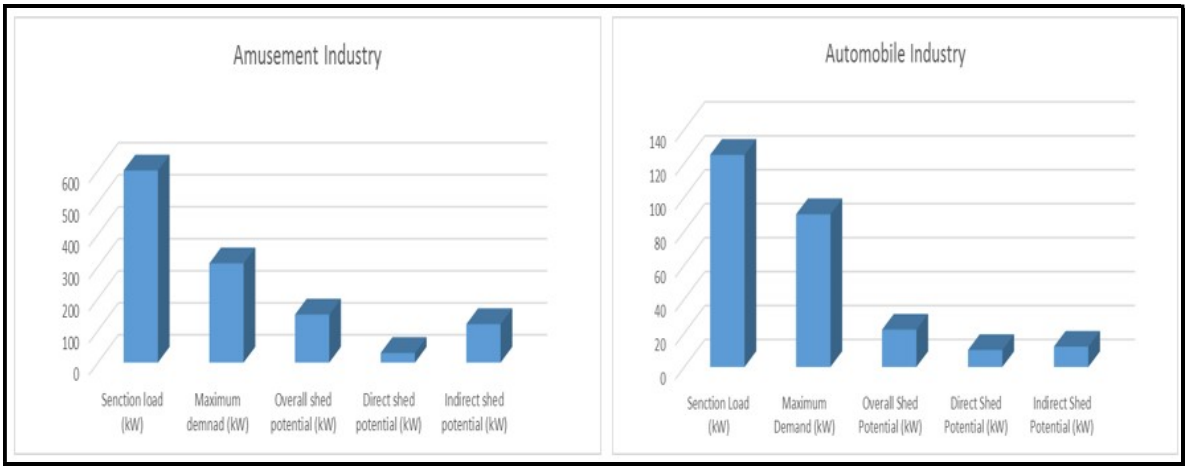
6. ANALYSIS:

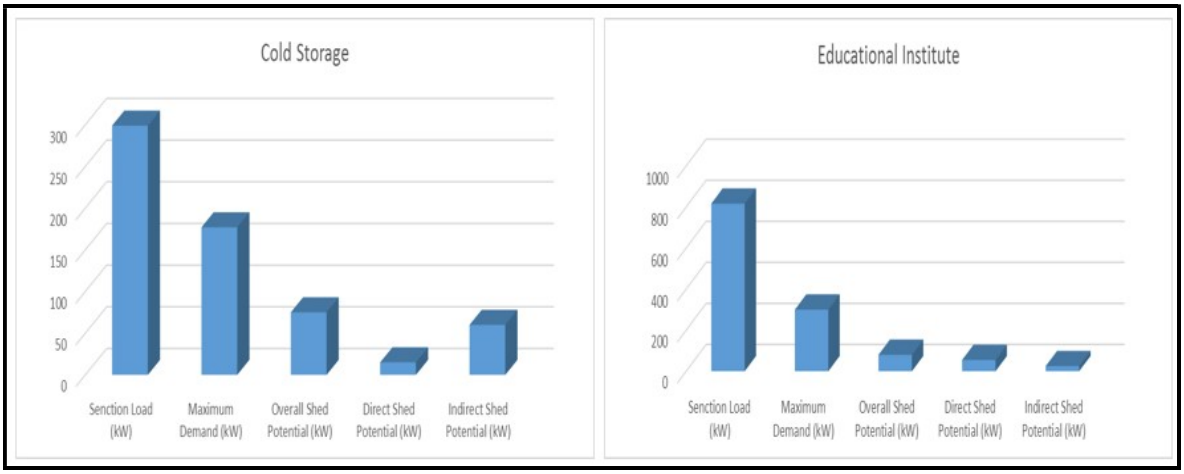
7.1 Cluster Analysis

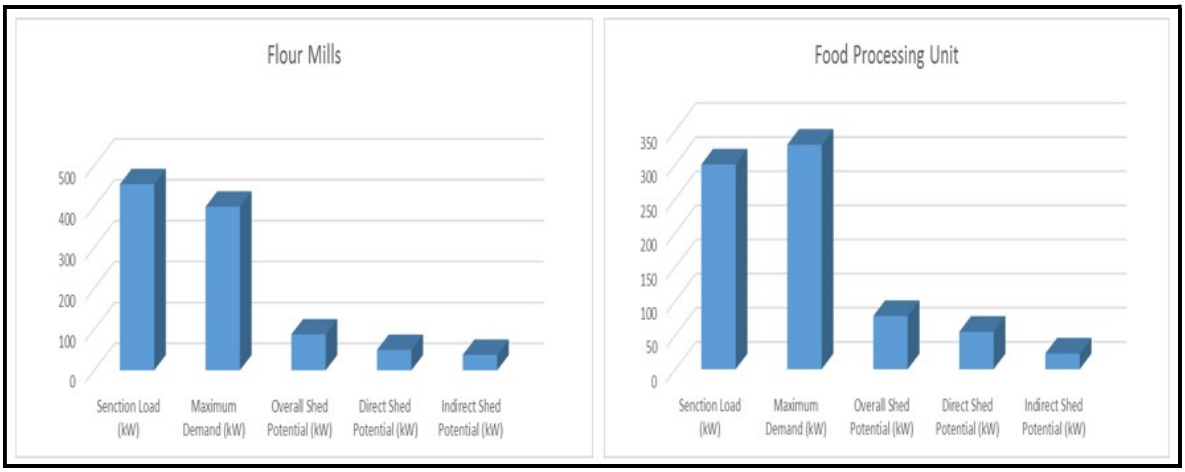
Cluster analysis is an interdependence multivariate method. As the name implies, the basic purpose of cluster analysis is to classify or segment consumers into groups so that objects within each group are similar to one another on a variety of variables. Cluster analysis seeks to classify segments or objects such that there will be as much likeness within segments and as much difference between segments as possible. Thus, this method strives to identify natural groupings or segments among many variables without designating any of the variables as a dependent variable.

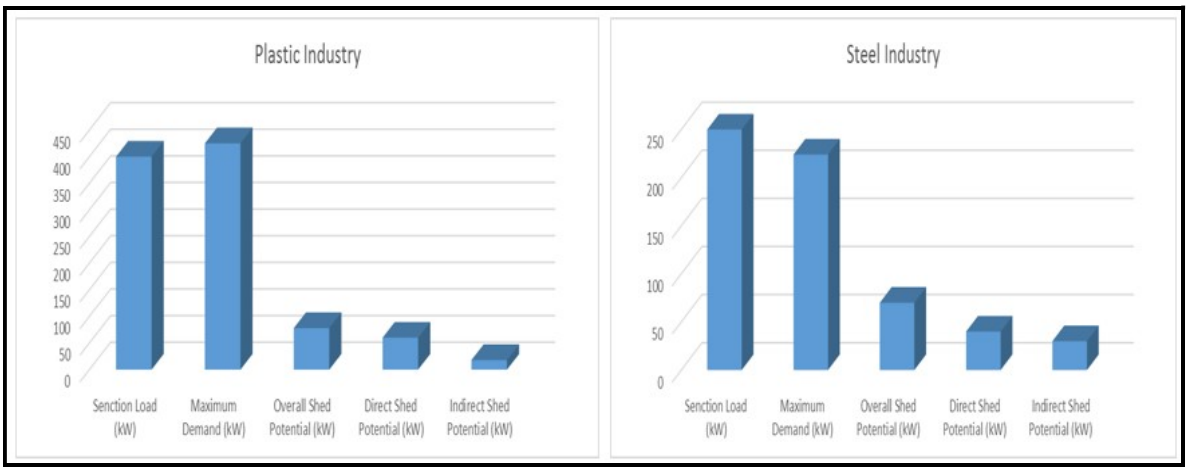
This analysis in this case would help and make clusters or segments of consumers, so as to differentiate these segments of consumers, which would have similarity within the segments, but difference among the segments as well. The consumer in each segment would have same structure/potential for specific attributes.

Cluster One – For this type of cluster consists of respondents/ potential participants for the variables are classified according to their Industries following manner.

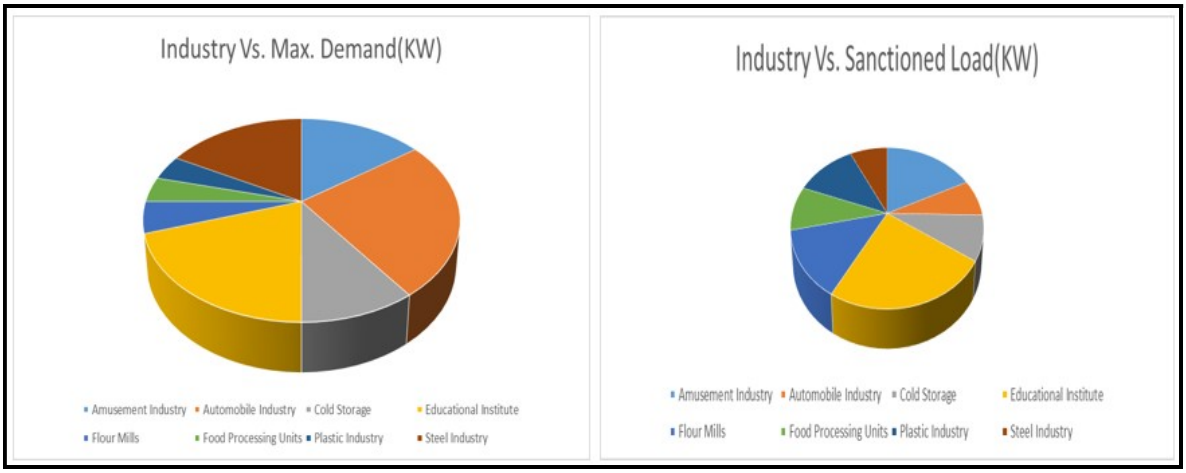


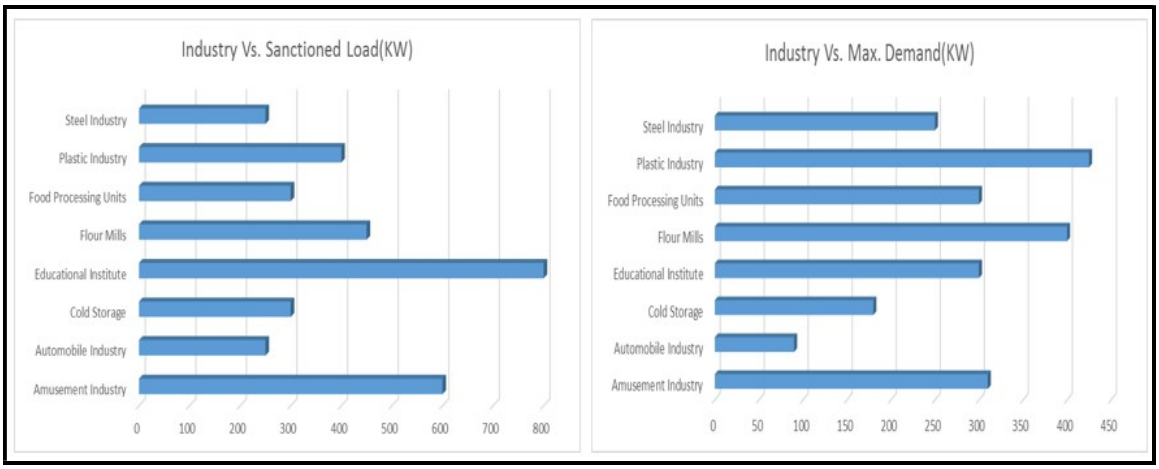




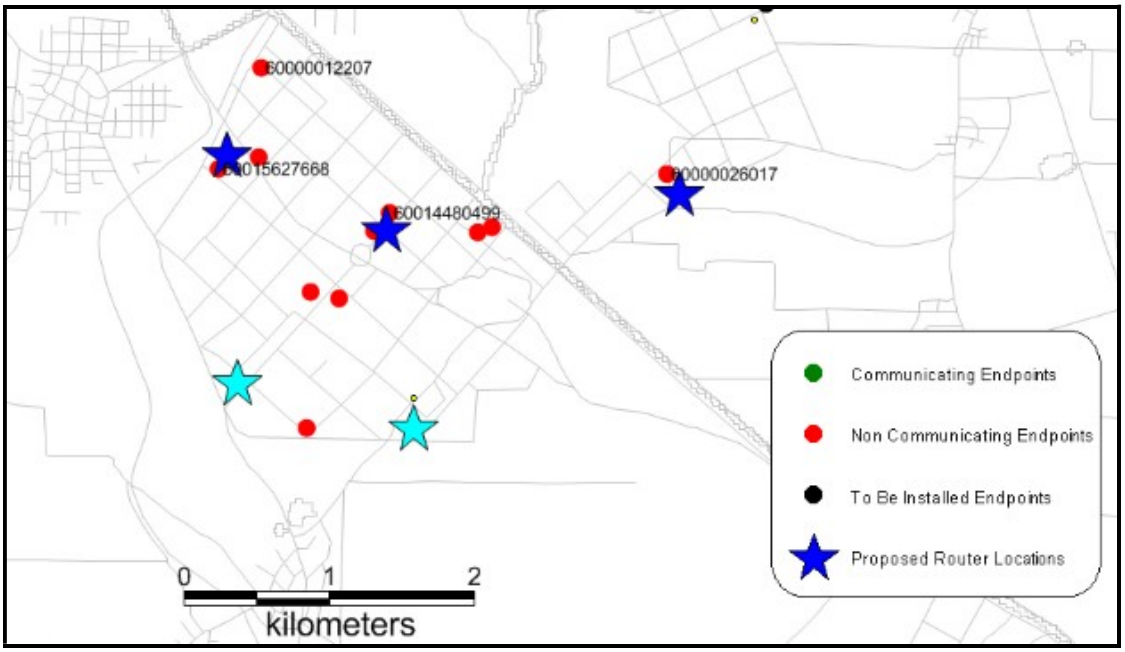


Cluster Two – For this type of cluster consists of respondents/ potential participants for the variables are classified according to their Sanctioned Load, Maximum Demand in following manner.





Cluster 3 – For this type of cluster consists of respondents/ potential participants for the variables are classified according to their geographic spread in following manner.



A sample estimate of the potential at TPDDL is as follows:

Name	Critical	Non Critical	kW	Load Off@ DR Hr	kWh	yearly saving(kWh)	yearly saving(Rs)
Lath M/C-1	yes	NO	7.5				
Lath M/C-2	No	yes	7.5	2	15	5475	32850
Lath M/C-3	No	yes	7.5	2	15	5475	32850
Lath M/C-4	No	yes	7.5	2	15	5475	32850
Lath M/C-5	No	yes	7.5	2	15	5475	32850
Lath M/C-6	No	yes	7.5	2	15	5475	32850
Lath M/C-7	yes	No	7.5				
Lath M/C-8	yes	No	7.5				
Lath M/C-9	yes	No	7.5				
Lath M/C-10	yes	No	7.5				
Manin Motor-1	Yes		25	2	50	18250	109500
Manin Motor-2		Yes	25				
Pump-1	Yes		10	2	20	7300	43800
Pump-2	Yes		10	2	20	7300	43800
Pump-3		Yes	10				
Pump-4		Yes	10				
Total						60225	481800

Table 7.1 Saving of a consumer with 200 kW connection

Graphical representations of Segment wise Industry wise Sanctioned load Vs Actual consumption Vs DR potential is as shown below:

Above study shows there is Virtual Power Plant potential of 18-22% of sanctioned load among high end consumers across varios industries; maximum across process based Industries.

7. CONCLUSION & RECOMMENDATIONS

Tata Power Delhi Distribution Limited's (TPDDL) advanced Smart Grid project plans to increase reliability and readiness of customers for automated demand response (AutoDR). The project includes smart meters and interoperable Communications for data analytics and automated dispatch for load reduction during power deficiency. This study characterizes TPDDL's integrated AutoDR system, including advanced metering infrastructure, data analytics, smart meters, and interoperability standards. We evaluate the technology effectiveness where the analyses show a 75th percentile load reduction of 10% for 144 commercial and industrial facilities with an aggregated coincident total

peak load of 25 megawatts (MW). AutoDR can improve customers' responsiveness and a utility's arbitrage for electricity shortfall and high cost of peak power. A well-designed program can accelerate technology use and encourage customer participation. Innovative technology solutions can enhance the grid reliability by minimizing the instances of outages in India, and improve energy security by enabling integration of renewable generation to scale.

The learning through the project has helped TPDDL to gain deep insights into the technology deployment & implementation challenge and this experience shall guide us to scale up these deployments. We have put forward schemes for scale up ADR which shall enable a peak reduction up to 40 MW and AMI scale up which shall cover high revenue base consumers nearing 2.5 lakhs. Analysis of the TPDDL's schedule and unrestricted system load data and power procurement data in calendar year 2014 from month January to Nov reveals that the actual load demand exceeded the permitted overdraw limit of 38 MW within a frequency band of 49.7 to 50.5 hertz during 317 hourly incidents. Thus, DR can be effectively used to manage the peak power in such scenarios.

In addition to this, TPDDL has already made suggestions to the regulator to introduce financial incentives for the participating consumers and also to make participation in DR mandatory for consumer having sanctioned load greater than 300 KW and for big government organizations like Delhi Jal Board, Delhi Metro Rail Corporation etc.

8. REFERENCES

- Characterization and Effectiveness of Technologies for India's Electric Grid Reliability and Energy Security, Author (s): Girish Ghatikar Lawrence Berkeley National Laboratory, US
- Asian Power Magazine (Issue 62, Dated. 30th April 2014)

- Smart Metering and Demand Response – Case study of TPDDL DR Program white paper by Sujay Saha
- TPDDL Smart Grid Pilot Statement of work.
- Information gathered from *www.tatapower-ddl.com*
- *http://www.cea.nic.in*
- *https://en.wikipedia.org/wiki/Electricity_sector_in_India*
- USAID Smart Grid course book, TPDDL
- *https://en.wikipedia.org/wiki/Energy_**demand_management***

9. ANNEXURES

10.1 Questionnaire

Name of the consumer /Company .....

Type of Industry .....

Sanctioned load .....

Max. Demand (KVA) .....

Contract Demand (KVA) .....

1. Do you monitor your Power consumption?

(a) Yes (b) No

2. How often you monitor your consumption?

(a) Shift wise (b) Daily (c) Weekly (d) Monthly (e) No monitoring

3. Do you have energy conservation mechanism?

(a) Yes (b) No

4. Is your production linked with consumption?

(a) Yes (b) No

5. Do you have any other source of Power source?

(a) Very High (b) High (c) Low (d) Very Low

6. Is your facility automated?

(a) Yes (b) No

7. Which are the sources that most influence your technology up gradation decision?

(a) Family (b) Friends (c) Magazines/Newspaper (d) T.V./Radio (e) Experimenting Nature (f) Retailer (g) Any Other

8. Do you want to participate in Demand side management schemes?

(a) Yes (b) No

9. Which type of Demand side management schemes do you prefer?

(a) Demand Response (b) Energy conservation (c) Energy Efficiency

10. Do you want to TPDDL to monitor electrical conditions of your facility remotely?

(a) Yes (b) No

11. Do you want prior intimation of Load shedding?

(a) Yes (b) No

12 Do you agree to sign –off MoU with TPDDL?

(a) Yes (b) No

Thanks you for your cooperation.

10.2 Sample Site Survey Report

Customer Information

Company Name: Kanodia Techno Plast Pvt Ltd CA#: 60000007728		
Address: A-43,Wazirpur Ind. Area		
City: Delhi	State: Delhi	Zip: NA

Contact

Name: Mr. K K shukla	Title: GM
Phone #: 9560047111	Fax #: Not Avl
Email: kkshukla@kanodia.com	

Company Profile

Type of Facility: Polymer	
Primary Business Purpose: Polymer	
Site Address: A-54,Wazirpur Ind. Area	☒ Same as Contact ☐ Multiple addresses
Building Layout: ☒ Single ☐ Multiple - If so, How many:	
Number of Floors: B +3	Year Constructed: Not Avl
Building Square Footage: NA	Percent of building that is air-conditioned: 10%
Hours of operations: 24 hr	Occupancy %: 60
Facility Management Type: ☒ Company Owned ☐ Outsourced	

Note : Date – 14-11-2013 Plastic Industry Neelesh/S P Goel/ Sanjeev

Demand Response Profile:

Utility Tariff ☒ TOD Structure:	
Max. Demand (KVA): 250	Contract Demand (KVA): 285
Average Load(KW):	Sanctioned Load(KW): 285
Approximate % breakdown of energy demand (kW) HVAC: 10 Lighting: 10 Process Load: 75 Others: 5	

☒ Transformer: _1 no. Rating(KVA):400 KVA	
☒ Meter Type : Outdoor Unit (Thru' CT/PT) out Metering Cubicle Package Substation	☒ Diesel Generator- 01 Rating(KVA): 200 X 01 & 125 X01 Loading:

Electrical System:

Shed Potential Estimation:

Equipment / Loads	**Priority**	**Automated Load Shed Opportunity Assessment**			
Name and Description of Equipment	**(High / Medium / Low)**	**Automatically Shutdown ?**	**Reason if No?**	**Avg HP**	**Duration**
Lath m/c-01	H	☒ Yes ☐ No		15	24
Lath m/c-02	H	☒ Yes ☐ No		15	24
Lath m/c-03	H	☒ Yes ☐ No		7.5	24
Lath m/c-03	H	☒ Yes ☐ No		7.5	24
Grinder -1 m/c	H	☒ Yes ☐ No		5	24
Blower m/c	H	☒ Yes ☐ No		15	24

Overall Shed Potential: 37.5 kW **Low Priority Shed Potential: NIL kW**

Direct Shed Potential: 37.5 kW **High Priority Shed Potential: 37.5 kW**

Indirect Shed Potential: NIL kW

Process:

Description:

As discussed with plant owner in presence of TPDDL team ,at the time of audit we found that the following loads to be shed –

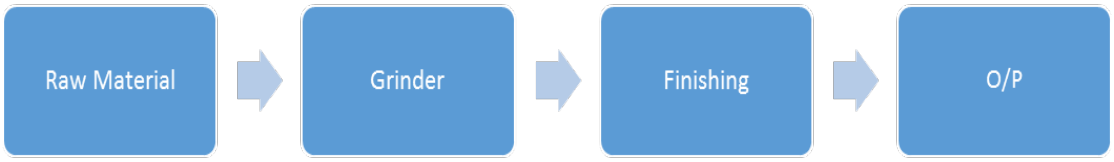
Name and Description of Equipment	**Avg HP**
Lath m/c-01	15
Lath m/c-02	15
Lath m/c-03	7.5
Lath m/c-03	7.5
Grinder -1 m/c	5
Blower m/c	15

Total Shed Load – 37.5 kW

***Costumer is agreeing for change to push button at the time of audit.**

Block Flow Diagram:

Load Details –



10.3 Field Survey Data

S.no	C. A number	Customer name	Type of facility	Senction load (kW)	Maximum demnad (kW)	Hours of operation	Overall shed potential (kW)	Direct shed potential (kW)	Indirect shed potential (kW)
1	60000000293	Omkara Developer	Shopping Mall / Show room	600	310	12	150	30	120
2	60000000376	Galaxy automobile	Shopping Mall / Show room	300	109	9	77	65	12
3	60000000525	Shri netaji flour mill	Flour mill	800	700	25	94	54	40
4	60000000566	MAX Hospital	Hospital	1310	855	24	308	252	56
5	60000001549	Mother dairy fruit & vrgetable	Food processing unit		2000	24	417		
6	60000001697	Sehgal art press	Printing press	285	291	24	94	94	0
7	6000000181	ality Ofsett	Printing press	280	190	12	38	38	0l

	2								
S.no	C. A number	Customer name	Type of facility	Senction load (kW)	Maximum demnad (kW)	Hours of operation	Overall shed potential (kW)	Direct shed potential (kW)	Indirect shed potential (kW)
8	60000001895	Batra art press	Printing press	150	105	24	30	30	
9	60000002083	Galaxy ofset (1) pvt lltd	Printing press	150	145	24	30	30	0
10	60000002364	Delhi flour mill	Flour mill	1485	1424	24	47		0
11	60000002521	Poly eva products	Rubber Industry	185	168	24	60	30	30
12	60000002539	Delhi school of economics	Educational Institute	607					0
13	60000002596	Facculty of art building	Educational Institute	1024					0
14	60000003057	Raves scan p ltd	Printing press	283	232	24	137	110	27
15	60000003214	Ashok flour mill	Flour mill	300	302	24	90	90	0
16	60000003271	Gogia flour mill	Flour mill	250	278	24	43	43	0
17	60000003396	Goldwn masala	Food processing unit	300	329	22	78	23	55
18	60000003503	Mahalaxmi roller flour mill	Flour mill	257		24	32	4	28
19	60000003966	Parmanad & sons food products	Food processing unit	240	362	10	30	15	15
20	60000004048	Satish Kr Jindel	Plastic industry	280		24			
21	60000004089	Gayatri polyrubs	Rubber Industry	285		24	100	100	0
22	60000004113	Bindal appearals	Shopping Mall / Show room	190	192	12	49	0	0
23	60000004139	Manas footwear ltd	Industrial	95	209	24	95		
24	60000004253	M/s Mahabir general mill	Flour / Rice mill	300	314	18	160	160	
25	60000004311	Bansal plastic industry	Plastic industry	175	225	12	45	45	0
26	60000004486	Rich like naresh kr	Flour mill	250	206	16-18	18	18	0
27	60000004626	Ram karan flour mill	Flour mill	240	246	12	30	26	22
28	60000004808	Avent agro p.ltd	Food processing unit	285	319	12	74	74	0
29	60000004956	Indian export house	Footwear	462		0	6	6	
30	60000005037	Honeywell polymer	Plastic industry	270	275	24	10	10	0
31	60000005086	J.K FOOD induartries	Flour / Rice mill	250	211	12	56	56	0
32	60000005151	SS food industries	food industries	243	230	41974	135	15	120
33	60000005292	J.K ENTERPRISE	Steel industry	250	224	24		30	0

34	60000005318	Manti enterprise	Plastic industry	200	147	24	64	64	0
35	60000005318	Manti entrerprise	Plastic industry	200	147	24	64	64	0
36	60000005474	delite plastic industry	Plastic industry	270	122	14	55	55	
37	60000005540	B.R ENTERPRISE	Steel industry	280	178	24	36	36	0
38	60000005565	Apex shoes pv ltd	Rubber Industry	241	262	24	65	40	25
39	60000005714	V.k box industries	Printing	200	136	0	150	150	
40	60000005920	lotus industries	Footwear	185		16	25	25	
41	60000006100	dandona industries	Plastic industry	300	115	24	108	108	0
42	60000006209	saroj hospital	Hospital	647	546	24	46	80	
43	60000006324	shyam udyog	Flour/Dal mill	150	104	0	60	5	55
44	60000006506	goyal food processors	Flour/Dal mill	180	152	18	92	10	82
45	60000006514	silvertone grand flex ltd		170		0	75	75	
46	60000006670	wheels india	Rubber Industry	225	120	24	45	45	45
47	60000006746	wheels polymer	Steel industry	270	326	24	120		0
48	60000006795	kanha keshav food	Food processing unit	300	220	24	62	62	0
49	60000006803	unisex footwear	Footwear	150		0			
50	60000006910	arihant footwear	Rubber Industry	180	98	12	55	55	0
51	60000006928	print shop	Printing	140	116	0		35	35
52	60000006969	ok indusytries	Steel industry	214	189	12	38	38	0
53	60000007058	steel world p ltd	Rubber Industry	150	110	12	60	60	0
54	60000007082	ahuja engg works	Steel industry	150		24	75	75	0
55	60000007207	Himgiri pvt ltd	Shopping Mall / Show room	200	151	10	24	24	0
56	60000007322	AIMIL pharama p ltd	Pharma Industry	190	190	16	35	35	
57	60000007504	E V see footwear	Footwear	180	143	9	23	23	0
58	60000007629	ARBRD pharmaceutical	Pharma Industry	250	245	8	48		0
59	60000007975	naveen	Footwear	200		16	40		
60	60000008171	chetan kanodia	Plastic Industry	220	218	24	36	36	0
61	60000008262	ranbilas	Flour mill	280	340	12	148	148	
62	60000008296	mr overseas p ltd	Flour / Rice mill	600	428	0	250	250	
63	60000008353	aggarwal trading company	Food Industry	290	464	0	100	100	

64	60000008460	parvesh overseas	Flour / Rice mill	150		12	48	23	25
S.no	**C. A number**	**Customer name**	**Type of facility**	**Senction load (kW)**	**Maximum demnad (kW)**	**Hours of operation**	**Overall shed potential (kW)**	**Direct shed potential (kW)**	**Indirect shed potential (kW)**
65	60000008676	unitech amusement park	Amusement Industry / Park	4000	1844	8	482	482	
66	60000008742	jai prakash	Plastic industry	180	144	12	38	23	15
67	60000008858	shwet garg nirman	Amusement Industry/cinema hall	400	195	0	21		0
68	60000008890	Mahender kumar garg	Flour mill	248	254	24	45	45	0
69	60000008959	BPIT	Educational Institute	250	114	12	27	27	
70	60000009062	Pooja int p.ltd	Plastic industry	320	171	12	110	40	70
71	60000010151	Vinayak agro p ltd	Flour / Rice mill	250	347	0	44	44	
72	60000010193	Dev kishan & coms	Cold storage	295	120	24	45	45	0
73	60000010300	Jaswant cold storage anice facyory	Cold storage	298	286	24	84	84	0
74	60000010417	Rajdhani cold storage	Cold storage	257	103	24	50	50	0
75	60000010466	MERA BABA	Shopping Mall / Show room	1000	543	10	35	35	0
76	60000010631	Jolly ice & cold storage	Cold storage	393	307	24	63	63	0
77	60000010912	Vidya ice & cold storage	Cold storage	190	260	24	90	90	
78	60000011340	AVSL industries	Plastic Industry	220	235	24	120	120	0
79	60000011365	Shrinivas dal & besan mill	Flour / Dal mill	285	293	12	145	11	135
80	60000011530	Gemscab cable	Steel industry	269	159	24	31		0
81	60000011878	Sylvania and laxman	Steel industry	175	185	10	25		0
82	60000012140	Siddharth Printing press	Printing Press	162	108	0	25	22	3
83	60000012207	Surinder kr singhal	Flour mill	290	356	12	50	50	
84	60000012264	Sachdeva polycabe p ltd	Plastic industry	130	124	0	80	60	20
85	60000012413	Jaiprakash bindal	Rubber Industry	200	215	12	73	73	0
86	60000012496	Victoria food	Flour mill	1400	1062	24	238	30	208
87	60000012553	Sunbeen food product p ltd	Food Industry	150		12	120	60	60
88	60000012736	Ganga rollr and flour mill	Food Industry	850	750	24	165	0	0
89	60000012868	Modern flour mill	Food Industry	650	414	12	76	37	39
90	6000001293	Mark	Steel industry	492	611	0	95	95	0

	4	sanitation p ltd							
S.no	C. A number	Customer name	Type of facility	Senction load (kW)	Maximum demnad (kW)	Hours of operation	Overall shed potential (kW)	Direct shed potential (kW)	Indirect shed potential (kW)
91	60000013056	Delux cold storage	Food Industry	650	506	24	132	12	120
92	60000013155	Ashulea roller flour mill	Food Industry	312	311	24	90	90	0
93	60000013312	KC plastic	Plastic Industry	400	425	12	78	74	3
94	60000014104	Sushil ice & cold storage	Cold storage	806		24	180	180	0
95	60000014112	REPS-2	STP-PUMP STATION	142	181	24	48		0
96	60000014179	DCICS tech centre building	STP-PUMP STATION	593	444	12	50	50	0
97	60000014211	Hanuman steel udhyog	Steel industry	350	184	24	153	145	8
98	60000014229	REPS-1	STP-PUMP STATION	142	136	42339			0
99	60000014427	Pawan steel	Steel industry	200	171	24	168	18	150
100	60000014484	K D Ramlal & co	Steel industry	350	228	24	67	67	0
101	60000014807	Hanuman enterprise	Steel industry	160	152	24	15	15	0
102	60000015010	Vimal industrial plastics	Rubber Industry	210	156	24	75	75	0
103	60000015036	Kanodia Techno Plast (P) Ltd.	Printing	285	121	24	66	0	0
104	60000015056	Kanodia Techno Plast	Polymer	285	262	24	0	0	0
105	60000015069	Sankar Molding Pvt Ltd.	Plastic Industry	200	221	27x7	0	0	0
106	60000015176	Excellent power cable p ltd	Steel industry	210	203	24	94	94	0
107	60000015226	Satnam rubber enterprises	Rubber Industry	170	194	12	56	56	0
108	60000015291	Delhi bottling co. ltd	Plastic Industry	800	757	16	60	60	90
109	60000015358	Goramal hariram p.ltd	Plastic Industry	355	152	0	28	28	0
110	60000015762	Badri Prasad	Rubber Industry	125	98	12	75	30	45
111	60000015804	Super wire drawing	Steel industry	150		0	10	10	
112	60000015929	kapoor rubber	Footwear	300	176	12	22	22	0
113	60000016463	Kamalex polyrex	Plastic Industry	380	272	24	75	75	0
114	60000016471	G.v.s international	Footwear	335	321	12	165	8	138
115	60000016596	Aar AAY Products (P) Ltd.	Rubber Industry	184	163	24x7	97	97	0

116	60000016745	Asian udhyog	Rubber Industry	150	110	12	70	10	60
S.no	**C. A number**	**Customer name**	**Type of facility**	**Senction load (kW)**	**Maximum demnad (kW)**	**Hours of operation**	**Overall shed potential (kW)**	**Direct shed potential (kW)**	**Indirect shed potential (kW)**
117	60000016844	Bonne care p ltd	Steel Industry	180		0	23	23	
118	60000017222	P Suren & company	Plastic indutry	235	125	12	54		
119	60000017487	Swatantra bharat leather cloth	leatherIndustry	190	62	0	40	40	
120	60000017545	Bal krishan vijay kr.	cold rolling	95	101	24	32	32	
121	60000017990	Amul Aggarwal	Food processing unit	101		0			
122	60000018014	Bhola Nath Foods Ltd.	Food processing unit	340	599	16	160	150	10
123	60000018048	Harpeet motor	workshop & showroom	287	403	10	11	11	
124	60000018162	Jay son	Steel Industry	128	120	12	43	43	
125	60000018857	Avent agro p.ltd	Food processing unit	120	243	16	49		
126	60000019061	Manu plastic	automobile industry	125	90	12	22	22	
127	60000019202	Hero plastic		170		0			
128	60000019285	Anand oil and flour mill	oil	180	105	24	170	15	154
129	60000019442	Best health food process	industriala	300	345	24	60	60	
130	60000019509	Chhabra & company	plastic industry	260	171	12	37	37	37
131	60000019723	Chuna mal ram nath	Cold storage	150	141	20	60	55	5
132	60000019806	Mera baba reality assosiate	mall	2000	1569	14	399	399	
133	60000019855	Sangat printers	printing press	220	222	12	128		
134	60000019913	Jai prakash food	Food processing unit	160	79	12	40	20	20
135	60000019970	Dutta rubber	Rubber Industry	150	156	12	20	20	
136	60000019988	JBS industries	Rubber Industry	192	129	0	23	23	
137	60000019996	Alipur pipe steel	steel	250	115	24	66	66	
138	60000020093	Calco polychem p ltd	polymer	300	316	24	69	69	
139	60000020135	Rubber hose	glass industry	285		12	14	14	0
140	60000020168	Horizon Industrial product	steel	250	155	24	40	40	
141	60000020184	AVM industry	steel	285	220	24	67	67	
142	60000020192	Puri optical works	glass industry	316		12	20	20	
143	60000020226	Hitkari brother	steel industry	150	82	14	30	30	

144	60000020309	Jupiter Polytech Pvt. Ltd.	Plastic	200	169	24	25	25	0
S.no	**C. A number**	**Customer name**	**Type of facility**	**Senction load (kW)**	**Maximum demnad (kW)**	**Hours of operation**	**Overall shed potential (kW)**	**Direct shed potential (kW)**	**Indirect shed potential (kW)**
145	60000020879	Central hosiery agencies	Plastic industry	200	118	24	52	38	15
146	60000020887	Mansfield conveyors	glass industry	750	426	12	23	23	
147	60000022982	AVSL industries	pvc	200	198	24	71	71	
148	60000023162	M/s IESISL	booster pump station	200	197	16	163	163	
149	60000026017	Roshanlal	copper wire drawing	262	224	24	83	83	
150	60003132655	TATA POWER(CENNET BUILDING)	Shopping Mall / Show room	90		0	5	5	
151	60006603496	Ajit industries	Plastic Industry	126	250	24	125	125	
152	60013266568	Tirupati food ind pvt ltd	Food processing unit	191	166	24	92		
153	60013286863	Color catalyst design p.ltd	Printing	375	345	12	36	18	19
154	60014264869	Govind ram kaham chand	Food processing unit	400	294	12	52	52	0
155	60014480499	Promilla roller flour mill	flour mill	650	434	12	27	27	
156	60014653095	Shree durga flour mill	flour mill	200	349	12	72	5	67
157	60014736932	Agro pure capital food	Food processing unit	650	400	24	30	30	
158	60015019619	Upaj Build Con Pvt Ltd		900	200	0	70	70	
159	60015627668	Golden masala	Food processing unit	400	340	12	75	75	0
160	60016010071	Delight Filteration Pvt Ltd.	plastic industry	0	204	0	60	60	
161	60016082103	Balraj singh	Rubber Industry	400	300	24	54	54	
162	60016211942	Ajay aggarwal	steel industry	350	272	14	160	160	
163	60016859401	Sourcewell agro food	Flour mill	1000		24	121	121	
164	60016882643	Kamal Jain	Steel Hot Rolling	218	138	24	150	150	0
165	60016958179	Coaster shoes company	Rubber Industry	220	216	24	48	18	30
166	60017543608	Durga Flour Mill	Flour mill	645		0			
167	60000000171	Chetan Kanodia	Plastic Industry	220	218	0	0	0	0
168	60000000210	Som fragnance		500		0	37		
169	60000000236	Best heallth food ltd	Food processing unit	850	587	15	15	15	0
170	60000003552	New Nirankari oil & gen. mill	Food processing unit	600	438	24	84	71	12

171	60000003735	Vikas pulse pvt ltd	Food processing unit	300	278	12	107	52	55