August' 2016

Report on

Load Forecasting Study and Preparation of Action Plan for Short Term (2-5 yrs), Medium Term (7-10 yrs) and Long Term (15-25 yrs).

Submitted to

Chandigarh Electricity Department

Submitted by
Feedback Infra Private Limited
ENERGY DIVISION

FEEDBACK INFRA
Making Infrastructure Happen

This volume has been prepared by Feedback Infra Private Limited (hereinafter, "Feedback Infra") based on the information shared by Chandigarh Electricity Department. (Hereinafter referred to as "CED" or "the Client") for load forecasting activity of Chandigarh Electricity Department.

The report has been prepared, within the confines of the Contract with the Client and the terms of reference for this assignment. The Report is intended for the sole use of the Client.

Feedback Infra accepts no liability of any kind and disclaims all responsibility for the consequence of any person (other than the Client on the above basis) acting or refraining to act or for any decisions made or not made that are based upon the Report.

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1. Executive Summary

Chandigarh Electricity Department (CED) vide its Memo No. EE/OP2/FY15-16/T.No. 42(14-15)/702 dated 21/ 01/16 mandated Feedback Infra Pvt. Ltd. to carry out "Load Forecasting study along with Preparation of Action Plan for short term (2-5 Years), medium Term (7-10 Years) and long term period (15-25 years) in the Electricity Dept. U.T. Chandigarh along with its submission, presentation and defense before J.E.R.C "

The Consultant has estimated the peak demand and energy availability till 2040 using econometric analysis. The consultant has also analyzed the demand supply gap month on month for the next three years (up to 2019).

In Line with the scope of work M/s Feedback Infra Pvt. Ltd. has done the following:

- Prepared an econometric model using Regression Analysis following the methodology presented before and approved by the JERC on 13th April, 2016.
- Prepared a Load Forecasting Model with 2015-2016 as the base year.
- Determined a demand supply gap analysis based on the three years of generation plan data provided by the CED officials against the projected demand.
- Forecasting of demand under three scenarios: optimistic, conservative and most likely.
- Summarizing results and formulating procurement strategy to meet the demand supply gap.

It was observed that while the gap between demand and supply in energy terms is within an acceptable range, the peak deficit is seen to be rising every year. This is owing to a very low annual and daily load factor.

Electrical Dept., UT Chandigarh needs to strengthen its distribution infrastructure to cope with the increasing peak load, and also adopt demand side management (DSM) measures to flatten the load duration curve. The use of DSM measures would be more suitable and financially viable to the CED as they prevent unnecessary capacity allocations.

The Projected Energy Demand and Peak Load as per the model is summarized below:

Table 1: Projected Energy Demand and Peak Load as per the model up to 2040

Year	Input Energy Requirement (MU)	Peak load (in MW)
2015-16	1,983	464.68
2016-17	2,048	477.78
2017-18	2,137	496.12
2018-19	2,227	514.85
2019-20	2,320	533.97
2020-21	2,388	542.98
2021-22	2,484	567.44
2022-23	2,581	587.59
2023-24	2,681	608.17
2024-25	2,783	629.20
2025-26	2,887	650.67
2026-27	2,994	672.61
2027-28	3,103	695.02
2028-29	3,179	704.03
2029-30	3,292	733.52
2030-31	3,406	757.16
2031-32	3,524	781.31
2032-33	3,644	805.99
2033-34	3,767	831.21
2034-35	3,892	856.99
2035-36	4,021	883.33
2036-37	4,152	910.25
2037-38	4,286	937.76
2038-39	4,423	965.88
2039-40	4,563	994.62

2. Project Background

2.1 About Electricity Department of UT, Administration of Chandigarh

Union Territory of Chandigarh came into existence from 1st November 1966 after re-organization of the erstwhile state of Punjab. The total population of the union territory was around10.5 lakhs as per 2011 census

The Engineering Department of Chandigarh Administration is responsible for creating and maintaining the entire infrastructure in the territory of Chandigarh comprising of road network, providing and laying of water supply system, providing and laying underground sewerage and storm water drainage system, distribution of electric power and construction of various public buildings and housing accommodation for government employees.

Electricity Department, under The Engineering Department of Chandigarh Administration of UT Administration of Chandigarh, is responsible for arranging power from various sources (as Chandigarh does not have its own source) and distribution and transmission to all types of consumers.

The Chandigarh Electricity Department 'hereinafter called CED', a deemed licensee under section 14 of the Electricity Act 2003, is carrying out the business of transmission, distribution and retail supply of electricity in Chandigarh (UT). The Chandigarh Electricity Department (CED) functions as an integrated distribution licensee of Union Territory of Chandigarh.

2.2 Rationale of the project

The cost of power constitutes the largest single component of the annual revenue requirement. It is therefore the responsibility of the distribution licensee to procure power at the least cost so as to minimize the overall cost to the consumer. At present, the U.T of Chandigarh has no generation of its own and hence, it sources power from central generating stations depending upon their allocation. It is important to meet the power requirement of consumers in a manner which is both reliable and cost-effective. With emphasis on "Power for All 24x7" and load growth, power requirement continues to grow and hence, the additional purchases will be required to meet the consumer power demand.

In the Tariff order issued by JERC for the FY 12-13 and FY 13-14, the commission advised CED to conduct load forecasting study as the Chandigarh Electricity Department is purchasing the short fall power through competitive bidding & through power exchanges. With this background the commission directed CED to conduct detailed load forecasting study, and also directed it to go for long term PPAs to meet with the base load requirement excluding more than I MW open access consumers. It felt that load forecasting study including load profile is imperative to assess peak and off peak power requirement and to use the forecasted demand to plan power procurement with an optimum mix of long term and short term power purchase arrangements with the aim of providing reliable power supply at an optimal cost. In compliance with the directions of the commission, the present study for load forecasting for short-term (2-5years), medium term (7-10 years) and long term period (15-20 years) respectively has been undertaken.

2.3 Key project steps

The broad steps as involved in the study are as follows:

- **Demand Forecast**

Assessment of unrestricted demand for power in MW and energy in MU across all consumer categories has been done - for short term, medium term and long term.

The demand forecast is based on following parameters:

- Overall economic growth projections of the state,
- Trends and statistical analysis of the historical data,
- Future projections taking into account efficiency improvement plans, investment plans, and others.

- **Assessment of the power availability**

Along with the power demand, it is important to assess the power availability and sourcing from different sources of power taking into account the daily and seasonal load profiles

- Existing shared sources of power including state owned, central government owned generating plants, non-conventional energy generators, CPPs and IPPs.
- Availability of power from traders, neighboring states, power exchange and other sources on competitive basis
- Share from new generating plants, UMPPs etc. due for commissioning.
- Renovation and modernization, upgradation, phasing out of existing plants.
- Constraints in intra-inter regional/ State, if any, affecting the bulk power transfer and other technical factors.

3. Power Scenario in Chandigarh

3.1 Area Served

Chandigarh comprises of an area of 114 sq. km. For operational purpose the area has been divided into 4 divisions namely Div-1, Div-2, Div-3 and Div-4.

The map of the area served is as below:

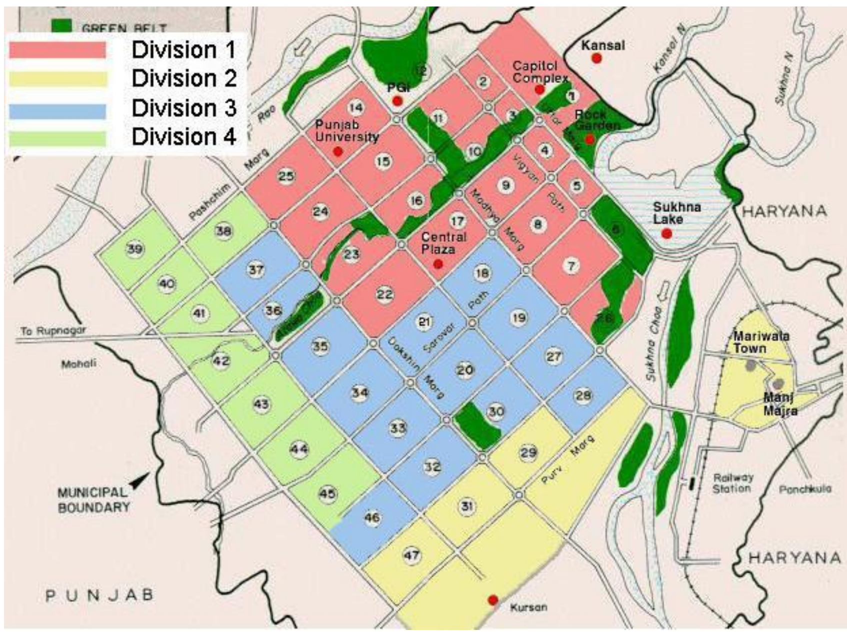

Figure 1: Chandigarh Division Map

3.2 Transmission and Distribution Network

Chandigarh Electricity Department serves a population of around 10. 5 Lacs as of 2011 according to Census of India, spread across an area of 114 sq. km. The transmission and distribution system in Chandigarh consist of 220 kV, 66 kV and 33 kV sub-stations. Power supply to Chandigarh is received mainly through the three sources, namely 220 kV Sub Station at Kishangarh Manimajra through 220KV double circuit Chandigarh-Nalagarh line of Power Grid, 66 KV Chandigarh-Mohali line at 66 KV Substation Sector-52 and Sector-39, Chandigarh-Dhulkot 66 KV line at Sector-28 Substation.

The details of the substations are as below:

Table 2: List of Substations in Chandigarh

S. No	Name of S/s	Substation Voltage Level (KV)	Installed Capacity (MVA)
220 kV substations			
1.	Kishangarg	220/66 KV	300 MVA
66 kV Substations			
2.	B.B.M.B Sector-28	66/33/11 KV	107.5 MVA
3.	Sector-52	66/33/11 KV	107.5 MVA
4.	Sector-56	66/11 KV	40 MVA
5.	Sector-39	66/11 KV	52.5 MVA
6.	Sector-12	66/11 KV	50 MVA
7.	Sector-12	66/11 KV	25 MVA
8.	Industrial Area Ph. 1	66/11 KV	57.5 MVA
9.	Industrial Area Ph. 2	66/11 KV	45 MVA
10.	Sector-32	66/11 KV	45 MVA
11.	I.T. Park M/Majra	66/11 KV	60 MVA
12.	Sector-47	66/11 KV	40 MVA
13.	Mani-Majra	66/11 KV	40 MVA
14.	Sector-18	66/11 KV	45MVA
33 kV substations			
15.	Sector-17	33/11 kV	43.5 MVA
16.	Sector-18	33/11 kV	24.5 MVA
17.	Sector-34	33/11 kV	25 MVA
18.	Sector-37	33/11 kV	10 MVA
19.	Industrial Area Ph. 1	33/11 kV	12 MVA

3.3 Power Demand and Supply

The total energy sold in Chandigarh has gone up-to 1482 MU in FY 2014-15 with Division 1 and Division 2 together consuming around 60% of the total energy sold and Division 3 and Division 4 accounting for the balance 40%.

The growth of energy sold during last 5 years in the 4 divisions is shown below in the chart below:

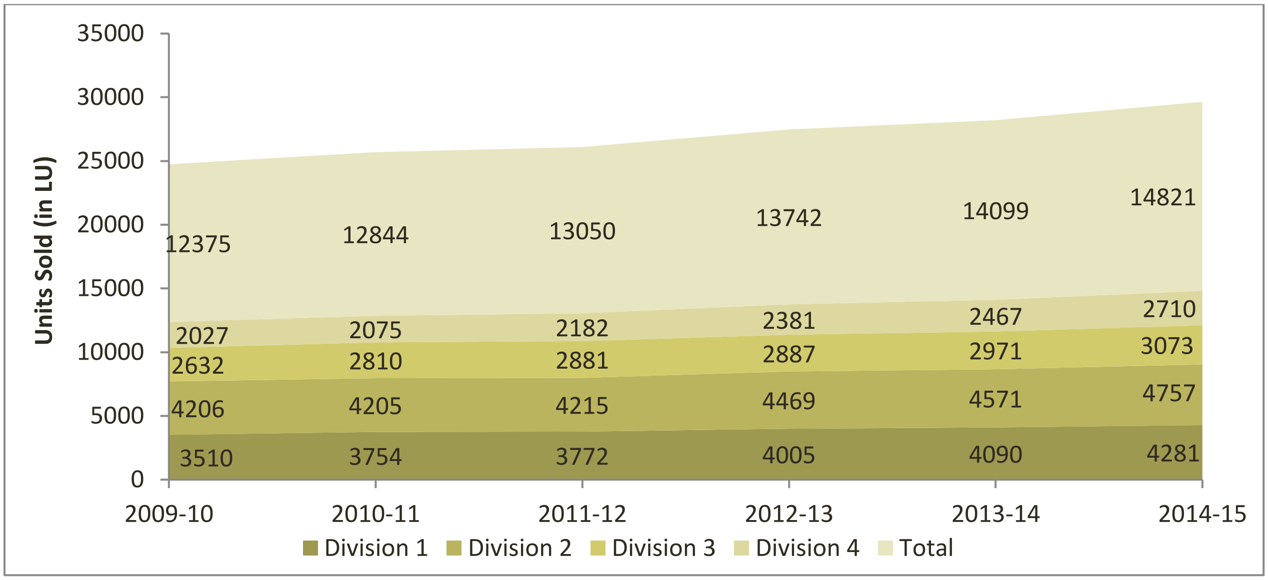

Figure 2: Units Sold Per Division

It is well understood fact that energy demand is a function of seasonal variations. As may be seen from the monthly energy sales given below, energy sales goes up during summer months of July to October and then decreases again as winter approaches.

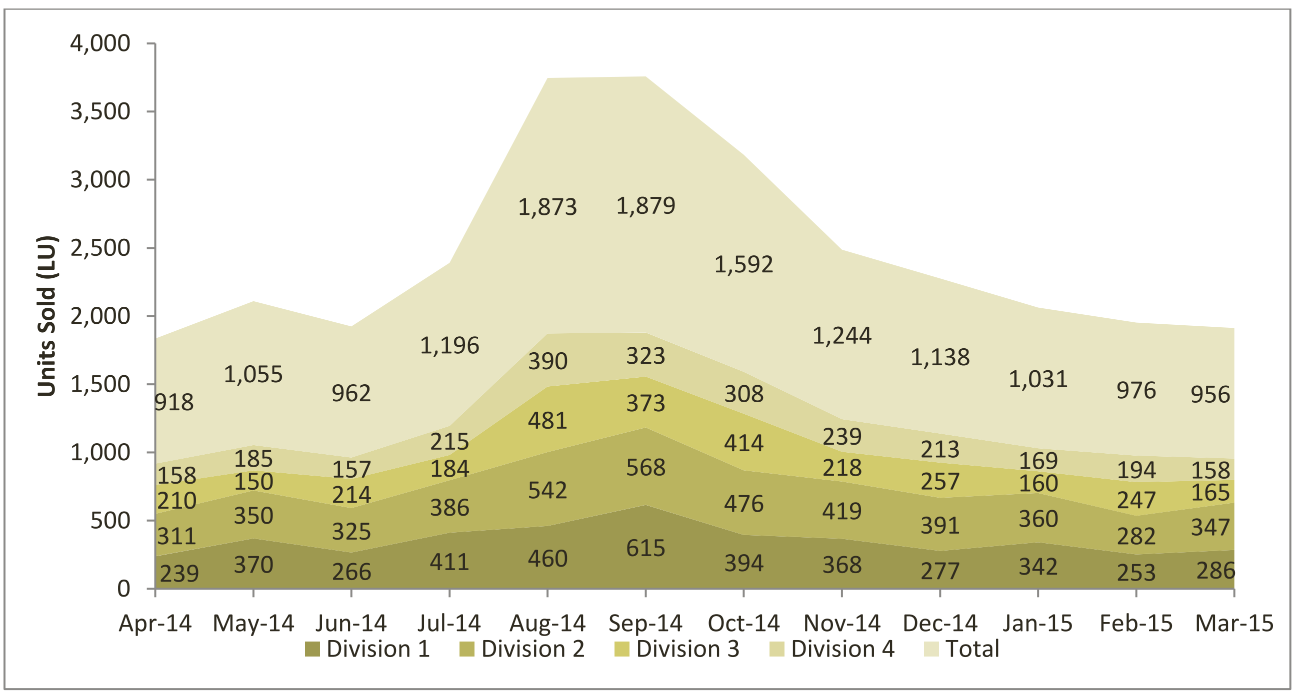

Figure 3: Energy sales

The contribution of the divisions to the energy sold is given below:

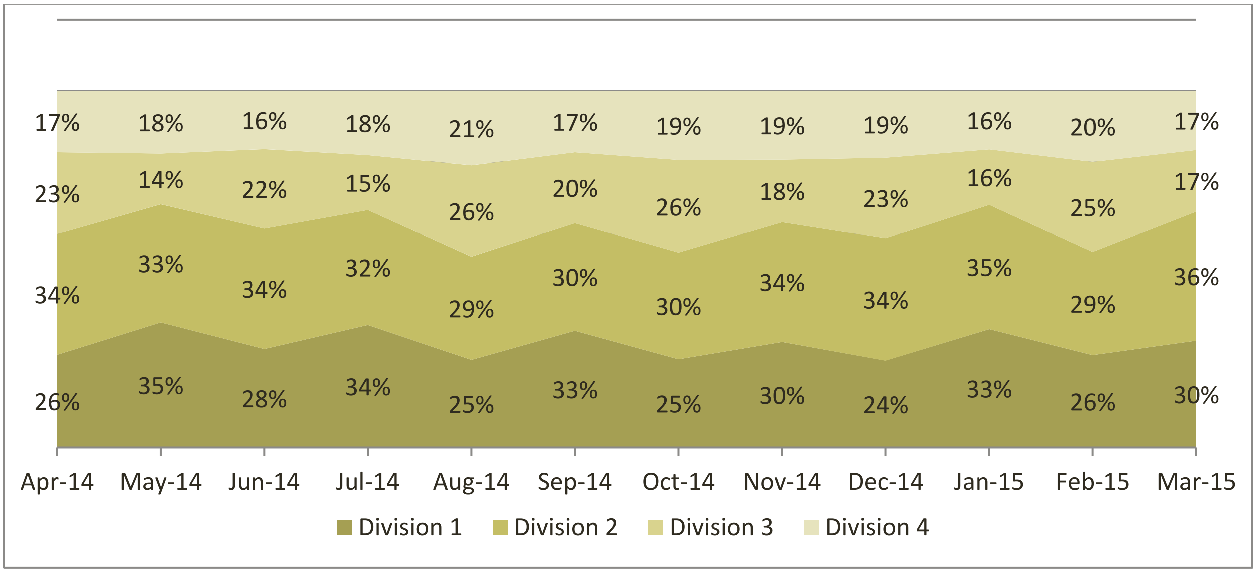

Figure 4: Contribution to energy

3.4 Energy Usage Pattern

The consumers in the region are categorized into nine categories, namely – Domestic, Commercial, Large Supply, Small Power, Medium supply, Agriculture, Public Lighting, Bulk Supply, Other - Temp.

Three of the above seven consumer categories, namely, *agricultural*, *public lighting* and *temporary connections*, together account for less than 2% of the total consumption. They also do not exhibit any definitive pattern in energy consumption from year to year. Hence these three groups have been clubbed together. Thus, for the purpose of study, seven broad categories have been considered.

It is observed that domestic category has been dominant consumer of the energy sold, followed by commercial category. These categories together consume around 70% of the energy consumption. Large supply consumes around 10% of the energy consumption and rest 20% is shared among categories - Small Power, Medium supply, Bulk Supply and Others.

The usage pattern is unchanged for the last 9 years and is as given on the next page:

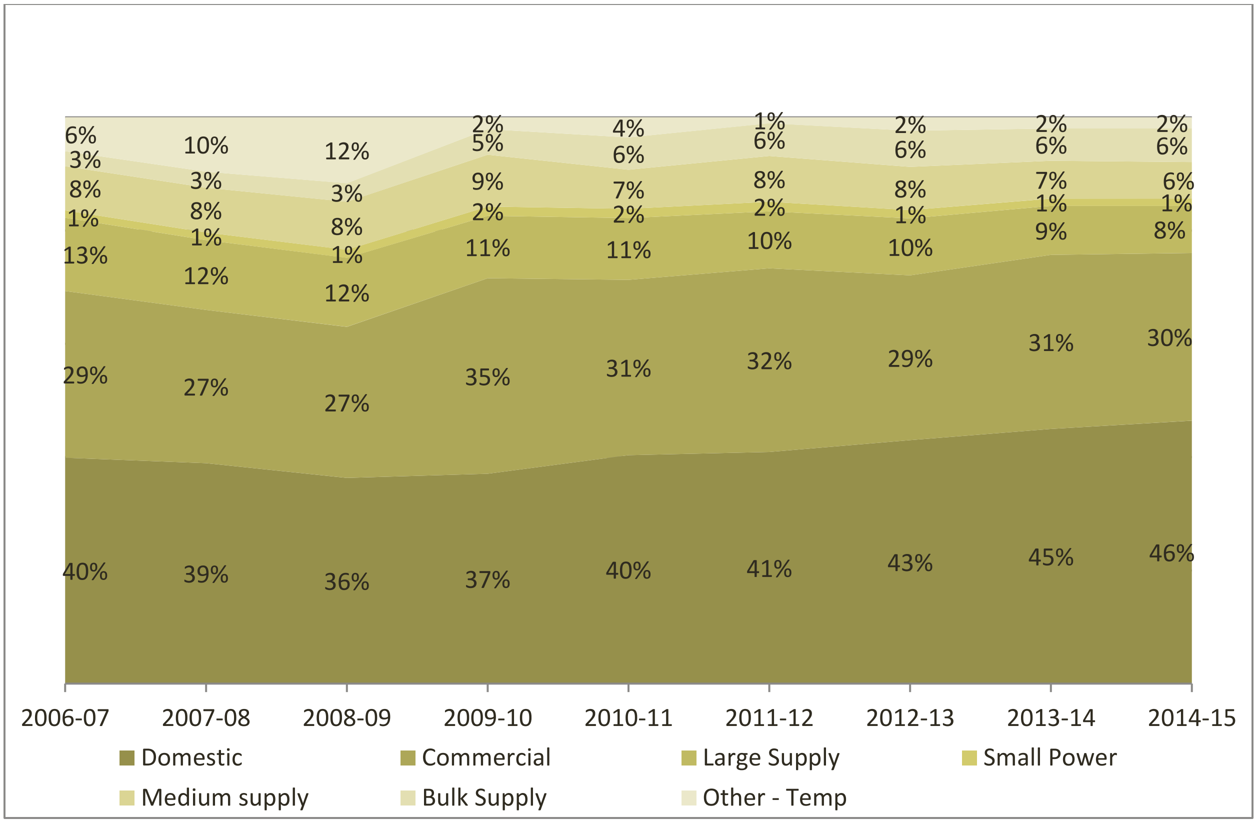

Figure 5: Energy Usage Pattern

3.5 Input Energy and T&D loss

The U.T of Chandigarh has no power generation capacity of its own and is completely dependent on allocation of the power from generating stations in other states. The trend of input energy and total energy billed is as below:

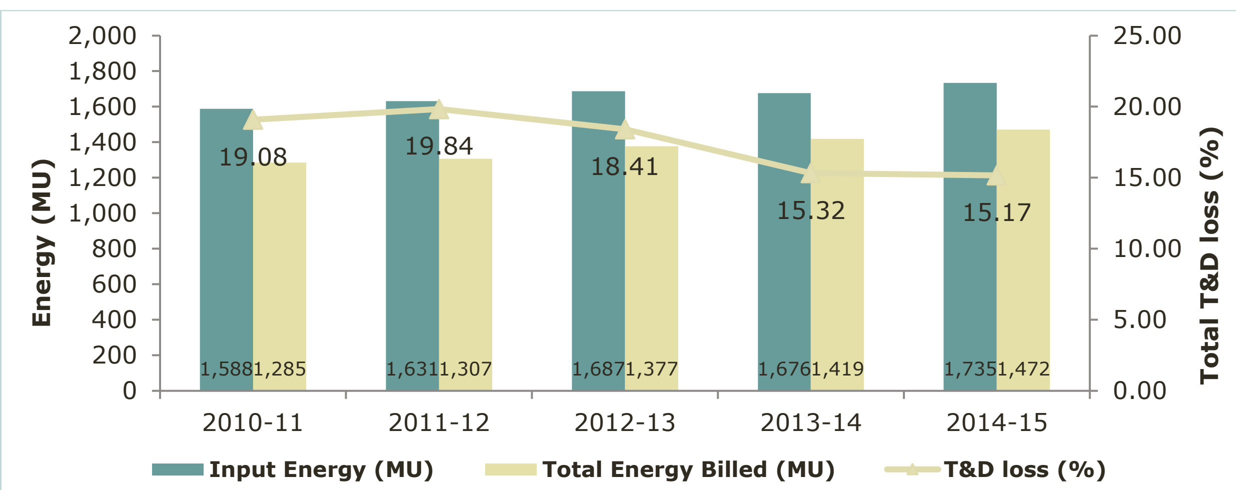

Figure 6: T & D Losses Graph

4. Assumptions

4.1 Assumptions for Energy forecasting

1. For energy forecasting purposes, Chandigarh consumers are classified into seven categories viz.
    a. Domestic
    b. Large Supply
    c. Medium Supply
    d. Small Supply
    e. Commercial
    f. Bulk Supply
    g. Others (Agricultural, Temporary Power and Street Lighting) category
2. Category wise energy sales data for FY 2006-07 to FY 2012-13 have been considered as input data for regression analysis Data for 2013-14 has not been considered as the economic data is available up to 2012-13.
3. Technical losses have been assumed at 10 % in consultation with CED officials. However it is assumed to decline as the years progress to 7% in 2039-40
4. Commercial loss was attributed to following consumer categories in proportion to the their sales:
    a. Domestic
    b. Commercial
    c. Small Power
    d. Medium supply
    e. Other – Temp

HT and Bulk Consumer categories were excluded as it is believed that there is zero commercial loss involved in their cases.

4.2 Assumptions for Demand forecasting

1. For Demand forecasting purposes, entire Chandigarh is assumed to be classified into 4 categories viz. Domestic, Industrial (Large, Medium and Small Supply), Commercial and Bulk. Other categories (Agricultural, Temporary Power and Street Lighting) have not been considered as they together account for only 2 % of the total energy delivered.
2. If a feeder is predominantly (80%) catering to a certain category, then that feeder is categorized under the said category and is assumed to portray the same load profile over the years.
3. The sample feeders are assumed to exhibit the load pattern of their respective categories.
4. The base year for load Forecasting has been taken as 2015 – 2016. All the estimates and projections are based on the ampere log book data collected for the base year.

5. Log book entries of the base year have been collected from Jan'2015 to Dec'2015. They are assumed to represent FY 15-16 as well, within the same readings.
6. The missing data in the manual log books, when the Feeder CB was OFF/ON/PTW is assumed to have the same demand as in the corresponding time slot of the preceding date.
7. Power factor is assumed at 0.9 for base year 2015 - 16.

4.3 Incorporation of Energy Efficiency and DSM Practices into Regression Model

As per Table 8.2 of "Power for All" Document Provided by Chandigarh Administration, it can be seen that the expected annual savings in energy is approx. 12.56 MU, which has a negligible effect and is within the margin of error allowed for the load forecasting study. Hence energy efficiency and DSM practices are not considered and their effects.

4.4 Incorporation of Metro Load

As per DMRC letter ref. no DMRC/Elect/DPR/Chandigarh/2012/32223 to Chandigarh Administration dated April, 16th 2012, the expected Metro Load can be found. However a timeline cannot be assigned to it and no clarity exists on whether the project would actually see the light of the day. Since electrical load is the last activity for a Metro Project it can be safely assumed that no load would be added in 3-5 years. For these reasons the Metro Load has not been taken into account for the load forecasting study.

5. Energy Forecasting: Approach and Methodology

5.1 Importance of Load Forecasting Model

Accurate models for load forecasting are vital to the operation and planning of a utility company. Load forecasting helps an electric utility to make important decisions including decisions on power purchasing and generating electric power, load switching and infrastructure development.

5.2 Forecasting: Time Horizons & Forecasting Techniques

Load forecasts can be divided into three categories: *Short-term forecasts, which are usually from one hour to one week, medium-term forecasts, which are usually from one week to one year and long-term forecasts, which are longer than a year*. The forecasts for different time horizons are important for different operations within a utility company. The natures of these forecasts are different as well. For example, for a particular region, it is possible to predict the next day peak load with an accuracy of approximately 1-3%. However, it is impossible to predict the next year peak load with similar accuracy since accurate long term weather forecasts are not available. For the next year peak forecast, it is possible to provide the probability distribution of the load based on historical weather observations.

Most forecasting methods use statistical techniques or artificial intelligence algorithms such as regression, neural networks, fuzzy logic and expert systems. Two of the methods, the End Use method and econometric approach are generally used for medium and long term forecasting.

1. Short Term Forecasting

Short term load forecasting can help to estimate load flows and to make decisions that can prevent overloading. Timely implementation of such decisions leads to the improvement of network reliability and to reduced occurrences of equipment failures and blackouts. A variety of methods, various regression models, time series, neural networks, statistical learning algorithms, fuzzy logic, and expert systems have been developed for short term forecasting.

2. Long Term Forecasting

Time series, *end use*, *econometric modeling* and their combinations are the methods most often used for medium and long term load forecasting.

3. End Use Models

The *End Use* approach directly estimates energy consumption by using extensive information on end use and end users, such as appliances, the customer use, their ages, sizes of houses, and so on. Statistical information about customers along with dynamics of change provides the basis for forecasts.

End use methods explain energy demand as a function of the number of appliances in the market. Ideally this approach is very accurate. *End use* forecast requires less historical data but needs a large amount of information relevant to appliances, including their age profile, customers, economics, etc. The method is complicated. Besides, collecting such information is difficult, requires a lot of human interface, and often much of the required information is not available at all.

4. Time Series Models

A *time series* is a sequence of data points, measured typically at successive times spaced at uniform time intervals. Examples of time series are the daily closing value of the Sensex or the annual flow volume of Yamuna at Delhi. *Time series* analysis comprises methods for analyzing *time series* data in order to extract meaningful statistics and other characteristics of the data. *Time series* forecasting is the use of a model to forecast future events based on known past events. An example of *time series* forecasting in econometrics is predicting the opening price of a stock based on its past performance.

When applied to load forecasting, it translates to extrapolating the past consumption pattern to the future. Using compounded annual growth rate (CAGR) for forecasting constitutes the simplest application of *time series* modeling.

5. Econometric modeling

The *econometric approach* combines economic theory and statistical techniques for forecasting energy demand. The approach estimates the relationships between energy demand (dependent variable) and economic and demographic factors influencing demand (independent variables), aimed at building robust and accurate load forecast models that are able to predict energy demand within reasonable margins of error, and application of the models so prepared to provide long term forecast of energy sales to various consumer categories (based on tariffs applied) and the total energy requirement to meet the demand.

It is widely recognized that demand for electrical energy is determined by various economic and demographic factors. In the present assignment *Regression Analysis* has been used as a tool to determine whether and how these factors determine the demand for electrical energy. These selected economic and demographic parameters constitute *independent variables* in regression analysis while energy requirement constitute *dependent variables*. It is important to highlight that reliability and robustness of the models are dependent on correctness of data used.

Consumer category wise annual energy requirement for the years 2006-07 to 2012-13 computed by adding billed energy and commercial loss for a given year are the dependent variables whose forecasted values determine the aggregate demand. Economic and demographic input data used are statistical data made publicly available by Government of India and Chandigarh Administration – the government statistics for district-wise GDP and the central government census data for population and population growth. 5-year compounded annual growth rates (CAGR) have been used to project population and GDP in the future years.

5.3 Reference Models

Long term load forecasting based on econometric models suitable for a distribution utility in India cannot draw much from models used in the western world because of following reasons which make their rules of business very different from what we have in India.

i. **"Commercial loss"** owing to theft, meter tampering, meter bypass etc. is virtually absent and loss due to meter and billing errors is too small to cause a significant difference between energy supplied and energy billed to a consumer.

ii. Long term power deficits requiring regular **load shedding** are not common in the developed world. Thus there is no difference between the demand of a consumer and the energy consumed by him. In the Indian context it is important to determine the unrestricted demand of a consumer by taking into account energy not served and then work backwards to see how much energy can be actually supplied given the actual availability at the receiving bus bars of the distribution utility.

iii. Tariff does not have to be built by taking into account the element of cross subsidies. Hence they do not require consumer category wise sales projections.

1. Input Data:

Regression analysis requires the energy data (dependent variables) and the GDP and population data have to be for the same period. Since the latest GDP data available is for the year 2012-13, the energy data used is also for period up to the same year. Regression analysis has been done on 7-years' data, whence the period selected for regression analysis is 2006-07 to 2012-13.

2. Drivers of Energy Demand

Following economic and demographic drivers have been selected for building the sales forecasting models:

i. Population
ii. Per capita GDP
iii. Contribution of tertiary sector of economy to per capita GDP

Electrical energy demand is price inelastic and tariff has little or no relationship with consumption. Hence, it has not been considered a driver of demand of electrical energy.

As will be seen later, regression analysis of energy requirement and economic and demographic drivers considered above may reveal that energy requirement of a given consumer class has a predictable relationship with one, two, all three or none of the drivers.

3. Discarded Independent Variables

Following factors, initially considered as possible predictors of demand were discarded before performing regression analysis owing to the reasons given against each:

i. Energy intensity of economy:

Energy intensity of economy is defined as primary energy used to produce 1 unit of GDP. Country-wise figures of energy intensity of economy in BTU per US Dollar (at constant year 2000 prices) from year 1980 to 2011 are available from the website of Energy Information Administration of US.

Energy intensity of economy tells us how much energy a country consumes to produce one unit of wealth. Lower the energy intensity of a country's economy, more efficiently it uses energy. However, this index is not a straightforward indicator of energy efficiency. It depends heavily on the relative contribution to GDP from primary, secondary and tertiary sectors of economy. Higher the contribution of industrial (secondary) sector to a country's economy, higher its energy intensity tends to be. Higher the energy efficiency of a country, lower the energy intensity of its economy tends to be. Thus, energy intensity is a function of both the above parameters, having positive correlation with one and negative correlation with the other. Also economies at lower levels of development which use non-commercial fuel like firewood and cattle carts to meet a substantial part of their energy needs tend to have lower values of energy intensity of economy.

Energy intensity in Btu of energy consumed to produce 1$ of economic output for India has not changed much from 19665 Btu/ $ in 1980 to 17486 Btu/$ in 2011 having reached the peak of 25667 Btu/$ and in a downward trajectory since that year. While energy consumption as well as demographic and economic parameters show rising trend, energy intensity has gone up and is now climbing down at a slow rate. Hence it has not been taken as one of the dependent variables for regression analysis.

ii. Cost of energy

The demand of electricity is practically price inelastic. Increase or decrease in tariff has no significant effect on consumption pattern of any consumer category. The reasons are obvious. For lighting and domestic appliances, which account for a large proportion of energy consumed, there is no real alternative to electricity. Use of electricity in homes, offices and commercial establishments is determined by the economic status of the consumer rather than tariff. Industrial machinery is driven either by electricity or by fossil fuel, the choice depending on suitability of machinery for the intended purpose rather than cost advantage electricity may or may not have over fossil fuel as the source of motive power. In case of agricultural pump sets, a farmer resorts to diesel pumps only when he finds power supply inadequate or unreliable. Electricity has always remained cheaper than diesel for driving agricultural pumps.

4. True demand of a given consumer group in a given area:

We have to recognize that the consumer demand is what one actually consumes or rather would have consumed had there been no power cuts or load shedding, and not the energy he has been billed for. Had there been no commercial loss one's bill would have been higher. Had there been no load shedding, one would have consumed more and received bill of a higher amount. It is this true demand that is expected to have a relationship with economic and demographic drivers. Hence commercial loss must be accounted for to arrive at the true demand of consumers.

<u>Commercial loss:</u>

All commercial loss in a system is energy that has not been lost as heat but has been utilized by some consumer somewhere. So the actual energy demand of a given consumer category is not just the billed energy but it also includes the commercial loss attributable to that consumer category.

<u>Accounting for Commercial Loss</u>:

A split of *Distribution loss* data between Technical & Commercial Loss is not available. It has been assumed that technical loss has been 10% of input energy throughout the seven year period under study and the balance is commercial loss in percent of input energy. Commercial loss has been distributed across all consumer categories except HT consumers, in proportion to their respective billed energy figures. The underlying assumption is that energy supplied to HT consumers correctly metered and billed and hence, in their case, there is no commercial loss to be added to billed energy to estimate the energy supplied.

<u>Load Shedding:</u>

Load shedding has not been applied in Chandigarh at any time. Hence energy supplied equals energy requirement in respect of all consumer categories in the entire seven year period under study. No adjustment needs to be made on this account.

5. Economic and Demographic Data: Past Data & Future Projections:

GDP Data:

Figures of contribution of primary, secondary and tertiary sectors to the State Gross Domestic Product for the union territory of Chandigarh are available up to the year 2012-13.

Population Data:

Population of Chandigarh in 2001 and 2011 are available from Census 2001 and Census 2011 respectively. From the difference between the two, compounded annual growth rate (CAGR) has been calculated and applied to estimate the population in the decade 2001-2011. The same CAGR has been applied on the population of 2011 to estimate the population in the years later than 2010-11.

Table 3: Past Values of state GDP

Known Values			
Year	**Population**	**GDP per Capita x 10^3 Rs.**	**Contribution of Tertiary Sector to GDP per Capita x 10^3 Rs.**
2006-07	990,133	109.03	86.89
2007-08	1,005,891	115.12	92.52
2008-09	1,021,900	122.51	106.17
2009-10	1,038,163	127.21	107.91
2010-11	1,054,686	126.45	108.59
2011-12	1,071,471	128.66	110.39

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5.4 Regression Analysis

Having identified the drivers that determine the demand of each consumer category mentioned above, regression analysis has been performed for the following consumer categories:

i. Domestic
ii. Commercial
iii. Large Supply
iv. Medium Power
v. Small Power
vi. Bulk Supply

Besides the above named consumer categories, regression analysis was done on Total Input Energy as well. Regression analysis was not done for the remaining consumer categories (Agricultural, Temporary Power and Street Lighting) - clubbed as others, as they did not exhibit any pattern or showed a flat trend. Together they account for less than 2% of consumption for year 2014-15.

For each consumer category regression has been performed first with all three independent variables (economic and demographic). The results were tested for its overall significance called *F test of significance*. *Significance F* tells us the probability that null hypothesis is true. Null hypothesis means there is no relationship between the independent X-variables (the driving parameters) and the dependent Y-variables (the predicted parameters). A high value of *Significance F* means that there is little significance or relationship between the independent X-variables and the dependent Y-variables. If the regression results showed a low enough *Significance F* of up-to 5% signifying less than 5% chance that there is no relationship between the independent variables and the dependent variable (annual energy consumption for a given consumer category), conversely signifying more than 95% chance that a quantitative relationship exists between the independent X-variables and the dependent Y-variable, the relationship was accepted as valid. If the *Significance F* was found to be higher than 5%, the results of regression were rejected and the analysis was performed with fewer independent variables. Even when *Significance F* values were low enough to be accepted, results were rejected if one or more *P Values* were unacceptably high and regression analysis performed with fewer independent X- variables.

6. Demand forecasting: Approach and Methodology

1. Composite Load Profile: To determine the composite annual hourly load curve, it is necessary to map the load curves of each of the major feeder types and derive the aggregate of these individual load curves.
2. Classification of Feeders: A feeder is classified as belonging to a particular category when over 80% of the energy supplied through it is accounted for by the said consumer category. Accordingly, the feeders are categorised as follows:
    a. Domestic: Feeders catering majorly to residential colonies
    b. Industrial: Feeders catering to industries: small, medium and large.
    c. Commercial: Feeders catering to shopping complexes, malls, hospitals, offices, or any other commercial establishments.
    d. Bulk supply: High voltage (11kV) feeders serving consumers procuring bulk power and having their own substation to step down the voltage.
    e. Mixed: Feeders serving a mix of two or more categories such that no one category is predominating
3. Major Consumer Categories: Four consumer categories, namely, Domestic, Industrial, Commercial and Bulk Supply account for 99% of the total energy supplied. The rest account for a negligible 1%.
4. Sampling of Feeders: For drawing up load profiles of different consumer categories, it is therefore necessary to select sample feeders of each category and build up the aggregate load profile of the sampled feeders of each type. The implicit assumption is that the sampled feeders of a given category reflect the profile of that category
5. Mapping of Feeders: For selecting sample feeders of each consumer category, first a list of all 11kV feeders was compiled and these were classified based on inputs from CED officials. The complete list of 245 feeders showing the feeder category and signed by CED Representative is attached as Annexure 1
6. Selection of Sample Feeders: The table below shows details of the 245 nos. 11kV feeders serving the CED consumers.

Table 4: Selection of Feeders as per Energy Served

Category	Billed Energy (MU)	No. of Feeders (No.)	Total Energy Delivered (MU)	% of Total Energy Delivered	Total Feeders Selected (No.)
Bulk	84.25	12	84.25	6%	2.00
Commercial	421.44	61	455.45	30%	10.00
Domestic	660.82	95	714.14	47%	18.00
Industrial	228.74	31	237.62	16%	6.00
Total	1,423.47	199	1,520.24	99%	36

The remaining 46 feeders are of mixed category where no one consumer category is predominant. A sample size of 36 amounting to approximately 15% of the total 245 nos. 11kV feeders was first selected. Numbers of feeders within this sample size of 36 were distributed between the four major feeder categories roughly in proportion to the energy delivered to the four major consumer categories as shown in the above table. Having decided the number of feeders to be sampled for each category, the samples were randomly chosen using Excel's random selection function. For example, 10 sample feeders required for Commercial category were randomly selected out of the 61 feeders of that category. Sample feeders of other categories were also randomly selected in a similar manner. Random selection ensures that there is no bias in selection, whereby the samples are deemed to be representative of the population they represent. The list of sample feeders so selected is attached at Annexure 3.

6.1 Feeder Ampere. Data Collection (Manual Log books)

A comprehensive data collection activity was conducted for obtaining the Ampere data of the selected feeders for 2015-16. Visits to substations were conducted to obtain the manual log readings recorded on an hourly basis. The data collected was converted to an editable soft copy in Excel format for analysis and computations.

Where the hourly Ampere readings were blank, values at the same time on the previous date were inserted with the implicit assumption that the load of a given feeder at a particular hour was likely to be the same as on another day in the same season.

6.2 Preparation of Category – wise Load Curve.

The hourly Ampere readings of all sample feeders of a given type were tabulated in consecutive columns and the sum of these currents at each hour were tabulated alongside. To scale up the load (Amperes) of the sampled feeders to the total of that category, the following scaling factor was used:

$$\text{Scaling Factor} = \frac{\text{Avg. Current of All Feeders}}{\text{Avg. Current of Sample Feeders}}$$

The average current of a given feeder type was determined as follows:

Average Current (Amperes) = Total Energy Delivered in MU * 10^6 ÷ (11*√3*8760* PF)

The Scaling Factor has to be multiplied to the hourly load of the sample feeder to get the total load for the said category. Load curve is plotted against these hourly values.

6.3 Preparation of Load curve for all Categories.

The Composite Load Curve for Chandigarh is the sum of scaled up load curve of all 4 categories viz. Domestic, Commercial, Industrial and Bulk supply.

6.4 Incorporating technical losses into the Load Curve

The scaled up load gathered for all the feeders includes commercial losses but the data doesn't include technical losses. The next objective was to add Technical Loss to the Load Curve showing Hourly Consumer Power Demand to obtain Input Power Curve. However one cannot add the Percent Technical (I^2R) Loss in MW to the Hourly Consumer Power Demand in MW. It is because Technical Loss is a function of the load. It is proportional to the square of the percent loading. Further, the Technical Loss figure is in energy terms, being 10% of the input energy. So, we must first compute Input Energy from Energy Delivered to Consumers, calculate Loss Load Factor from Load Factor, which in turn has to be computed from the Load Curve, and then obtain Power Loss at Peak Demand. Having obtained Technical Loss at Peak Demand, we calculate Technical Loss at a given load by multiplying the former by the square of percent loading.

Power (I^2R) Loss at Any Load = Power (I^2R) Loss at Peak Demand* n^2;

Where n = Load/ Maximum Demand

Power (I^2R) Loss at Peak Demand (MW) = Technical Loss (in MU)*1000 / (Loss Load Factor*8760)

7. Results: Energy Forecasting

7.1 Findings

Following table summarizes the results of regression analysis done consumer category wise

Table 5: Regression Results

Consumer Category / Independent X-Variables	Population + GDP + Contribution of Tertiary Sector to GDP	Population + GDP	Population + Tertiary GDP	Population
Total Energy Requirement	**0.01%**	-	-	-
Domestic	0.05%*	0.02%*	**0.0%**	-
Commercial	14.24%	8.83%	10.67%	**2.46%**
Large Supply	46.09%	23.76%	22.4%	25.26%
Medium Power	21.24%	10.91%	19.27%	12.7%
Small Power	7.59%	2.14%*	2.71%*	**0.52%**
Bulk Supply	0.86%*	0.1%*	0.09%*	**0.01%**

**** Regression results rejected despite Significance F values being within the upper limits as one or more P Values were unacceptably high.***

Interestingly, the most important parameter of all, Total Energy Requirement, has a predictable relationship with all three economic and demographic parameters considered, *State Gross Domestic Product (GSDP), Contribution of Tertiary Sector to GSDP* and *Population*. Energy requirement of *Domestic* consumers has a relationship with *Contribution of Tertiary Sector to GSDP* and *Population*, while the energy requirement of *Commercial, Small Power and Bulk Supply* consumer categories has a relationship only with *Population*. Energy requirement of two consumer categories, namely, *Large Supply* and *Medium Power* do not yield to regression analysis. This may be explained by the fact that energy requirement of these consumer classes show no discernible trend, going up and down in consecutive years and being flat in the long term. Keeping in view that the consumer classes for which regression analysis does not yield acceptable results account for less than 20% of the total energy requirement, it can be said that the overall results of regression analysis are quite satisfactory and acceptable.

The category wise forecasted value of the energy demand is shown in the subsequent sections:

7.2 Input Energy Requirement (incl. commercial losses)

Interestingly, the most important parameter of all, Input Energy (Energy requirement), has a predictable relationship with all three economic and demographic parameters considered, *State Gross Domestic Product (GSDP), Contribution of Tertiary Sector to GSDP* and *Population*.

Table 6: Coefficients Input Energy (W/O technical Losses)

Particulars	Coefficients
Intercept	-2242.0951
Population	0.0025864
GDP	14.75539
Contribution of Tertiary to GDP	-8.7082012

The forecasted energy requirement is as below:

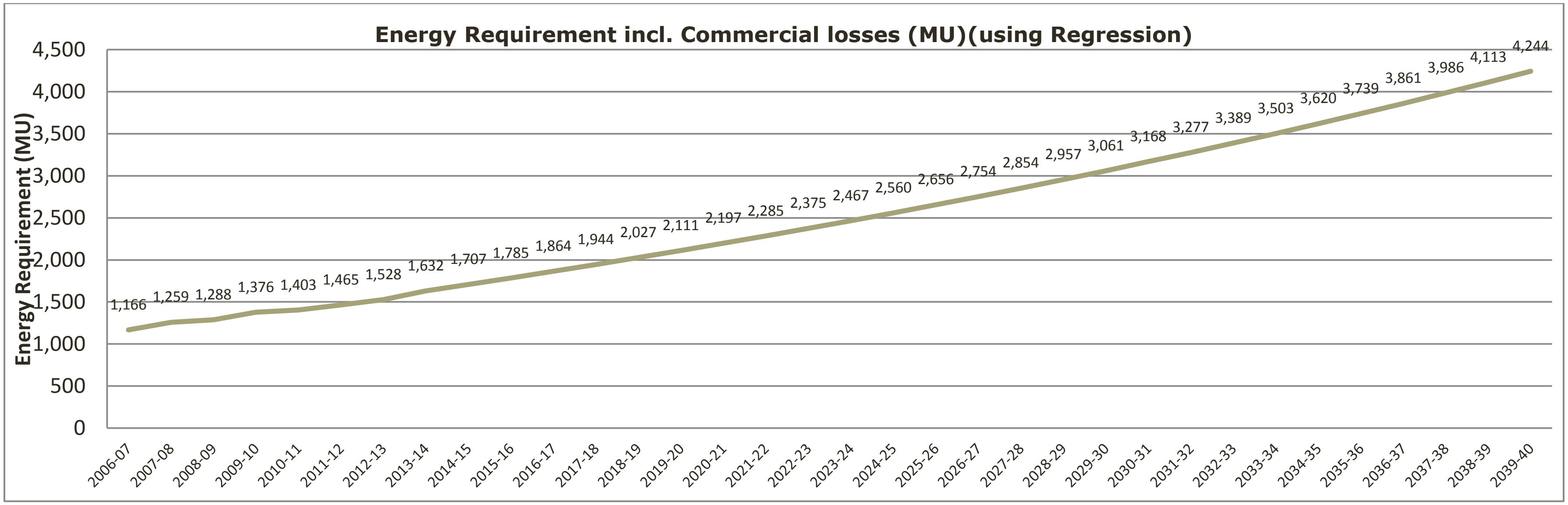

Figure 7: Energy Requirement W/o Losses

7.3 Domestic Category

Energy requirement of *Domestic* consumers has a relationship **with *Contribution of Tertiary Sector to GSDP* and *Population*.** On the basis of regression the results are as shown below:

Table 7: Coefficients Domestic Category

Particulars	Coefficients
Intercept	-2,514.93478
Population	0.00354
Contribution of Tertiary Sector to GDP	-5.92765

The forecasted energy requirement is as below:

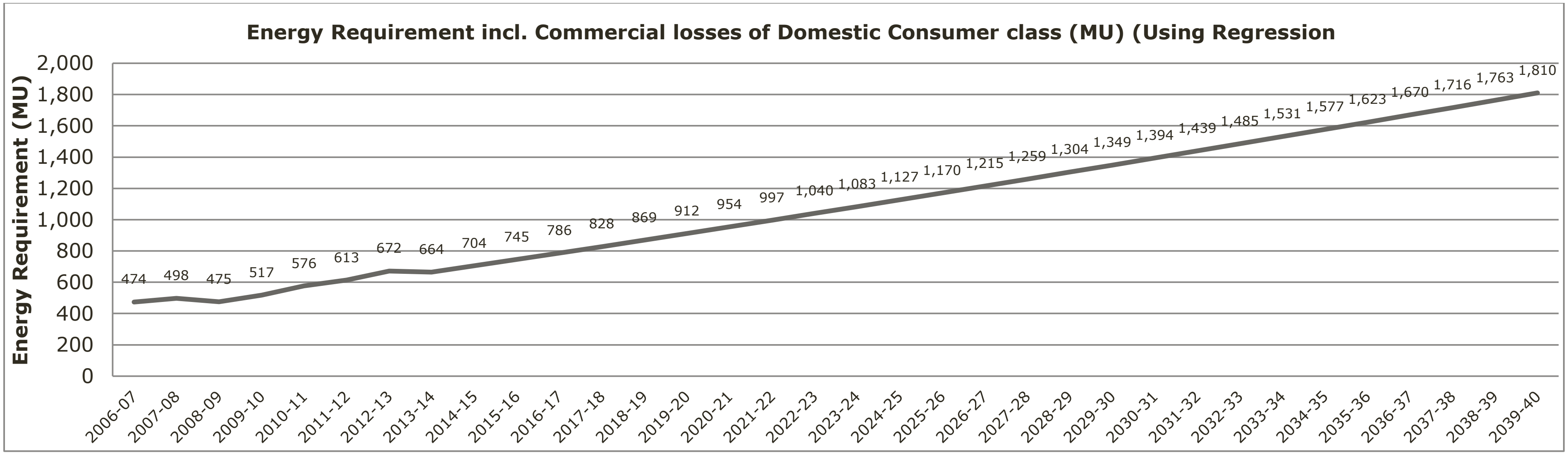

Figure 8: Forecasted Energy Domestic Category

7.4 Commercial Category

Energy requirement of *Commercial Category* consumers has a relationship **with Population** only. On the basis of regression the results are as shown below:

Table 8: Coefficients Commercial Category

Particulars	Coefficients
Intercept	-1147.0262
Population	0.001504646

The forecasted energy requirement is as below:

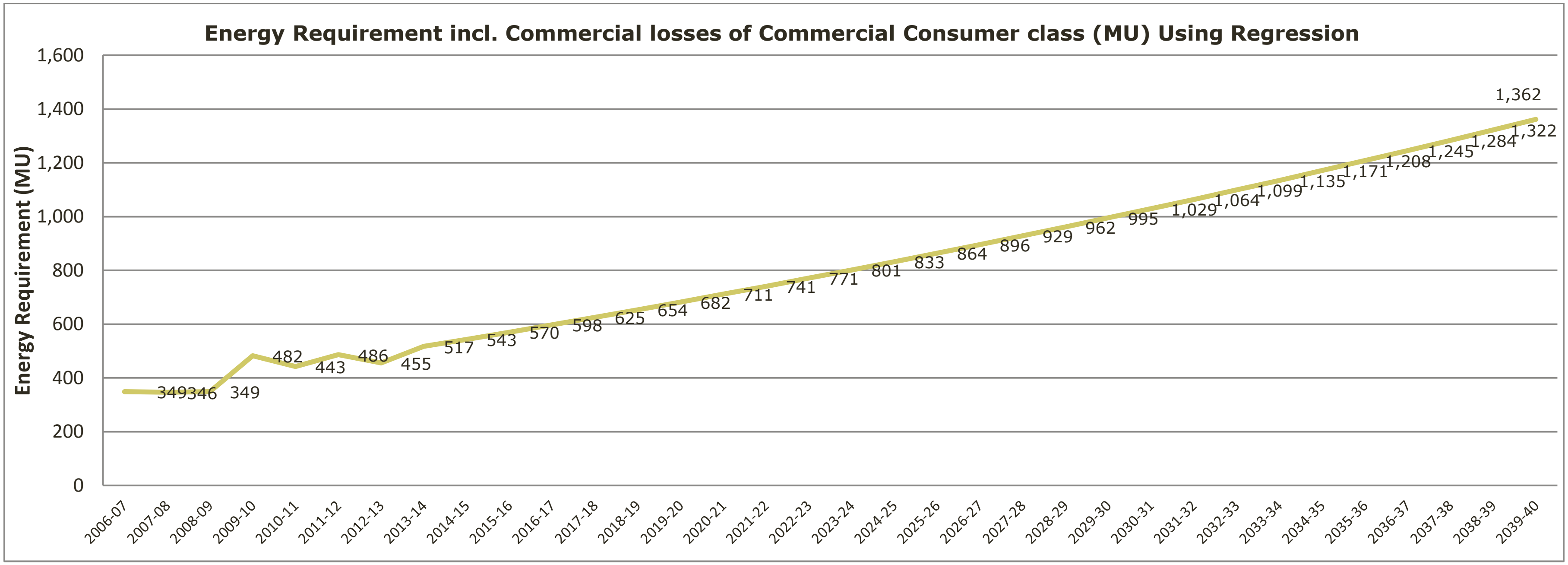

Figure 9: Commercial Energy Req. including Commercial Losses

7.5 Bulk Supply

Energy requirement of *Bulk Category* consumers has a relationship **with Population** only. On the basis of regression the results are as shown below:

Table 9: Coefficients of Bulk Supply

Particulars	Coefficients
Intercept	-612.1390159
Population	0.000643356

The forecasted energy requirement is as below:

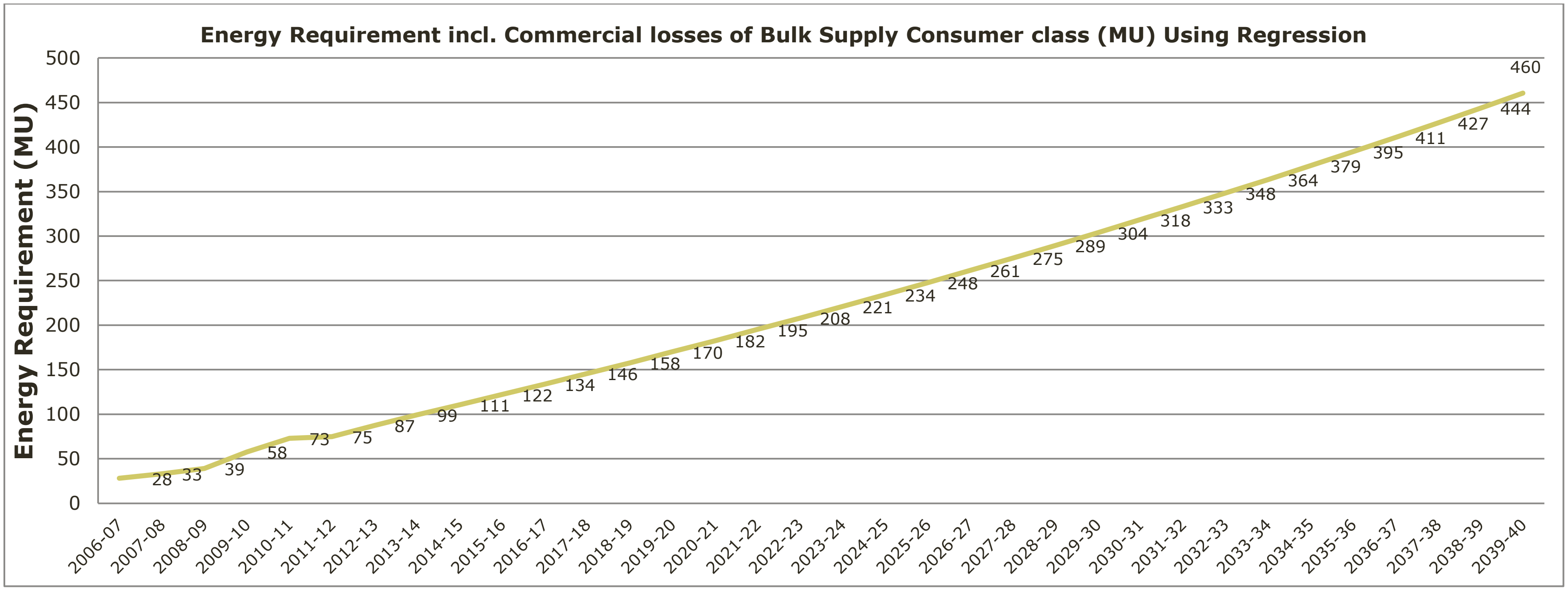

Figure 10: Energy req. of Bulk Supply

7.6 Small Power

Energy requirement of *Small Power Category* consumers has a relationship **with Population** only. On the basis of regression the results are as shown below:

Table 10: Coefficients Small Power

Particulars	Coefficients
Intercept	-75.7734184
Population	9.31296E-05

The forecasted energy requirement is as below:

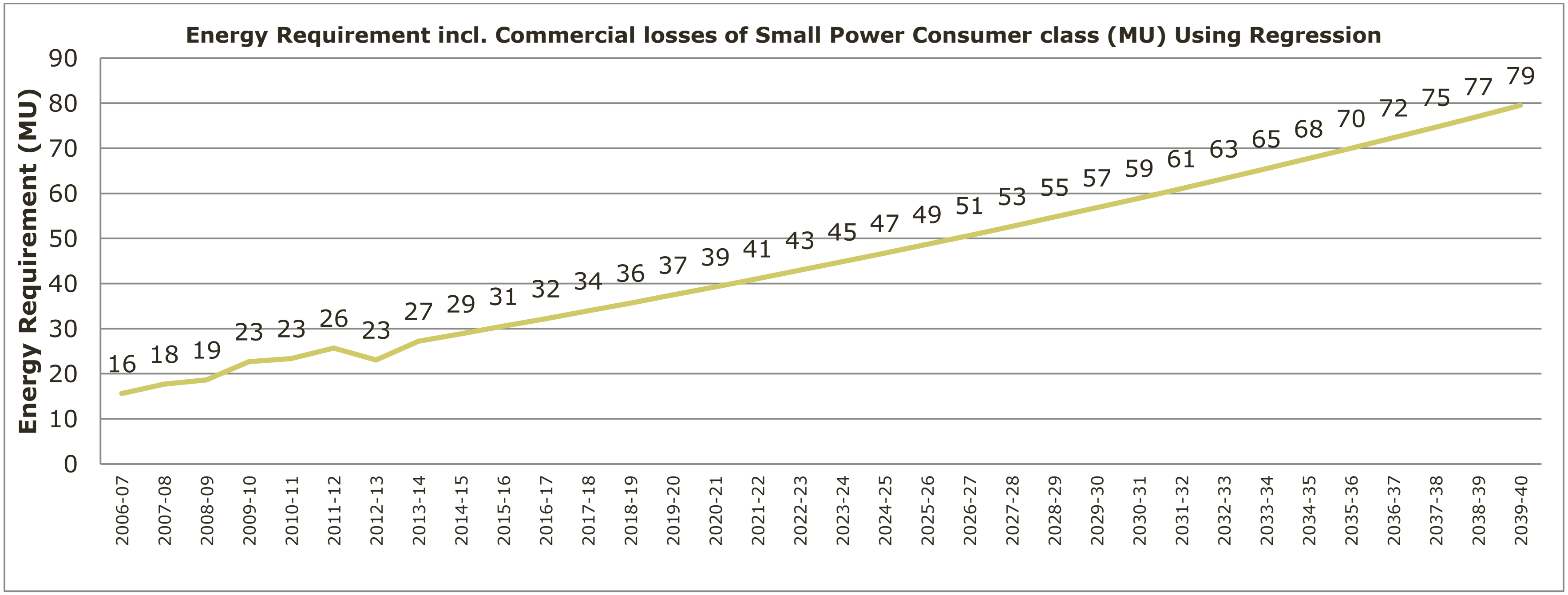

Figure 11: Energy Req. Small Power

7.7 Medium Power and Large Power

Energy requirement of two consumer categories, namely, Large Supply and Medium Power do not yield to regression analysis. These consumer classes for which regression analysis does not yield acceptable results account for less than 20% of the total energy requirement, and hence the energy has been calculated by subtracting the energy requirement of Domestic, Commercial, Bulk, Small Power from the forecasted values of the total energy requirement.

The energy requirement is as below:

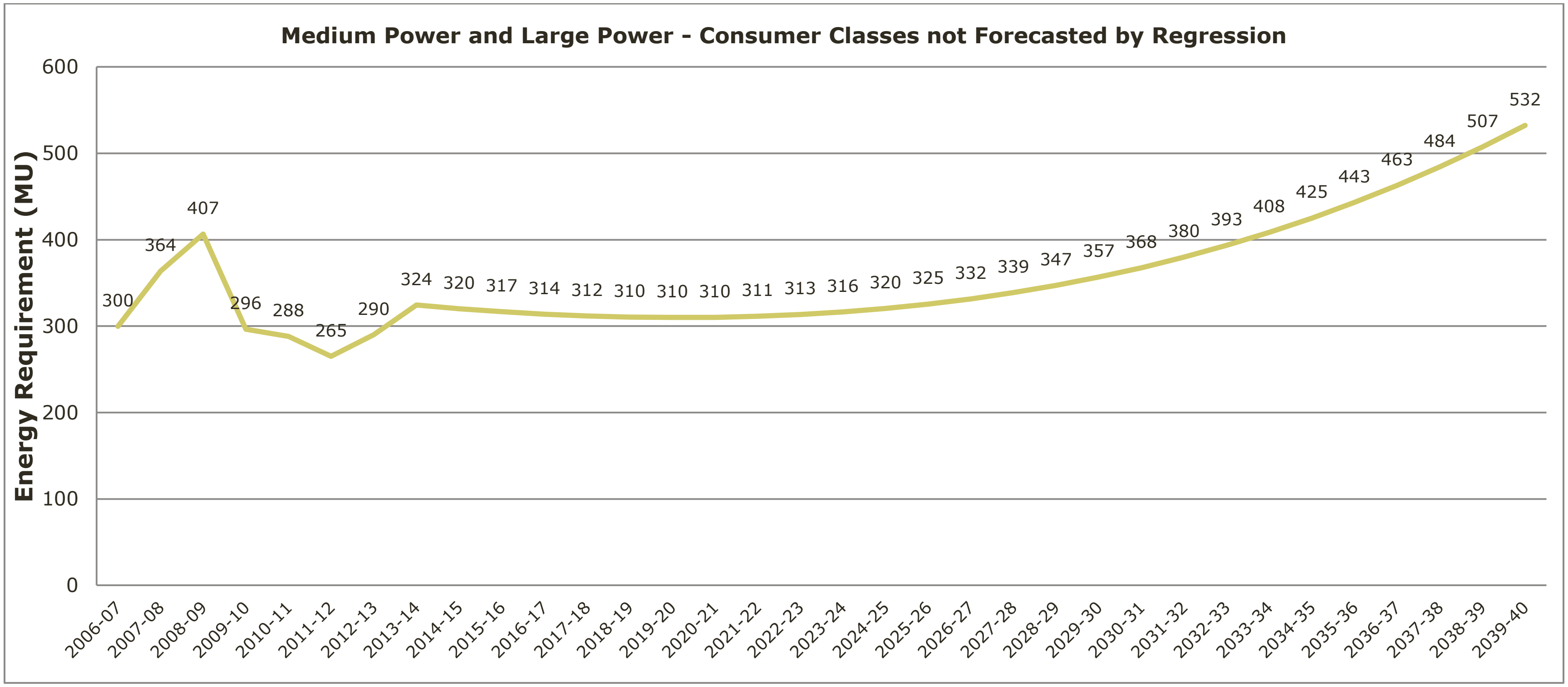

Figure 12: Energy req. Medium and Large Power

7.8 Total Energy Requirement

The technical losses have been added to the total energy requirement (incl. commercial losses) to give the total energy requirement (incl. technical losses). The graph below shows the total energy requirement:

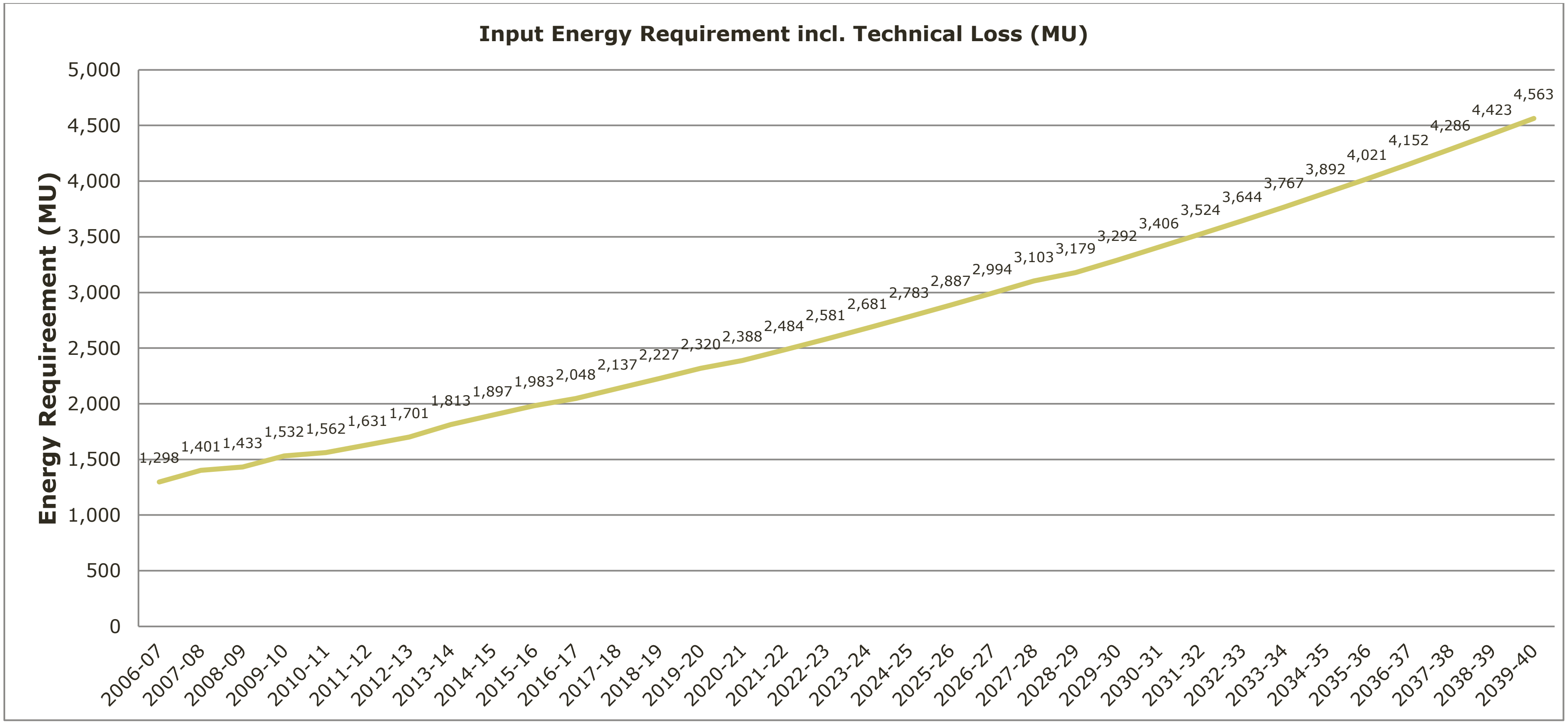

Figure 13: Input Energy Incl. Technical Losses

7.9 Results

The table given below gives the values of the energy forecast for the Chandigarh Electricity Department as carried by the study:

Table 11: Regression Results: Category wise (in MU)

Year	Energy Requirement of Consumer Classes (including Commercial Losses) Forecasted by Regression						Energy Requirement of Consumer Classes (including Commercial Losses) NOT Forecasted by Regression	Input Energy Requirement incl. Technical Loss
	Domestic	Commercial	Bulk Supply	Small Power	Total Energy Requirement of Consumer Classes whose energy requirement is forecasted by Regression	Total (excl. Technical Loss)		
2006-07	474	349	28	16	**867**	1,166	300	1,298
2007-08	498	346	33	18	**895**	1,259	364	1,401
2008-09	475	349	39	19	**881**	1,288	407	1,433
2009-10	517	482	58	23	**1,080**	1,376	296	1,532
2010-11	576	443	73	23	**1,115**	1,403	288	1,562
2011-12	613	486	75	26	**1,200**	1,465	265	1,631
2012-13	672	455	87	23	**1,238**	1,528	290	1,701
2013-14	664	517	99	27	**1,307**	1,632	324	1,813
2014-15	704	543	111	29	**1,387**	1,707	320	1,897
2015-16	745	570	122	31	**1,468**	1,785	317	1,983
2016-17	786	598	134	32	**1,550**	1,864	314	2,048
2017-18	828	625	146	34	**1,633**	1,944	312	2,137
2018-19	869	654	158	36	**1,716**	2,027	310	2,227
2019-20	912	682	170	37	**1,801**	2,111	310	2,320
2020-21	954	711	182	39	**1,887**	2,197	310	2,388
2021-22	997	741	195	41	**1,974**	2,285	311	2,484
2022-23	1,040	771	208	43	**2,061**	2,375	313	2,581

Year	Energy Requirement of Consumer Classes (including Commercial Losses) Forecasted by Regression						Energy Requirement of Consumer Classes (including Commercial Losses) NOT Forecasted by Regression	Input Energy Requirement incl. Technical Loss
	Domestic	Commercial	Bulk Supply	Small Power	Total Energy Requirement of Consumer Classes whose energy requirement is forecasted by Regression	Total (excl. Technical Loss)		
2023-24	1,083	801	221	45	**2,150**	2,467	316	2,681
2024-25	1,127	833	234	47	**2,240**	2,560	320	2,783
2025-26	1,170	864	248	49	**2,331**	2,656	325	2,887
2026-27	1,215	896	261	51	**2,423**	2,754	332	2,994
2027-28	1,259	929	275	53	**2,516**	2,854	339	3,103
2028-29	1,304	962	289	55	**2,609**	2,957	347	3,179
2029-30	1,349	995	304	57	**2,704**	3,061	357	3,292
2030-31	1,394	1,029	318	59	**2,800**	3,168	368	3,406
2031-32	1,439	1,064	333	61	**2,897**	3,277	380	3,524
2032-33	1,485	1,099	348	63	**2,996**	3,389	393	3,644
2033-34	1,531	1,135	364	65	**3,095**	3,503	408	3,767
2034-35	1,577	1,171	379	68	**3,195**	3,620	425	3,892
2035-36	1,623	1,208	395	70	**3,296**	3,739	443	4,021
2036-37	1,670	1,245	411	72	**3,398**	3,861	463	4,152
2037-38	1,716	1,284	427	75	**3,502**	3,986	484	4,286
2038-39	1,763	1,322	444	77	**3,606**	4,113	507	4,423
2039-40	1,810	1,362	460	79	**3,711**	4,244	532	4,563

8. Results: Load Forecasting Model

8.1 Base Year Results (Unrestricted)

Following table summarizes the results of load forecast done for the Base year 2015-2016

Table 12: Category Wise Load details for FY 2015-16

Category	Peak Load (in MW)	Avg. Load (in MW)	Min Load (in MW)
Domestic	199.37	92.47	34.84
Commercial	174.42	70.76	22.45
Industrial	76.53	38,55	10.65
Bulk	37.56	13.95	3.24
All Categories	**447.41**	**216.93**	**88.58**
All Categories (Including Technical Losses)	**464.88**	**221.42**	**89.25**

8.2 Load Duration Curve Base Year

The Load duration curve plots the load against its corresponding duration for which the said is required. The LDC of base 2015 -16 is given below.

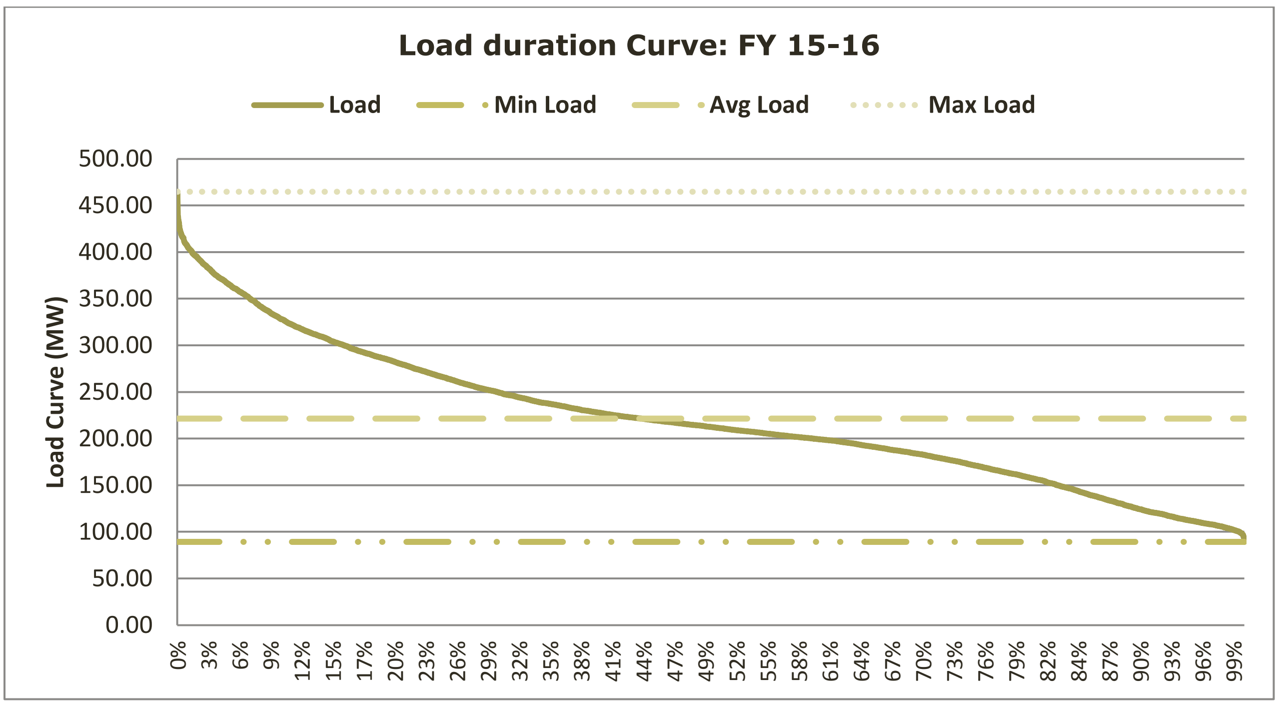

Figure 14: Load Duration Curve FY 15-16

8.3 Yearly Curve

The projected peak, avg. and Minimum load up to 25 years is summarized in the table below:

Table 13: Yearly Load as Projected (MW)

Year	Peak Load	Average Load	Minimum Load
2015-16	464.68	221.42	89.25
2016-17	477.78	227.64	91.93
2017-18	496.12	236.32	95.58
2018-19	514.85	245.18	99.30
2019-20	533.97	254.23	103.09
2020-21	542.98	260.74	106.54
2021-22	567.44	270.10	109.77
2022-23	587.59	279.64	113.74
2023-24	608.17	289.38	117.78
2024-25	629.20	299.33	121.91
2025-26	650.67	309.49	126.11
2026-27	672.61	319.87	130.40
2027-28	695.02	330.48	134.77
2028-29	704.03	337.72	138.67
2029-30	733.52	348.76	142.30
2030-31	757.16	359.95	146.88
2031-32	781.31	371.39	151.55
2032-33	805.99	383.07	156.31
2033-34	831.21	395.01	161.16
2034-35	856.99	407.22	166.11
2035-36	883.33	419.69	171.16
2036-37	910.25	432.43	176.30
2037-38	937.76	445.46	181.55
2038-39	965.88	458.78	186.90
2039-40	994.62	472.39	192.36

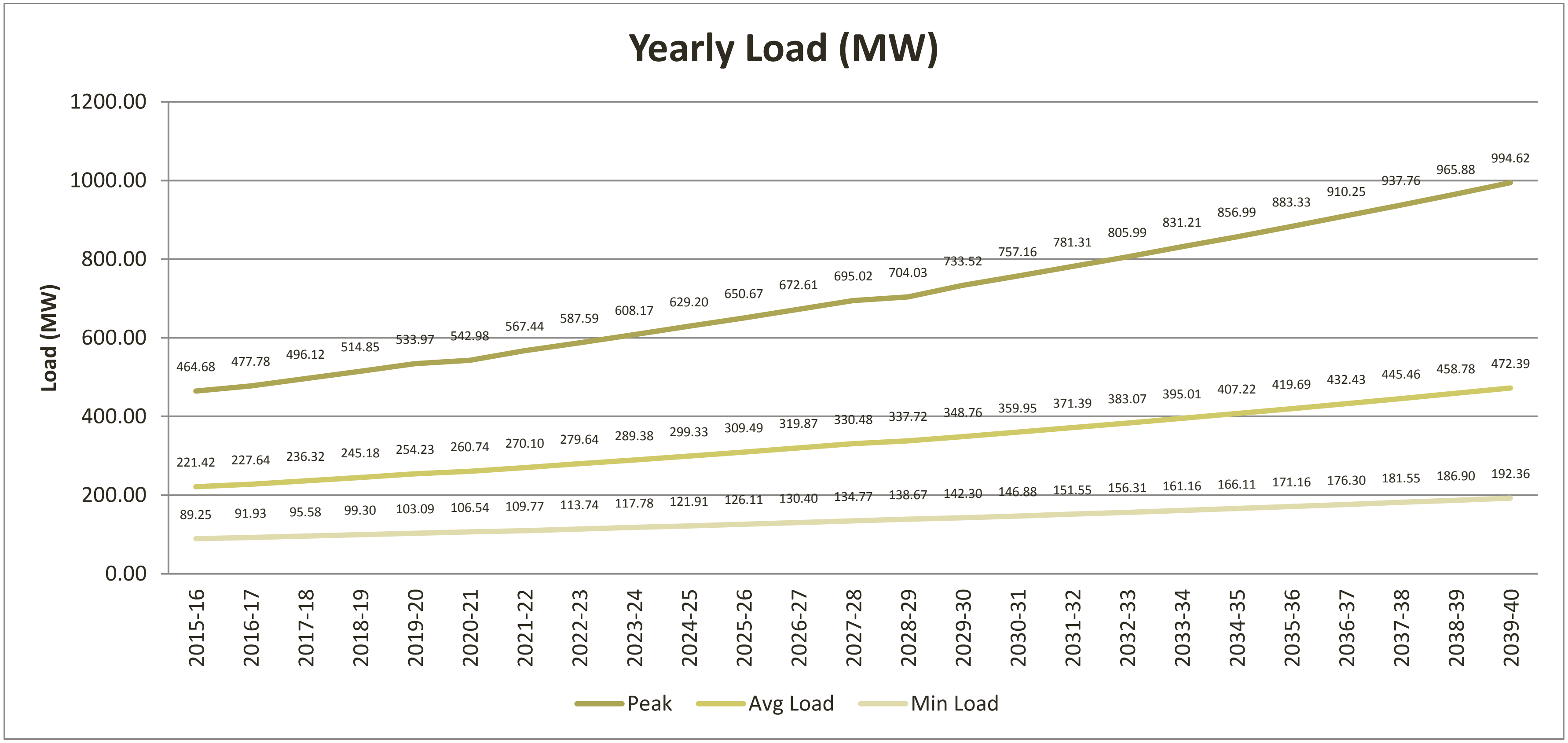

Figure 15: Yearly Load

8.4 Seasonal Curves

Indian Meteorological department (IMD) designates four seasons:

1. Winter
2. Summer
3. Monsoon
4. Autumn (or Post Monsoon)

The daily curves for a typical seasonal day is provided below:

The curves depict the consumption pattern for the state of UT Chandigarh during a typical winter, summer, monsoon and autumn day. The figures are for base year 2015-16.

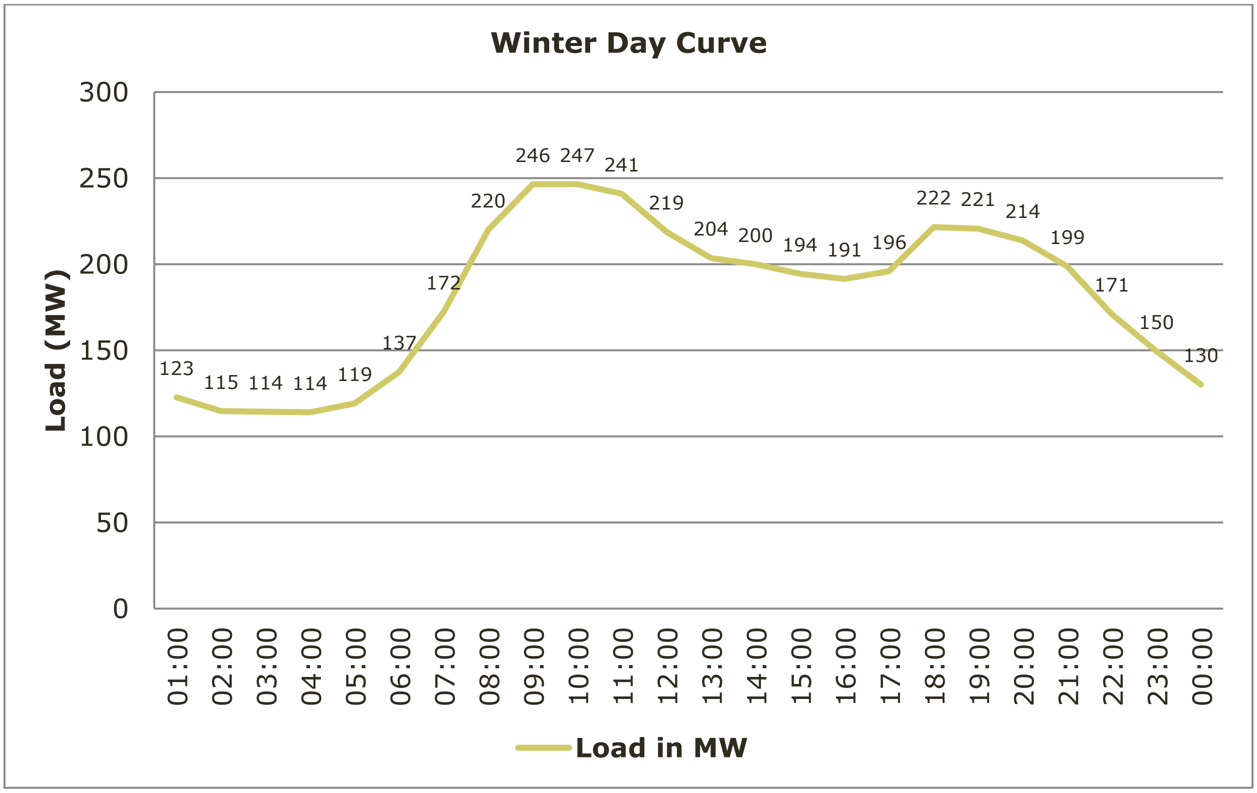

Figure 16: Winter Curve

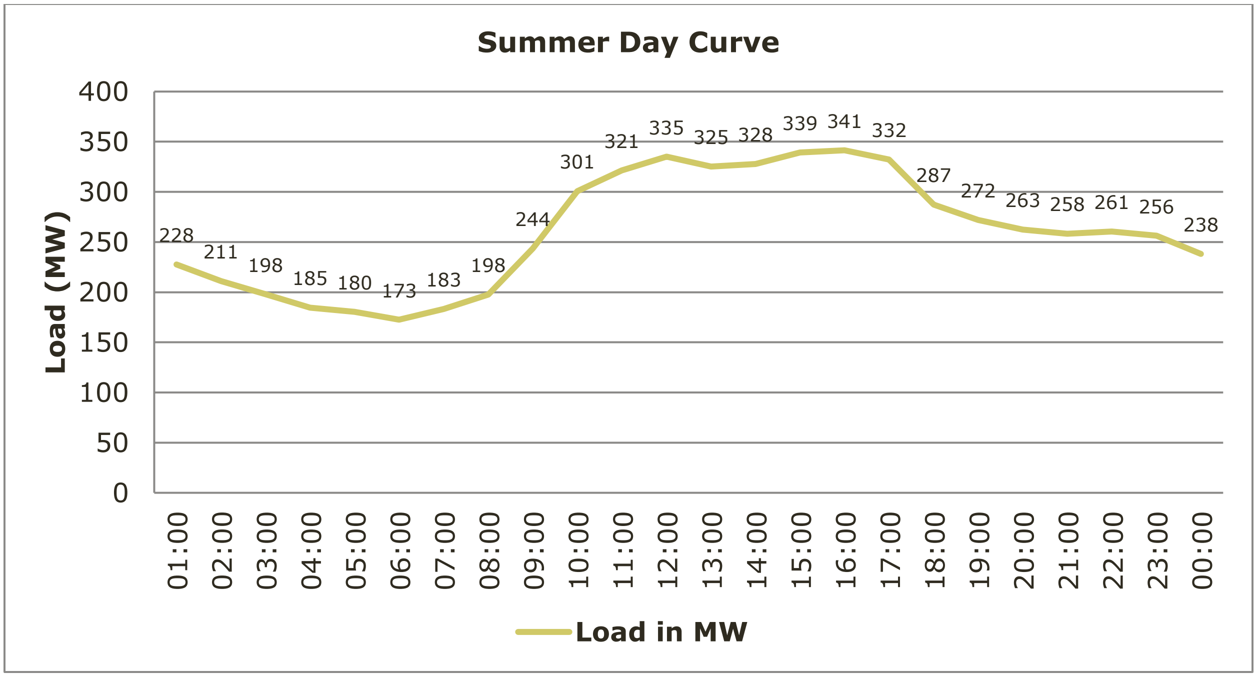

Figure 17: Summer Curve

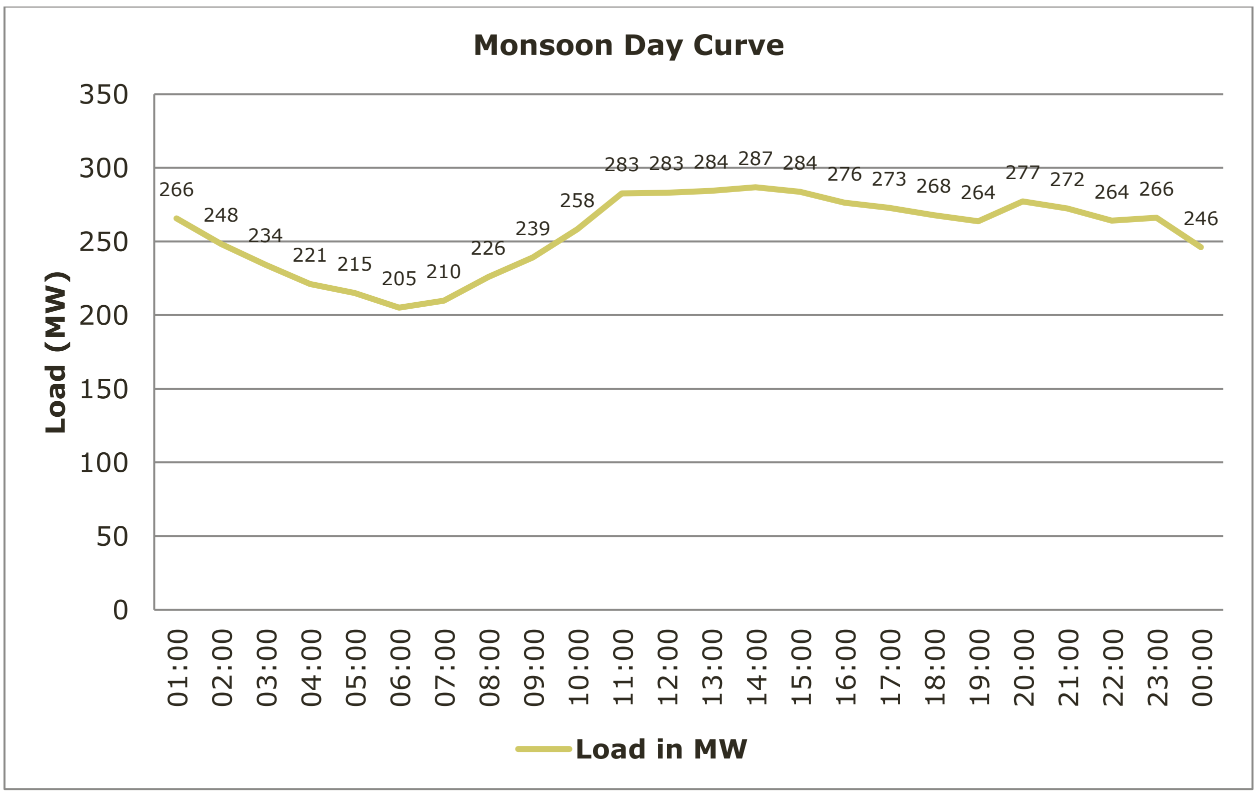

Figure 18: Monsoon Curve

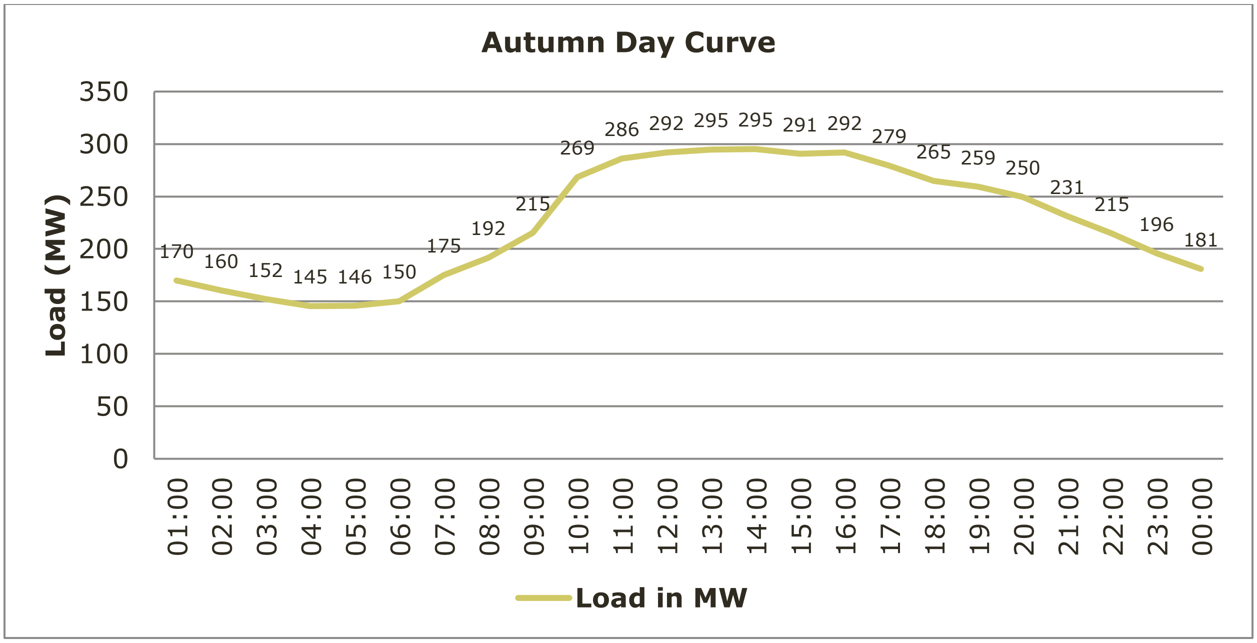

Figure 19: Autumn Curve

8.5 Peak Day Curve

The Peak day curve plots the load against 24 hours of the day that peak load (for the year) occurrence is projected. For the base year 2015-16 the peak demand occurred on 19h June.

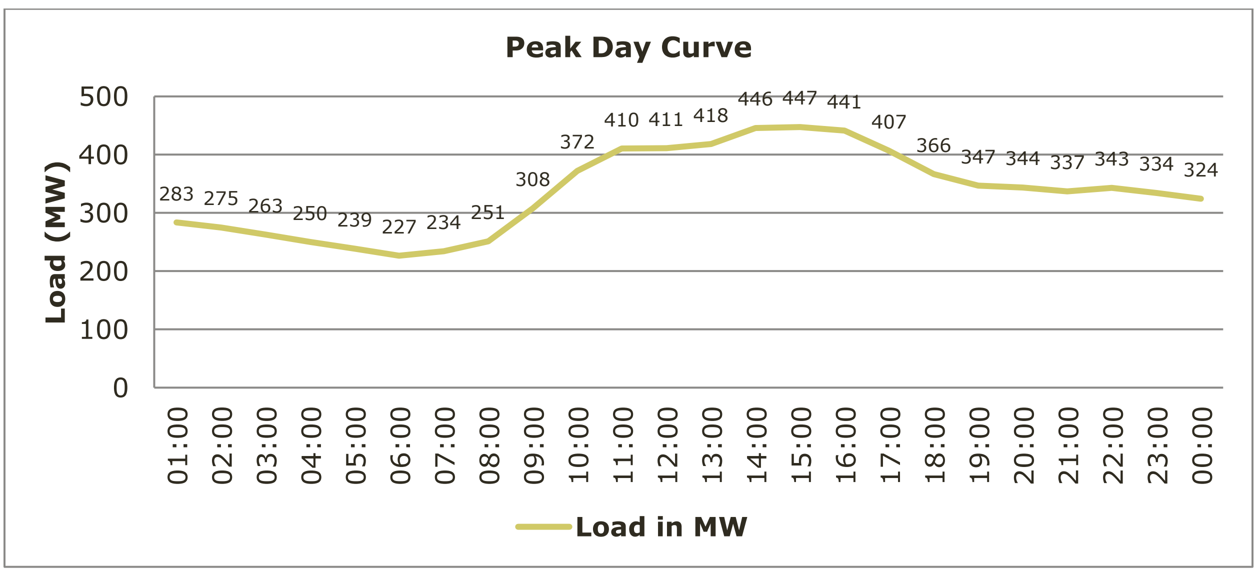

Figure 20: Peak Day Curve

8.6 Short Term Monthly Demand

The Table below summarizes the monthly Demand as per the model for 3 years from FY 2016-17 to FY 2018-19

Table 14: Monthly Demand and Energy Requirement as per Model for FY 16 -17 to FY 18-19

	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Peak Demand (MW)												
FY 16-17	331.20	304.70	477.78	454.26	434.78	428.13	320.94	238.51	265.71	325.27	300.34	276.90
FY 17-18	343.49	467.68	496.12	472.25	451.02	444.22	332.72	247.52	275.99	337.68	311.74	287.09
FY 18-19	356.08	485.50	514.85	490.60	467.60	460.65	344.78	256.74	286.47	350.34	323.37	297.52
Energy Requirement (MU)												
FY 16-17	146.15	199.92	208.41	226.71	214.00	194.27	148.49	122.18	131.91	151.07	121.00	131.69
FY 17-18	151.61	207.80	216.62	235.68	222.23	201.60	154.01	126.71	136.86	156.73	125.46	136.57
FY 18-19	157.19	215.83	225.00	244.83	230.62	209.08	159.67	131.34	141.92	162.51	130.02	141.56

9. Generation Plan

9.1 Short Term Planning

The following procurement plan was provided by CED for the next three year power purchase.

For FY 2016-17

Table 15: Generation Plan as per CED Data FY 16-17 to FY 18-19

	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Peak Availability (MW)												
FY 16-17	195	253	287	304	274	260	202	159	204	209	191	189
FY 17-18	229	299	340	365	329	307	254	192	237	255	228	217
FY 18-19	226	283	366	333	318	294	232	186	232	248	217	225
Energy Availability (MU)												
FY 16-17	131	178	200	207	201	162	138	119	131	142	123	130
FY 17-18	169	229	257	267	258	208	178	153	168	183	159	167
FY 18-19	170	231	260	269	261	210	180	154	170	185	160	169

9.2 Solar Capacity Additions

As per MNRE program, the UT has to plan to develop the Grid Connected Rooftop Solar Projects as per the following Plan:

FY15-16	FY16-17	FY17-18	FY 18-19	Total
1 MW	12 MW	12 MW	14 MW	39 MW

Existing Solar Capacity is of 5.32 MW as on 31st March '2015

Solar Capacity entitlement for Short term period is:

FY15-16	FY16-17	FY17-18	FY 18-19
6.32 MW	18.32 MW	30.32 MW	44.32 MW

9.3 Medium and Long Term Planning

Long Term PPAs:

The following tables summarizes the long term PPA engaged with Generation companies**:**

Table 16: Long Term PPA's

S. No	Organization	Name of Project	Entitlement in MW
1.	NTPC	Anta	7.67
2.		Auraiya	7.89
3.		Dadri GPP	7.55
4.		Dadri II TPP	2.55
5.		Kahalgaon II	3.00
6.		Rihand I	12.40
7.		Rihand II	10.50
8.		Rihand III	8.25
9.		Singrauli	4.80
10.		Unchahar I	2.39
11.		Unchahar II	4.16
12.		Unchahar III	1.60
13.		Jhajjar (Aravali)	4.80
14.		Koldam	11.00
15.	NHPC	Chamera I	21.06
16.		Chamera II	4.32
17.		Chamera III	1.49
18.		Dhauliganga	3.94
19.		Dulhasti	4.33
20.		Parbathi III	6.45
21.		Salal	1.86
22.		Sewa II	1.76
23.		Tanakpur	1.20
24.		Uri-I	2.88
25.		Uri II	1.44
26.	NPCIL	NAPP	7.74
27.		RAPP (#3 and #4)	3.48
28.		RAPP(#5 and #6)	7.57
29.	SJVNL	NATHPA JHAKRI	14.25
30.		RAMPUR (U Q)	1.61
31.	BBMB	BBMB 3.5 %	171.50
32.		BBMB 1 LU	1 LU per day
33.		BBMB 10 LU	10 LU per day
34.		PONG	12.60
35.		DEHAR	34.65
36.	THDC	Koteshwar	2.80
37.		Tehri	9.40

10. Power Sourcing

10.1 Current Procurement

As of FY 2016-17, Chandigarh Electricity Department relies majorly on hydel resources to meet their energy required; 67 % of the power purchase is from hydel resources, 21% from thermal and remaining 12% from nuclear and gas based plants.

10.2 Energy availability

The UT of Chandigarh does not have any generation capacity of its own and most of the power / energy requirement is being met from the allocation of central generating stations.

The various assumptions as considered for the power planning are as below:

- The PPA has been taken as perpetual for the period till FY 2039-40.
- It is assumed that all the plants have been considered to be present for next 25 years without any deterioration in the PLF.
- Cut-off of the plants have not been taken into account
- No new PPA have been considered for the power procurement planning.
- Further as the UT is heavily dependent on hydro source (about 60%-74% during the study period), the power requirement may change slightly on year to year basis depending upon monsoon scenario in the country. In poor monsoon years the availability of energy from Hydro Power Plants is also likely to be poor. However, the availability of the hydel plants has been considered same.

10.3 Energy Requirement and Availability

In the three years for which the power availability is provided the energy is in deficit for 2016-17 but is in excess as per the energy projections for the year 2017-18 and 2018-19.

Year	Energy Projections (MU)	Energy Availability (MU)	Excess (-ve)/Deficit (+ve) (MU)
2016-17	2,048	1,866	182
2017-18	2,137	2,396	-259
2018-19	2,227	2,419	-192

Year	Peak Load Projections (MW)	Peak Demand Available (MW)	Excess (-ve)/Deficit (+ve) (MU)
2016-17	464	304	160
2017-18	477	365	112
2018-19	496	366	130

It can be seen that even when Chandigarh is energy excess it is still in peak power deficit. This is mainly due to a low annual load factor. This may result in high peak stress on an already ageing and capped distribution system. Corrective demand side management measures should be adopted to curtail the peak demand.

The pending power requirement can be sourced from long term PPA's and other bilateral agreements.

Taking 70% of the energy requirement to be met through Long term PPA, the remaining 30% may be met through Short term PPA's / bilateral agreements, banking arrangement with other states and UI/Exchange/Non-Conventional Energy Sources. The following strategy has been considered for the power sourcing: Sourcing of 70% power from long term PPA, 10 % from Short term PPA's/bilateral agreements, 10 % from banking from other states and the remaining 10% from UI / Exchange / Non-Conventional Energy Sources.

Considering requirement of 70% of the input energy requirement through Long-term PPA and 30% due to peak load, the power sourcing is given in graph below:

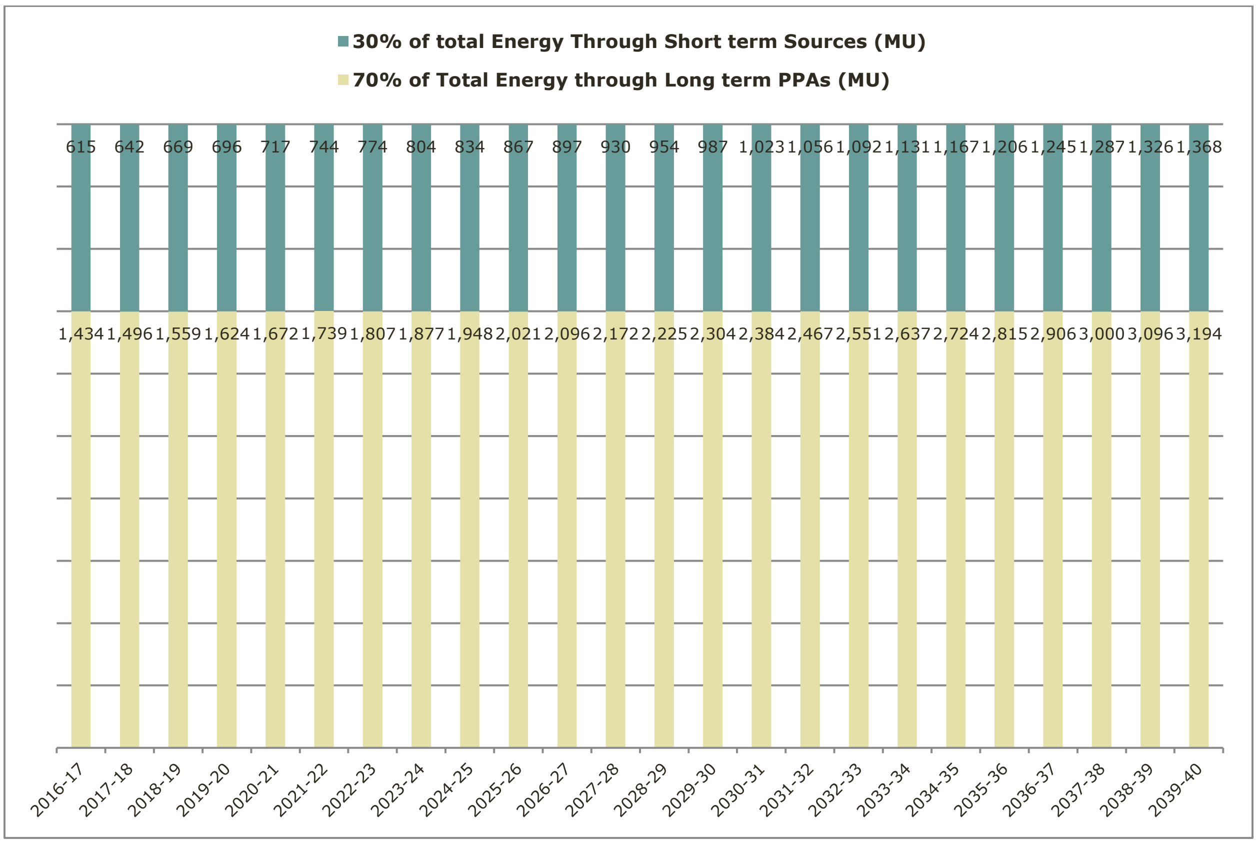

Figure 21: Energy Requirement

Table 17: Power Sourcing

Year	Energy Requirement (MU)	Energy Required on Long Term Basis (MU)	Balance Energy to be procured through Short Term Power Purchase / Banking/ Bilateral Arrangements (MU)	Energy Already Tied-up through Long Term PPAs (MU)[1]	Balance to Procured on Long Term Power Purchase (MU)	Cumulative Energy Available on Long Term Basis (MU)
	A	B	C = A-B	D		
2016-17	2,048	1,434	614	1,866	-	1,866
2017-18	2,137	1,496	641	2,396	-	2,396
2018-19	2,227	1,559	668	2,419	-	2,419
2019-20	2,320	1,624	696	2,419	-	2,419
2020-21	2,388	1,672	716	2,419	-	2,419
2021-22	2,484	1,739	745	2,419	-	2,419
2022-23	2,581	1,807	774	2,419	-	2,419
2023-24	2,681	1,877	804	2,419	-	2,419
2024-25	2,783	1,948	835	2,419	-	2,419
2025-26	2,887	2,021	866	2,419	-	2,419
2026-27	2,994	2,096	898	2,419	-	2,419
2027-28	3,103	2,172	931	2,419	-	2,419
2028-29	3,179	2,225	954	2,419	-	2,419
2029-30	3,292	2,304	988	2,419	-	2,419
2030-31	3,406	2,384	1,022	2,419	-	2,419
2031-32	3,524	2,467	1,057	2,419	48	2,467
2032-33	3,644	2,551	1,093	2,419	132	2,551
2033-34	3,767	2,637	1,130	2,419	218	2,637
2034-35	3,892	2,724	1,168	2,419	305	2,724
2035-36	4,021	2,815	1,206	2,419	396	2,815
2036-37	4,152	2,906	1,246	2,419	487	2,906
2037-38	4,286	3,000	1,286	2,419	581	3,000
2038-39	4,423	3,096	1,327	2,419	677	3,096
2039-40	4,563	3,194	1,369	2,419	775	3,194

[1] The existing PPAs have been assumed to be continued till 2030 and energy availability has been assumed to be the same till FY2030 as per the data provided by CED, OP div 2. Via Memo no. EE/OP@ FY 16-17/DB/:4755 dated 23-05-16

11. Demand Supply Gap

While demand forecast has been made for up to the year 2040, estimation of deficit/surplus has been limited to the next three years based on the availability of generation capacity to Chandigarh. Three approaches to estimate the peak demand and energy demand have been employed based on the results of the econometric model and on analysis of the power scenario for UT Chandigarh.

11.1 Optimistic Approach

Demand forecasting from the model is considered to be accurate.

11.1.1 Demand Supply gap for FY 16-17

Table 18: Demand Supply Gap for FY 16-17 (optimistic)

	April	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
	MW	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**
Peak Demand	331.20	304.70	477.78	454.26	434.78	428.13	320.94	238.51	265.71	325.27	300.34	276.90
Peak Availability	195	253	287	304	274	260	202	159	204	209	191	189
Gap (MW)	**136.20**	**51.70**	**190.78**	**150.26**	**160.78**	**168.13**	**118.94**	**79.51**	**61.71**	**116.27**	**109.34**	**87.90**
	MU	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**
Energy Demand	146.15	199.92	208.41	226.71	214.00	194.27	148.49	122.18	131.91	151.07	121.00	131.69
Energy Availability	131.40	178.50	200.30	207.60	201.10	162.20	138.90	119.10	131.10	142.60	123.80	130.10
Gap (MU)	**14.75**	**21.42**	**8.11**	**19.11**	**12.90**	**32.07**	**9.59**	**3.08**	**0.81**	**8.47**	**-2.80**	**1.59**

11.1.2 Demand Supply gap for FY 17-18

Table 19: Demand Supply Gap for FY 17-18 (optimistic)

	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
	MW	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**
Peak Demand	343.49	467.68	496.12	472.25	451.02	444.22	332.72	247.52	275.99	337.68	311.74	287.09
Peak Availability	229	299	340	365	329	307	254	192	237	255	228	217
Gap (MW)	**114.49**	**168.68**	**156.12**	**107.25**	**122.02**	**137.22**	**78.72**	**55.52**	**38.99**	**82.68**	**83.74**	**70.09**
	MU	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**
Energy Demand	151.61	207.80	216.62	235.68	222.23	201.60	154.01	126.71	136.86	156.73	125.46	136.57
Energy Availability	169.10	229.60	257.80	267.10	258.70	208.70	178.70	153.30	168.60	183.50	159.30	167.40
Gap (MU)	**-17.49**	**-21.80**	**-41.18**	**-31.42**	**-36.47**	**-7.10**	**-24.69**	**-26.59**	**-31.74**	**-26.77**	**-33.84**	**-30.83**

11.1.3 Demand Supply gap for FY 18-19

Table 20: Demand Supply Gap for FY 18-19 (optimistic)

	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
	MW	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**	**MW**
Peak Demand	356.08	485.50	514.85	490.60	467.60	460.65	344.78	256.74	286.47	350.34	323.37	297.52
Peak Availability	226	283	366	333	318	294	232	186	232	248	217	225
Gap (MW)	**130.08**	**202.50**	**148.85**	**157.60**	**149.60**	**166.65**	**112.78**	**70.74**	**54.47**	**102.34**	**106.37**	**72.52**
	MU	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**	**MU**
Energy Demand	157.19	215.83	225.00	244.83	230.62	209.08	159.67	131.34	141.92	162.51	130.02	141.56
Energy Availability	170.80	231.90	260.30	269.70	261.20	210.80	180.50	154.70	170.31	185.30	160.80	169.10
Gap (MU)	**-13.61**	**-16.07**	**-35.30**	**-24.87**	**-30.58**	**-1.72**	**-20.83**	**-23.36**	**-28.39**	**-22.79**	**-30.78**	**-27.54**

11.2 Conservative Approach:

The Conservative Approach considered demand levels 10% lower than those predicted by the load forecast model

11.2.1 Demand Supply gap for FY 16-17

Table 21: Demand Supply Gap for FY 16-17 (Conservative)

	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
Peak Demand	298.08	274.23	430.00	408.84	391.30	385.32	288.84	214.66	239.14	292.74	270.31	249.21
Peak Availability	195.00	253.00	287.00	304.00	274.00	260.00	202.00	159.00	204.00	209.00	191.00	189.00
Gap (MW)	**103.08**	**21.23**	**143.00**	**104.84**	**117.30**	**125.32**	**86.84**	**55.66**	**35.14**	**83.74**	**79.31**	**60.21**
	MU	MU	MU	MU	MU	MU	MU	MU	MU	MU	MU	MU
Energy Demand	131.54	179.93	187.57	204.04	192.60	174.84	133.64	109.96	118.72	135.96	108.90	118.52
Energy Availability	131.40	178.50	200.30	207.60	201.10	162.20	138.90	119.10	131.10	142.60	123.80	130.10
Gap (MU)	**0.14**	**1.43**	**-12.73**	**-3.56**	**-8.50**	**12.64**	**-5.26**	**-9.14**	**-12.38**	**-6.64**	**-14.90**	**-11.58**

11.2.2 Demand Supply gap for FY 17-18

Table 22: Demand Supply Gap for FY 17-18 (Conservative)

	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
Peak Demand	309.14	420.91	446.51	425.03	405.92	399.79	299.45	222.77	248.39	303.91	280.56	258.38
Peak Availability	229.00	299.00	340.00	365.00	329.00	307.00	254.00	192.00	237.00	255.00	228.00	217.00
Gap (MW)	**80.14**	**121.91**	**106.51**	**60.03**	**76.92**	**92.79**	**45.45**	**30.77**	**11.39**	**48.91**	**52.56**	**41.38**
	MU	MU	MU	MU	MU	MU	MU	MU	MU	MU	MU	MU
Energy Demand	136.45	187.02	194.96	212.11	200.00	181.44	138.61	114.04	123.17	141.06	112.92	122.91

	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Energy Availability	169.10	229.60	257.80	267.10	258.70	208.70	178.70	153.30	168.60	183.50	159.30	167.40
Gap (MU)	**-32.65**	**-42.58**	**-62.84**	**-54.99**	**-58.70**	**-27.26**	**-40.09**	**-39.26**	**-45.43**	**-42.44**	**-46.38**	**-44.49**

11.2.3 Demand Supply gap for FY 18-19

Table 23: Demand Supply Gap for FY 18-19 (conservative)

	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
Peak Demand	320.47	436.95	463.36	441.54	420.84	414.58	310.30	231.06	257.82	315.30	291.04	267.77
Peak Availability	226.00	283.00	366.00	333.00	318.00	294.00	232.00	186.00	232.00	248.00	217.00	225.00
Gap (MW)	**94.47**	**153.95**	**97.36**	**108.54**	**102.84**	**120.58**	**78.30**	**45.06**	**25.82**	**67.30**	**74.04**	**42.77**
	MU	MU	MU	MU	MU	MU	MU	MU	MU	MU	MU	MU
Energy Demand	141.47	194.24	202.50	220.35	207.55	188.17	143.70	118.21	127.72	146.26	117.02	127.40
Energy Availability	170.80	231.90	260.30	269.70	261.20	210.80	180.50	154.70	170.31	185.30	160.80	169.10
Gap (MU)	**-29.33**	**-37.66**	**-57.80**	**-49.35**	**-53.65**	**-22.63**	**-36.80**	**-36.49**	**-42.59**	**-39.04**	**-43.78**	**-41.70**

11.3 Most Likely Approach

Most Likely approach considers demand 5% lower than the forecasted values.

11.3.1 Demand Supply gap for FY 16-17

Table 24: Demand Supply Gap for FY 16-17 (Most Likely)

	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
Peak Demand	314.64	289.46	453.89	431.55	413.04	406.72	304.89	226.59	252.43	309.00	285.33	263.05

	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Peak Availability	195.00	253.00	287.00	304.00	274.00	260.00	202.00	159.00	204.00	209.00	191.00	189.00
Gap (MW)	**119.64**	**36.46**	**166.89**	**127.55**	**139.04**	**146.72**	**102.89**	**67.59**	**48.43**	**100.00**	**94.33**	**74.05**
	MU	MU	MU	MU	MU	MU	MU	MU	MU	MU	MU	MU
Energy Demand	138.85	189.93	197.99	215.37	203.30	184.56	141.06	116.07	125.32	143.52	114.95	125.11
Energy Availability	131.40	178.50	200.30	207.60	201.10	162.20	138.90	119.10	131.10	142.60	123.80	130.10
Gap (MU)	**7.45**	**11.43**	**-2.31**	**7.77**	**2.20**	**22.36**	**2.16**	**-3.03**	**-5.78**	**0.92**	**-8.85**	**-4.99**

11.3.2 Demand Supply gap for FY 17-18

Table 25: Demand Supply Gap for FY 17-18 (Most Likely)

	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW
Peak Demand	326.32	444.30	471.31	448.64	428.47	422.01	316.09	235.15	262.19	320.79	296.15	272.73
Peak Availability	229.00	299.00	340.00	365.00	329.00	307.00	254.00	192.00	237.00	255.00	228.00	217.00
Gap (MW)	**97.32**	**145.30**	**131.31**	**83.64**	**99.47**	**115.01**	**62.09**	**43.15**	**25.19**	**65.79**	**68.15**	**55.73**
	MUs	MUs	MUs	MUs	MUs	MUs	MUs	MUs	MUs	MUs	MUs	MUs
Energy Demand	144.03	197.41	205.79	223.90	211.12	191.52	146.31	120.38	130.02	148.89	119.19	129.74
Energy Availability	169.10	229.60	257.80	267.10	258.70	208.70	178.70	153.30	168.60	183.50	159.30	167.40
Gap (MU)	**-25.07**	**-32.19**	**-52.01**	**-43.20**	**-47.58**	**-17.18**	**-32.39**	**-32.92**	**-38.58**	**-34.61**	**-40.11**	**-37.66**

11.3.3 Demand Supply gap for FY 18-19

Table 26: Demand Supply Gap for FY 18-19 (Most likely)

	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW	MW

	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
Peak Demand	338.28	461.22	489.10	466.07	444.22	437.62	327.54	243.90	272.14	332.82	307.21	282.65
Peak Availability	226.00	283.00	366.00	333.00	318.00	294.00	232.00	186.00	232.00	248.00	217.00	225.00
Gap (MW)	**112.28**	**178.22**	**123.10**	**133.07**	**126.22**	**143.62**	**95.54**	**57.90**	**40.14**	**84.82**	**90.21**	**57.65**
	MUs	MUs	MUs	MUs	MUs	MUs	MUs	MUs	MUs	MUs	MUs	MUs
Energy Demand	149.33	205.03	213.75	232.59	219.09	198.62	151.68	124.78	134.82	154.38	123.52	134.48
Energy Availability	170.80	231.90	260.30	269.70	261.20	210.80	180.50	154.70	170.31	185.30	160.80	169.10
Gap (MU)	**-21.47**	**-26.87**	**-46.55**	**-37.11**	**-42.11**	**-12.18**	**-28.82**	**-29.92**	**-35.49**	**-30.92**	**-37.28**	**-34.62**

12. Annexure

12.1 Annexure A: Input Energy Curve

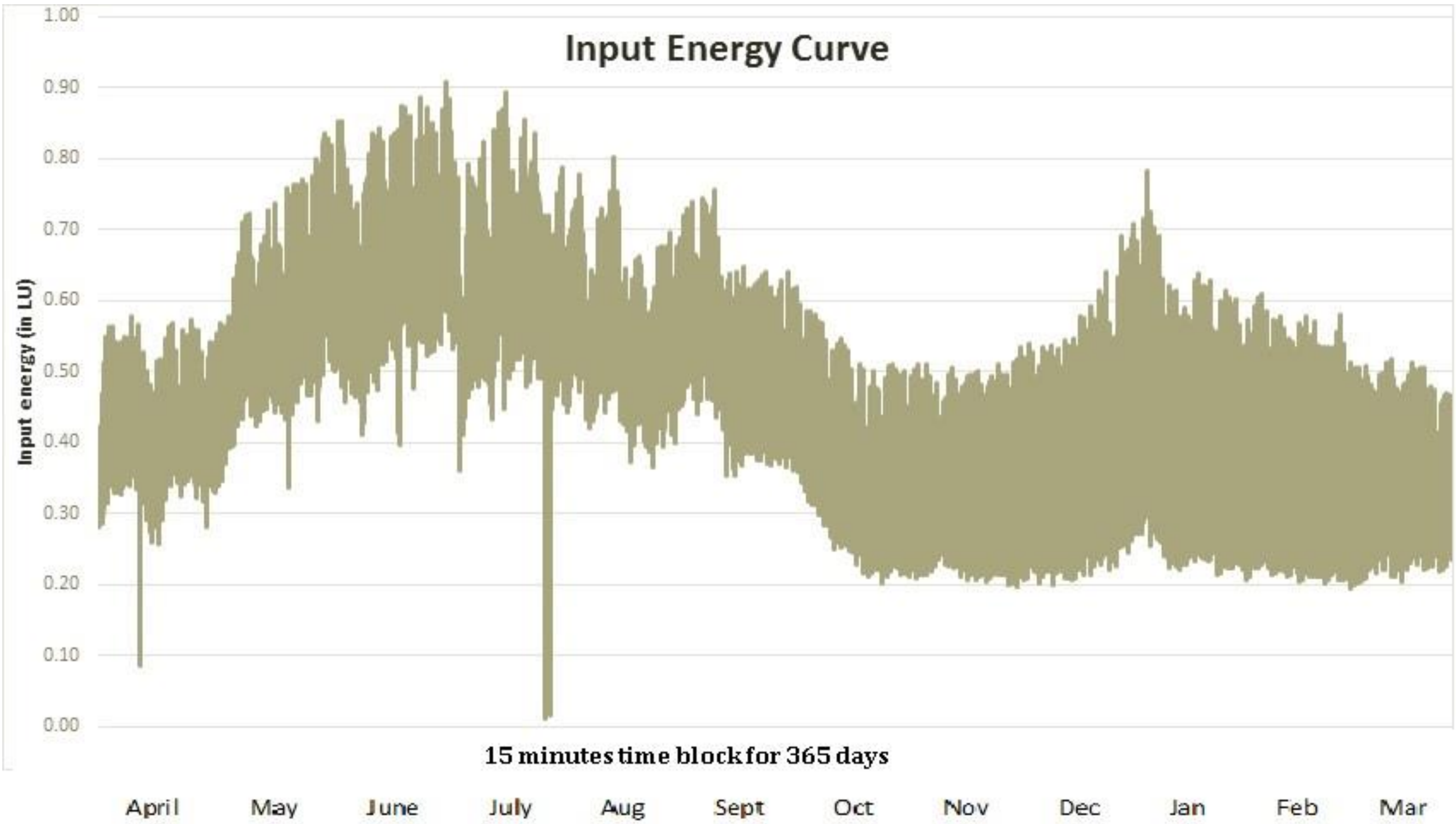

Figure 22: Input energy Curve (as per NRPC Data)

12.2 Annexure B: Mapping of 11 KV feeders

Table 27: Mapping of 11 KV Feeders

11 KV feeder	Category Served
11 KV M& I Feeder	Industrial
11 KV Hallomajra Feeder	Mixed
11 KV Phawa chain feeder	Industrial
11 KV Sector -29 Feeder	Domestic
11 KV OCF feeder	Industrial
11 KV Devendra Feeder	Industrial
11 KV Krasan Feeder	Industrial
11 KV Colony Feeder	Domestic
11 KV Modella Feeder	Industrial
11 KV sector - 35 Feeder (UG)	Domestic
11 KV Sector 45 Feeder	Mixed
11 KV Sector 22 feeder	Commercial
11 KV Radio Station & Station Transformer Feeder	Commercial
11 KV sec -21 A Feeder	Domestic
11 KV Sector -20C Feeder	Domestic
11 KV Sector 33 feeder	Domestic
11 KV Sector-20 A Feeder	Domestic
11 KV Sector- 21 C feeder	Mixed
11 KV Sector 34 C Feeder	Domestic
11 KV City Center Sec 34 Feeder	Commercial
11 KV Sec 35 B &C Feeder	Commercial
11 KV Sector 23 Feeder	Mixed
11 KV Hotel JW Marriott Sec 35 Feeder	Commercial
11 KV sector - 24 Feeder	Mixed
11 KV Sector 40 & 41 Feeder	Mixed
11 KV Sector 37 C & D feeder	Domestic
11 KV Telephone Exchange Feeder	Mixed
11 KV sec -41 Feeder	Mixed
11 KV water works sec -37A Feeder	Mixed
11 KV Gurudwara Sector-37 Feeder	Mixed
11 KV Sector 36 Feeder	Mixed
11 KV Police Colony	Domestic
11 KV Shoping Center	Commercial
11 KV Sec 22	Mixed

11 KV feeder	Category Served
11 KV AG Punjab	Commercial
11 KV Custom	Commercial
11 KV PSIDC Sec 17	Commercial
11 KV Mandi Karan	Commercial
11 KV P&T feeder	Commercial
11 KV Hotel shivalik view	Commercial
11 KV Sec 18D	Mixed
11 KV Sector-21 A Feeder	Domestic
11 KV Sector- 8C Feeder	Domestic
11 KV Chandigarh Housing Board Feeder	Mixed
11 KV sector 18 A feeder	Domestic
11 KV PNB Feeder	Commercial
11 KV Tagore Theater	Domestic
11 KV Shoping Centre	Commercial
11 KV Police Colony	Domestic
11 KV Sector - 9C Feeder	Commercial
11 KV RBI feeder	Commercial
11 KV AG Punjab Feeder	Commercial
11 KV New Radial Feeder	Commercial
11 KV Tribune Feeder	Industrial
11 KV BBMB Complex Feeder	Domestic
11 KV PFIZER Feeder	Industrial
11 KV Water Works feeder	Bulk Supply
11 KV SLDC -1 Feeder	Commercial
11 KV Southern -I Feeder	Domestic
11 KV Southern -II Feeder	Domestic
11 KV Kashmir cold store Feeder	Industrial
11 KV SLDC Complex-2 Feeder	Commercial
11 KV Ring main Feeder	Domestic
11 KV Old Radial Feeder	Mixed
11 KV Industrial -2 Feeder	Industrial
11 KV Industrial -1 Feeder	Industrial
11 KV AWHO Feeder	Domestic
11 KV Bajwara (U/G) Feeder	Domestic
11 KV Kalka feeder	Domestic
11 KV Bajwara Feeder (O/H)	Domestic
11 KV LIC Feeder	Commercial
11 KV Govt. tube well feeder	Domestic
11 KV SLDC Complex	Domestic
11 KV Industrial-3 Feeder	Industrial
11 KV Industrial-1 Feeder	Industrial

11 KV feeder	Category Served
11 KV Ramdarbar-2 Feeder	Mixed
11 KV BRD Feeder	Bulk Supply
11 KV Tribune feeder	Commercial
11 KV C.S.I.D Feeder	Industrial
11 KV Sector -47 Feeder	Mixed
11 KV N & K Area Feeder	Bulk Supply
11 KV Sector 31 Feeder	Mixed
11 KV Nabha Feeder	Bulk Supply
11 KV Industrial -2 Feeder	Industrial
11 KV Industrial - 4 Feeder	Industrial
11 KV Industrial -6 feeder	Industrial
11 KV Ramdarbar -1 Feeder	Domestic
11 KV CSIO Feeder	Mixed
11 KV sector - 30 Feeder	Domestic
11 KV Railway Feeder	Industrial
11 KV Airforce Feeder	Bulk Supply
11 KV General Hospital Sector 32 Feeder	Commercial
11 KV Sukhna Feeder	Mixed
11 KV Fire Brigade feeder	Industrial
11 KV Indian Express	Industrial
11 KV Behlana Feeder	Mixed
11 KV Avery -I Feeder	Industrial
11 KV L&T / Elante Mall Feeder	Commercial
11 KV Needle Feeder	Industrial
11 KV poultry farm Feeder	Industrial
11 KV Avery - II feeder	Industrial
11 KV Laxman flour mill Feeder	Industrial
11 KV PVR Feeder	Industrial
11 KV Milk Plant Feeder	Industrial
11 KV Amrit flour mill Feeder	Industrial
11 KV godrej	Commercial
11 KV G. B. Feeder	Industrial
11 KV IT park Feeder	Commercial
11 KV Indira Colony Feeder	Domestic
11 KV Infosys feeder	Commercial
11 KV New Town Feeder	Domestic
11 KV DLF Feeder	Commercial
11 KV Hotel Lalit	Commercial
11 KV Plot 22 Feeder	Mixed
11 KV Shivalik Feeder	Commercial
11 KV Dhillon Feeder	Commercial

11 KV feeder	Category Served
11 KV Modern Housing Comples (MHC) feeder	Domestic
11 KV Substation Feeder	Domestic
11 KV Rural Feeder	Domestic
11 KV Town Feeder	Mixed
11 KV New City Feeder	Commercial
11 KV Mouli Complex	Domestic
11 KV Mouli Feeder	Domestic
11 KV Shastri Feeder	Domestic
11 KV Pump House Feeder	Bulk Supply
11 KV Punjab & Haryana High Court Feeder	Commercial
11 KV Vidhan Sabha Feeder	Commercial
11 KV Punjab & Haryana feeder	Commercial
11 KV Sector-7 Feeder	Mixed
11 KV Sec 2 & sec -10 Feeder	Domestic
11 KV Punjab Engineering College Feeder	Commercial
11 KV CPWD Feeder	Commercial
11 KV Sector - 3 & 4	Domestic
11 KV Sector -8B Feeder	Domestic
11 KV Sector 9B Feeder	Domestic
11 KV sector -15D Feeder	Mixed
11 KV Western Feeder	Domestic
11 KV Rural area Feeder	Domestic
11 KV Aman Feeder	Domestic
11 KV University Feeder	Domestic
11 KV PGI Colony feeder	Domestic
11 KV Sector 14 Farmacy Feeder	Commercial
11 KV Water Works Sector 12 Feeder	Bulk Supply
11 KV Park View Feeder	Commercial
11 KV New secretariat Feeder	Commercial
11 KV Dhanas REH Colony feeder	Domestic
11 KV Sector 15 A Feeder	Domestic
11 KV Dhanas Feeder	Domestic
11 KV Dhanas and Sarngpur Feeder	Domestic
11 KV Independent feeder	Commercial
11 KV sector 15 C Feeder	Domestic
11 KV Circle Feeder	Domestic
11 KV Taj Feeder	Commercial
11 KV MSW Sector-25 Feeder	Domestic
11 KV Sector 11 C New Feeder	Domestic
11 KV Cricket Stadium Sec-16	Bulk Supply
11KV Punjab & Sindh Sec 17	Commercial

11 KV feeder	Category Served
11KV Mandi Karan Sec 17	Commercial
11KV Sec-8 Market	Commercial
11KV SBI Sec-17	Commercial
11KV Sec-22	Domestic
11KV Circle Sector-9	Domestic
11KV Sec-18B	Domestic
11KV RCC Sector -17	Commercial
11KV 30 bays Sec-17	Commercial
11KV Aroma Sec-22	Commercial
11KV BSNL Sec 17	Commercial
11KV VIP Sector-7	Domestic
11KV LIC Sector- 17	Commercial
11 KV sector - 34 Feeder (UG)	Commercial
11 KV GMCH Block -B Feeder	Mixed
11 KV Sector 45 C Feeder	Mixed
11 KV Sector 32 C&D Feeder	Domestic
11 KV water works sec -32 Feeder	Bulk Supply
11 KV Sector 45 A Feeder	Domestic
11 KV Sector 48 Feeder	Mixed
11 KV Sector 46 C Feeder	Domestic
11 KV Sector 33 Feeder	Mixed
11 KV Burail Feeder	Mixed
11 KV 32 A Sarai building Feeder	Commercial
11 KV Sector 43 Feeder (OH)	Mixed
11 KV GMCH Block -c Feeder	Commercial
11 KV Sector-29 Feeder	Mixed
11 KV Sector 20 D Feeder	Mixed
11 KV Sector - 27 Feeder	Domestic
11 KV Sector 34 Overhead	Commercial
11 KV Gurudwara Sec 34 Feeder	Commercial
11 KV Water Works- 1 feeder Sec 39	Bulk Supply
11 KV Sector 40 feeder	Domestic
11 KV Dadu Majara Colony	Domestic
11 KV Sector 38 Feeder	Domestic
11 KV Water Works- 1 feeder Sec 39	Bulk Supply
11 KV IMT -II Feeder	Domestic
11 KV malaya Colony Feeder	Domestic
11 KV Sector 38 West Feeder	Domestic
11 KV Motor Market 38 West feeder	Mixed
11 KV Village Maloya feeder	Domestic
11 KV Sector 38 C&D Feeder	Domestic

11 KV feeder	Category Served
11 KV IMT - I Feeder	Commercial
11 KV Sector - 24 Feeder	Mixed
11 KV Sector - 37 Feeder	Domestic
11 KV Minister House Feeder	Domestic
11 KV Village Dadu Majra Feeder	Domestic
11 KV Sector 48 New Feeder	Domestic
11 KV Sector 50 Feeder	Domestic
11 KV Sector 47 old Feeder	Mixed
11 KV Sector 44C Feeder	Mixed
11 KV Sector 46 Feeder	Domestic
11 KV Sub Station Feeder	Domestic
11 KV Sector 49 C & D Feeder	Domestic
11 KV Sector 48 old Feeder	Domestic
11 KV sector 50A Feeder	Domestic
11 KV Sector 47 New feeder	Mixed
11 KV Sector 49 (A&B)	Domestic
11 KV Bair majra Feeder	Mixed
11 KV Sector 45 Feeder	Commercial
11 KV Sector 43 (O/H)Feeder	Domestic
11 KV Kazheri Feeder	Mixed
11 KV Sector 35 C Feeder	Commercial
11 KV Sec 42 O/H Feeder	Domestic
11 KV Sec 41 Feeder	Domestic
11 KV Sector 52 Feeder	Domestic
11 KV Sector 44 D Feeder	Mixed
11 KV Sec 32 Feeder	Mixed
11 KV sector 51 C & D Feeder	Domestic
11 Kv Sector 35 D Feeder	Mixed
11 Kv Sector 34 D Feeder	Domestic
11 KV Sector 36 C Feeder	Domestic
11 KV Sector 61 Feeder	Domestic
11 KV Sector 42 (UG)Feeder	Mixed
11 KV Sector 22 Feeder	Mixed
11 KV Sector 44A Feeder	Domestic
11 KV Sec 46	Mixed
11 KV Sec 43 U/G Feeder	Mixed
11 KV Judicial Academy	Commercial
11 KV Sec 51 Feeder	Domestic
11 KV sector Jail Feeder	Bulk Supply
11 KV Sector 41 Feeder	Mixed
11 KV Sector 40 Feeder	Domestic

11 KV feeder	Category Served
11 KV Substation Feeder	Domestic
11 KV Sector 56 New	Domestic
11 KV Sector 39DFeeder	Mixed
11 KV Sector 55 Feeder	Mixed
11 KV 40 C Feeder	Mixed
11 KV Sector 56 Old Feeder	Domestic
11 KV Sector 39 West Feeder	Domestic
11 KV Sector 42 Feeder	Mixed

12.3 Annexure C: Sampling of Feeders

Table 28: Sample List of Feeders

Feeder	Substation	Category
11 KV Industrial -6 feeder	66/11 KV Industrial Area Phase - II Grid Substation	Industrial
11 KV G. B. Feeder	66/11 KV Industrial Area Phase -I Grid Substation	Industrial
11 KV Milk Plant Feeder	66/11 KV Industrial Area Phase -I Grid Substation	Industrial
11 KV Amrit flour mill Feeder	66/11 KV Industrial Area Phase -I Grid Substation	Industrial
11 KV Needle Feeder	66/11 KV Industrial Area Phase -I Grid Substation	Industrial
11 KV C.S.I.D Feeder	66/11 KV Industrial Area Phase - II Grid Substation	Industrial
11 KV IT park Feeder	66/11 KV IT Park Grid Substation	Commercial
11 KV DLF Feeder	66/11 KV IT Park Grid Substation	Commercial
11KV LIC Sector- 17	66 KV Grid substation Sector-18	Commercial
11KV Mandi Karan Sec 17	66 KV Grid substation Sector-18	Commercial
11KV Sec-8 Market	66 KV Grid substation Sector-18	Commercial
11 KV Punjab Engineering College Feeder	66/11 KV Sec-01 Grid Substation	Commercial
11 KV Circle feeder	66/11 KV Sec-12 Grid Substation	Commercial
11 KV Infosys feeder	66/11 KV IT Park Grid Substation	Commercial
11 KV Sector 35 C Feeder	66 KV Grid substation Sector-52	Commercial
11 KV RBI Centre	33 KV Grid substation Sector-18	Commercial
11 KV Airforce Feeder	66/11 KV Industrial Area Phase -I Grid Substation	Bulk Supply
11 KV Cricket Stadium Sec-16	66 KV Grid substation Sector-18	Bulk Supply
11 KV Sector -29 Feeder	33/11 KV Substation Industrial area phase -I Grid Ss	Domestic Feeders
11 KV sec -21 A Feeder	33/11 KV Sector 34 C grid Ss	Domestic Feeders
11 KV Sector 52 Feeder	66 KV Grid substation Sector-52	Domestic Feeders
11 KV Sector 36 C Feeder	66 KV Grid substation Sector-52	Domestic Feeders
11 KV Sector 32 C&D Feeder	66/11 KV Sec-32 A Grid Substation	Domestic Feeders
11 KV Sector -34 C Feeder	33/11 KV Sector 34 C grid Ss	Domestic Feeders
11 KV Police Colony	33 KV Grid substation Sector-17	Domestic Feeders
11 KV sector - 35 Feeder (UG)	33/11 KV Sector 34 C grid Ss	Domestic Feeders
11 KV Sector 48 New Feeder	66 KV Grid substation Sector-47	Domestic Feeders
11 KV IMT -II Feeder	66/11 KV Sec-39 Grid Substation	Domestic Feeders
11 KV Sec 42 O/H feeder	66 KV Grid substation Sector-52	Domestic Feeders
11 KV sector - 30 Feeder	66/11 KV Industrial Area Phase -I Grid Substation	Domestic Feeders
11KV Sec-18B	66 KV Grid substation Sector-18	Domestic Feeders
11 KV Ramdarbar -1 Feeder	66/11 KV Industrial Area Phase - II Grid Substation	Domestic Feeders
11 KV Sector 38 West Feeder	66/11 KV Sec-39 Grid Substation	Domestic Feeders
11 KV Circle Feeder	66/11 KV Sec-12 Grid Substation	Domestic Feeders
11 KV Sector 46 C Feeder	66/11 KV Sec-32 A Grid Substation	Domestic Feeders
11 KV Sector -8B Feeder	66/11 KV Sec-01 Grid Substation	Domestic Feeders

12.4 Annexure D: Load Curve of Base Year

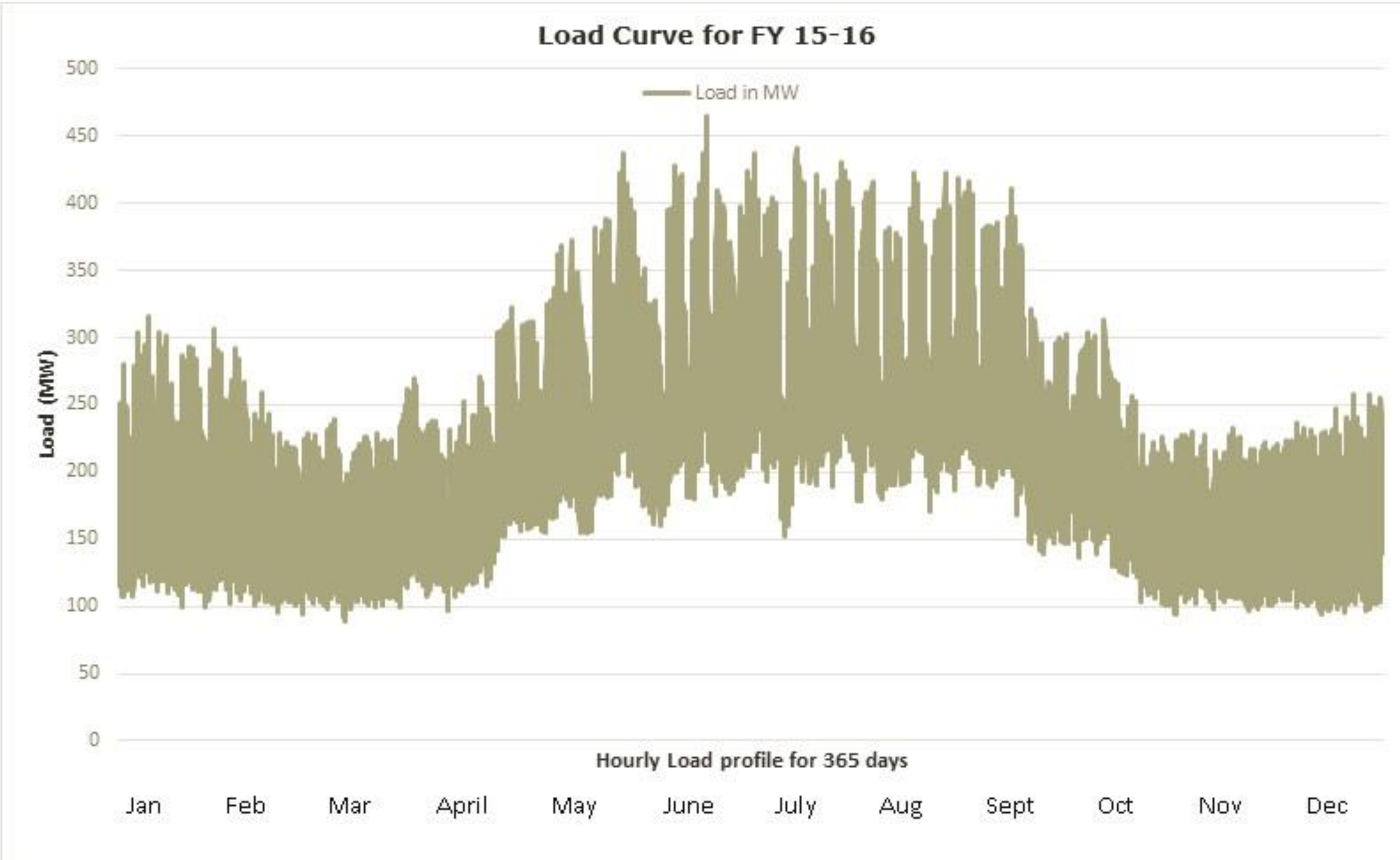

Figure 23: Load Curve for Base year 2015-16