A Study on the Demand Side Management (DSM) Adopted by Kerala State Electricity Board Limited

Thesis
Submitted to the
University of Calicut
for the award of the Degree of

DOCTOR OF PHILOSOPHY IN COMMERCE

Under the Faculty of Commerce and Management Studies

By

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October 2018

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I, **Anitha K.,** hereby declare that, the thesis entitled, '**A Study on the Demand Side Management (DSM) Adopted by Kerala State Electricity Board Limited',** is a bonafide research work done by me under the supervision of **Dr. Sr. Rosa K. D.,** Research Guide & Associate Professor (Retd.), Research and PG Department of Commerce and Management Studies, St. Joseph's College, (Autonomous), Irinjalakuda. I further declare that no part of this thesis has been presented before for the award of any degree, diploma, associateship, fellowship or other similar title or recognition in any University/ Institution.

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Abbreviations

AAGR	Average Annual Growth Rate
ADB	Asian Development Bank
AGFI	Adjusted Goodness of Fit Index
AMI	Advanced Metering Infrastructure
ANERT	Agency for Non-conventional Energy and Rural Technology
ANOVA	Analysis Of Variance
APTS	Anti Power Theft Squad
ASI	Annual Survey of Industries
BCR	Benefit Cost Ratio
BDPP	Brahmapuram Diesel Power Plant
BEE	Bureau of Energy Efficiency
BLDC	Brush Less Direct Current
BLY	Bachat Lamp Yojana
BU	Billion Unit
CBA	Cost Benefit Analysis
C-DIT	Centre for Development of Imaging Technology
CDM	Clean Development Mechanism
CEA	Central Electricity Authority
CEAMA	Consumer Electronics and Appliances Manufacturers Association
CEM	Clean Energy Ministerial
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CFL	Compact Fluorescent Lamp
CFM	Cubic Feet per Minute
CL	Connected Load

CMM	Cubic Metre per Minute
CR	Critical Ratio
CSO	Central Statistical Organisation
CUTS	Consumer Unity & Trust Society
DELP	Domestic Efficient Lighting Programme
DF	Degrees of Freedom
DLC	Direct Load Control
DPC	Distribution Profit Centre
DR	Demand Response
DSM	Demand Side Management
EC	Energy Conservation
ECBC	Energy Conservation Building Codes
EE	Energy Efficiency
EEA	European Environment Agency
EEAF	Energy Efficient Appliance Financing
EESL	Energy Efficient Services Limited
EFA	Exploratory Factor Analysis
EHT	Extra High Tension
EMC	Energy Management Centre
EMIS	Energy Management Information System
ESCO	Energy Savings Coordination
FOR	Forum of Regulators
FTA	Free Trade Agreements
GFI	Goodness of Fit Index
GPC	Generation Profit Centre
GST	Goods & Services Tax
GWh	Giga Watt Hours
HH	House Hold
HT	High Tension
HVAC	Heat Ventilation and Air Conditioning
IEEE	Institute of Electrical and Electronics Engineers

IEP	Integrated Energy Policy
IIT	Indian Institute of Technology
IPCL	Indian Petrochemicals Corporation Limited
IPPs	Independent Power Producers
IRR	Internal Rate of Return
KAMCO	Kerala Agro Machinery Corporation
KDPP	Kozhikode Diesel Power Project
KMO	Kaiser Meyer Olkin
KSEB Ltd.	Kerala State Electricity Board Limited
KSECF	Kerala State Energy Conservation Fund
kVA	Kilo Volt Ampere
kW h	Kilo Watt Hour
LED	Light Emitting Diode
LM	Load Management
LT	Low Tension
MSEB	Maharashtra State Electricity Board
MU	Million Units
MVA	Mega Volt Ampere
MW	Mega Watt
NAPCC	National Action Plan on Climate Change
NEP	National Electricity Policy
NFI	Normed Fit Index
NGO	Non Governmental organisations
NHPC	National Hydroelectric Power Corporation Limited
NMEEE	National Mission for Enhanced Energy Efficiency
NPCIL	Nuclear Power Corporation of India Limited
NPV	Net Present Value
NTPC	National thermal Power Corporation Ltd
OECD	Organisation for Economic Co-operation and Development
PB	Pay Back

PI	Profitability Index
PV	Photo Voltaic
RMR	Root Mean square Residual
RMSEA	Root Mean Square Error of Approximation
RPM	Revolutions Per Minute
SARI/E	South Asian Women Energy Professionals
SAVE	Serve As a Volunteer of Energy
SC	Standardised Coefficient
S.E.	Standard Error
SE	Standardised Estimate
SEAD	Super-efficient Equipment and Appliance Deployment
SEE	State and Local Energy Efficiency Action Network
SEEP	Super Efficient Equipment Programme
SEM	Structural Equation Modelling
SME	Small and Medium Enterprises
SPSS	Statistical Package for Social Sciences
T&D	Transmission and Distribution
TLI	Tucker-Lewis Index
TOD	Time Of Day tariff
TPC	Transmission Profit Centre
TWh	Tera Watt Hours
UC	Unstandardised Coefficient
UE	Unstandardised Estimate
UN-ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNIDO	United Nations Industrial Development Organization
USAID	United States Agency for International Development
UT	Union Territories
WTO	World Trade Organization

Chapter 1

Introduction

Contents

1.1 Introduction

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Chapter 1
Introduction

1.1 Introduction

The world today is very much advanced in terms of technology, economic status, standard of living and industrial growth. As a result, energy needs are also increasing day by day. Electricity is the popularly used form of energy but it is not independently present in nature and cannot be stored on a large scale. Electricity is generated in power plants using thermal sources (with fossil fuels viz. coal, gas and oil), hydro, nuclear and non-conventional energy sources like solar energy, wind energy etc.

According to the Global Energy Statistical Year Book 2017, world's total electricity generation is 24816 TWh. China is the world's largest producer of electricity (6529 TWh), United States is the second largest producer (4251 TWh) and India stands third (1541 TWh). China stands first among the countries in case of electricity consumption (Electricity Consumption of China is 5,683 TWh while the world total is 20917 TWh). The rapid economic development and mass electrification programmes in the Non-OECD (Organisation for Economic Co-operation and Development) Asian countries like India, Malaysia, Thailand, Indonesia etc. increased the total electricity consumption while energy management in Russia, Japan etc. has led to a fall in their electricity demand.

The current levels of energy production and consumption are not sustainable. In the year 2014, the United Nations General Assembly declared the period 2014-2024 as the UN Decade of Sustainable Energy for All. In 2015, the UN General Assembly adopted the 2030 Agenda for Sustainable Development and its aim was to "ensure access to affordable, reliable, sustainable and modern energy for all".

In India, Electricity is a concurrent subject and appears as the 38thitem in List III (seventh Schedule) of the Indian Constitution. The Ministry of Power is mainly responsible for the power development activities in the country.

During the period of 1950-1985, electricity generation in India was lower than that of developed nations. But from 1990 onwards India had an accelerated growth in the generation of electricity. During the last five years i.e, from 2012 to 2017 there was an increase in power generation using coal and renewable energy sources compared to the power generation using oil, natural gas and hydropower plants.

As per the data given by Ministry of Power, Govt. Of India, India's total installed capacity as on 31.12.2017 is 330,861 MW. India's overall generation of electricity has increased from 1173.458 BU (2014-15) to 1173.603 BU (2015-16) and to 1242.010 BU (2016-17). India's electricity requirement is 1142929 MU and availability is 1135334 MU for 2016-17.

In the case of Kerala, the peak demand for electricity is 4132 MW and the peak met is 3996 MW as per the reports of Central Electricity Authority (2016-17). Kerala State Electricity Board Ltd. is engaged in the generation, transmission and distribution of electricity.

1.2 The Research Problem

Kerala is not self-sufficient in the case of electricity. Power crisis is one of the serious problems faced by the state today. This serious issue of power crisis should be tackled to ensure Kerala's economic, social and industrial development. The state depends mainly on its hydro potential for electricity since it does not have sufficient fossil fuel reserves. The supply of electricity is not increasing compared to the demand for electricity. Capacity additions are not easily possible due to public protests against new power projects. The fossil fuels used for electricity generation is harmful for the environment. The solution for these problems is energy management.

In Kerala, the electricity consumption of subsidised domestic category of consumers accounts for around half of the total energy consumed. The peak demand in the state is almost twice the off-peak demand. The average load factor is lower in the winter season as compared to the summer season. During the summer season load shedding is imposed to meet the demand variation. In order to meet the peak demand more investment is required in the power system. But this additional capacity created for meeting the peak demand remains idle during the off-peak periods. As a result of the enactment of various laws for environment protection, strict rules for the protection of flora and fauna and due to public protests, many of the proposed hydroelectric projects were given up and electricity had to be purchased at higher cost.

Since increase in the supply of energy is not an easy task, the idea is to tackle the problem from the demand side. At this juncture, it is relevant to analyse the various aspects of Demand Side Management. Demand Side Management helps the utilities to avoid or delay generating capacity additions and power purchase at higher costs by bringing down the demand. DSM measures are essential for providing quality, reliable and affordable power for all categories of consumers. This increases the performance of utilities and customer satisfaction. Moreover the energy savings attained through Demand Side Management could be distributed to high-end consumers such as commercial and industrial sectors, which would pay higher rate for this compared to domestic consumers. DSM also reduces the negative impact of power plants on the environment and ensures sustainable consumption of energy.

Demand Side Management (DSM), also known as Energy Demand Management is the modification of demand for electricity through behaviour modification of consumers. For this, demarketing strategies are being used by the utilities. The promotion of Demarketing Strategies among the consumers is considered to be the first option available for DSM. Demarketing is marketing in reverse; electricity utilities usually use this strategy in the situations of over demand for electricity. Demarketing in its various forms is used throughout the world to attain the goal of Energy Demand Management or Demand Side Management.

The study is of great significance because like marketing strategies, demarketing strategies and consumer behaviour is equally important in the area of services marketing. Different studies conducted so far mainly deals with the supply side variables of the energy management. Moreover demand side variables are controllable by the utilities as compared to the supply side variables. From the literature review, it is revealed that no systematic study has been conducted in this area and hence the researcher has taken it as the research problem.

The present work investigates into the following aspects of the research problem:

- The demarketing strategies implemented by Kerala State Electricity Board Limited in the domestic sector of Kerala for the promotion of Demand Side Management
- The influence of demarketing strategies on the domestic consumer behaviour leading to Demand Side Management
- Financial viability of the energy efficient lights and fans used by the domestic consumers
- The trends in the electricity consumption in Kerala
- The level of perception of the domestic consumers regarding Demand Side Management
- Impact of Demand Side Management on the future electricity consumption

1.3 Scope of the Study

The present work is a study on the Demand Side Management adopted by Kerala State Electricity Board Ltd. The study is confined to the domestic category of consumers of KSEB Ltd. In the case of this category of consumers, voluntary options are better than mandatory programmes. Technology deployment in the domestic sector is not feasible as it results in more cost with less benefit. In the case of other categories, (industrial and commercial consumers) Energy Conservation Building Code and other norms are almost mandatory, not voluntary. Moreover the electricity saving potential is high in the case of domestic category of consumers as compared to other categories, according to the report of the expert committee of Kerala State Planning Board. In this work, the consumption pattern of electricity is analysed. The dimensions of Demand Side Management namely energy conservation, energy efficiency and load management are also dealt with.

Demand Side Management can be attained only through a modification of consumer perception and behaviour. This study attempts to examine the exposure of domestic consumers towards the demarketing strategies implemented in Kerala for promoting Demand Side Management and the influence of these strategies on their electricity usage behaviour. The four P's of demarketing namely Product, Price, Place and Promotion are analysed for this. Cost Benefit Analysis of Demand Side Management is also made with special reference to energy efficient lights and fans. There is further scope for research in analysing the cost and benefit of other demarketing strategies. The role played by the Agency for Non-conventional Energy and Rural Technology (ANERT) and Energy Management Centre (EMC) in energy management is also examined. The perception of the domestic consumers towards DSM and the problems faced by the consumers in practising DSM are analysed and recommendations are given.

1.4 Objectives of the Study

The main objective of the study is to analyse the Demand Side Management in the Electricity Sector of Kerala. Hence the demand for electricity, strategies for the promotion of Demand Side Management, perception and behaviour of the domestic consumers towards the promotion of DSM, Cost Benefit Analysis of DSM and barriers to the implementation of DSM are analysed.

In order to attain the main objective, the following specific objectives are stated:

1. To examine the demarketing strategies implemented by Kerala State Electricity Board Limited for the promotion of Demand Side Management among the domestic consumers

2. To analyse the effect of demarketing strategies on the domestic consumer behaviour towards electricity

3. To conduct a 'Cost Benefit Analysis' of Demand Side Management with special reference to energy efficient lights and fans in the domestic sector of Kerala

4. To assess the trends of electricity consumption of the domestic consumers of Kerala State Electricity Board Limited

5. To study the level of perception of the domestic consumers of Kerala State Electricity Board Limited regarding the promotion of Demand Side Management

6. To analyse the effect of Demand Side Management measures on the future electricity consumption

1.5 Research Hypotheses

In accordance with the objectives, the following hypotheses were formulated.

H_0.1: Demarketing strategies of KSEB Ltd. have no significant effect on the domestic consumer behaviour towards electricity.

H_0.2: There is no significant association between the location of residence and the use of lighting appliances.

H_0.3: There is no significant association between the location of residence and the use of ceiling fans.

H_0.4 : The electricity saving potential in the households of Kerala is not significant.

H_0.5: There is no significant association between the size of the household and the level of electricity consumption

H_0.6: There is no significant association between the location of residence and the level of electricity consumption.

H_0.7: There is no significant association between the location of the residence and the use of alternative sources of energy.

H_0.8: There is no significant association between the type of building and the level of electricity consumption.

H_0.9: There is no significant association between the type of roofing of the building and the level of electricity consumption.

H_0.10: There is no significant relationship between the income level and the expenditure for electricity of the domestic consumers of KSEB Ltd.

H_0.11: Awareness of the domestic consumers regarding Demand Side Management is not significant.

$H_{0.}$ 12: Opinion of the domestic consumers regarding Demand Side Management is not significant.

H_0.13: Problems confronted by the domestic consumers in practising Demand Side Management is not significant.

$H_{0.}$14: There is no significant difference between the rural and urban consumers in the level of perception regarding satisfaction in practising Demand Side Management.

H_0.15: Load Management Measures have no significant effect on the future electricity consumption.

H_0.16 : Energy Efficient Measures have no significant effect on the future electricity consumption.

H_0.17: Energy Conservation Measures have no significant effect on the future electricity consumption.

1.6 Research Methodology

"A Study on the Demand Side Management (DSM) Adopted by Kerala State Electricity Board Limited" is the title of the present study which is both descriptive and analytical. It is descriptive because, it collects descriptive data that describes the characteristics of population. The study is also analytical because hypotheses were formulated and tested with the appropriate statistical tools. In order to analyse Demand Side Management, both the qualitative and quantiative methods are used.

1.6.1 Period of the Study

The secondary data for a period starting from 2006-2007 to 2016-17 is analysed in the study. The study was carried out from January 2014 onwards. Interview Schedule was prepared by August 2016 and data collection was completed in September 2017.

1.6.2 Sources of Data

Both the Secondary and the Primary Data are used for the study. The Secondary data sources comprises of Reports and Publications of Government organisations like Central Statistical Organisation, Kerala State Planning Board, Kerala State Electricity Board Ltd., Agency for Non-Conventional Energy and Rural Technology, Energy Management Centre, Central Electricity Authority and the Ministry of Power. In addition to this, related articles in reports, journals, magazines and websites are also used.

Primary data collection methods were used to study the demographic profile, electricity usage pattern, scope for DSM, perception and the problems of the domestic consumers. Interviews with the experts in the field and Interview Schedules for domestic consumers are the survey techniques used in the study.

1.6.3 Interview Schedule Design

Structured Interview Schedule for domestic consumers is used for the primary data collection in the present study. The questions are standardised and the responses are limited to fixed alternatives. Likert’s five point scale is used for the study.

Part A –DP.1. To DP.11

This part relates to the demographic profile of the domestic consumers.

Part B – CP.1 To CP.11

This part of the Interview Schedule deals with the consumption pattern of the domestic consumer

Part C –DS.1 To DS.11

This part is to survey the exposure of the domestic consumers towards the demarketing strategies and the effect of the demarketing strategies on the domestic consumer behaviour.

Part D – DSM 1 To DSM V1

This part is meant to study the consumer perception towards DSM and it collects the details regarding the willingness to practise DSM. In addition to this, an unstructured Interview Schedule for KSEB Ltd. was also used in the study for collecting qualitative data.

1.6.4 Variables of the Study

This part of the chapter deals with the objectives, components, variables and sub variables of the study. The first objective is to examine the demarketing strategies implemented by KSEB Ltd. for the promotion of Demand Side Management among the domestic consumers. For this, a qualitative analysis was carried out. After that, the domestic consumer exposure towards various demarketing strategies of KSEB Ltd. is analysed quantitatively.

Table 1.1

Variables of the Demarketing Strategies

Variable	Components of the study
Demarketing strategy	• Demarketing Mix implemented in the Kerala's Electricity Sector • Domestic consumer exposure towards various demarketing strategies of KSEB Ltd.

The second objective is to analyse the effect of ten demarketing strategies (independent variables) on the domestic consumer behaviour towards electricity (dependent variable).

Table 1.2

Variables of the Effect of Demarketing Strategies

Independent Variables	Dependent Variables
1.Energy Education Programmes	Domestic Consumer Behaviour Towards Electricity
2. Public Awareness Campaigns	
3. Sponsored Programmes/ Advertisements	
4. Increase in Tariff Rates	
5. CFL /LED Distribution	
6. Promotion of BEE Star Rated Equipment	
7. Retrofitting Energy Efficient Equipment	
8. Promotion of Alternative Sources	
9. Load Shedding	
10. Statutory Measures	

Third objective is to conduct a 'Cost Benefit Analysis' of Demand Side Management with special reference to energy efficient lights and fans in the domestic sector of Kerala. The electricity saving potential of retrofitting energy efficient fans and lights is analysed.

Table 1.3

Variables of the Cost Benefit Analysis

Variable	Components of the study
Energy Efficient Fans Super Efficient Fans Energy Efficient Lights	Pay Back Period
	Net Present Value
	Internal Rate of Return
	Benefit Cost Ratio
	Sensitivity Analysis
	Usage Pattern of Lights And Fans
	Saving Potential

The fourth objective is to assess the trends of electricity consumption of the domestic consumers of Kerala State Electricity Board Limited. For this, the consumption pattern, demographic profile and the scope for DSM in the residential sector is analysed.

Table 1.4

Variables of the Electricity Consumption Pattern

Variable	Components of study	
Electricity consumption of the Domestic Consumers	Socio-Demographic Profile of the Respondents	Gender Age Educational qualification Number of family members Location of residence Monthly family income Type of building Type of roofing Area in square feet
	Consumption Pattern	Level of electricity consumption Electricity consumption pattern of households Expenditure pattern for electricity Type of connection Connected load
	Scope for DSM	Use of alternative sources Time span of electrical home appliances Time of high use of the electrical home appliances

The fifth objective is to study the level of perception of the domestic consumers of Kerala State Electricity Board Limited regarding the promotion of Demand Side Management.

Table 1.5

Variables of Consumer Perception

Variable	**Components of the study**
Consumer Perception	Factors considered while purchasing electrical appliances
	Awareness
	Opinion towards DSM
	Level of satisfaction
	Problems in practising DSM

The sixth objective is to analyse the effect of Demand Side Management measures on the future electricity consumption. For this, the effect of load management, energy efficiency and energy conservation measures on the future electricity consumption is analysed.

Table 1.6

Variables of the Effect of Demand Side Management Measures

Independent Variables	**Dependent Variables**
1 .Energy Conservation Measures	Future Electricity Consumption
2. Energy Efficiency Measures	
3. Load Management Measures	

1.6.5 Pretesting

The draft interview schedule was given to the experts in the field of research, to get content validity. To find out the reliability and validity of the Interview Schedule, a preliminary survey was conducted. Draft Interview Schedule was given to 80 domestic consumers belonging to Ollur electrical sub division of KSEB Ltd., Thrissur. The reliability of the measurement scales was tested using Cronbach's Alpha Reliability Coefficient.

Table 1.7

Reliability Statistics

Variables	**Alpha Value**	**Internal consistency**
Energy Education Programmes	0.723	Acceptable
Public Awareness Campaigns	0.714	Acceptable
Sponsored programmes / Advertisements	0.756	Acceptable
Increase in Tariff Rates	0.813	Good
CFL /LED Distribution	0.766	Acceptable
Promotion of BEE Star Rated Equipment	0.830	Good
Retrofitting Energy Efficient Equipment	0.855	Good
Electricity Saving Potential	0.729	Acceptable
Promotion of Alternative Sources	0.791	Acceptable
Load Shedding	0.844	Good
Statutory Measures	0.738	Acceptable
Effectiveness of Demarketing Strategies	0.786	Acceptable
Level of Satisfaction	0.754	Acceptable
Behavioural Intention	0.828	Good
Consumer Awareness	0.905	Excellent
Consumer Opinion	0.817	Good
Problems in Practising DSM	0.828	Good
Reduction in the Electricity Consumption	0.896	Good

1.6.6 Validity

Validity of the study is concerned with the extent to which an instrument measures what it is intended to measure. It includes content validity and construct validity. Content validity of the study was ensured with the help of academicians and experts in the field. Construct validity can be divided into convergent validity and discriminant validity. Convergent validity ensures whether the two measures that should be theoretically related are infact related. Discriminant validity checks whether two measures that are theoretically not correlated are infact differentiated. Construct validity was ensured through Confirmatory Factor Analysis.

1.6.7 Test for Normality

Kolmogorov Smirnov test was used to test the normality to apply parametric tests. The test was conducted to check whether sample was drawn from normal population. Null hypothesis was that sample data is not different from the normal. Since the probability values were greater than 0.05, the null hypothesis was accepted. On the basis of the pilot study, modifications were made and a final form of standardised Interview Schedule was prepared.

1.6.8 Sample Design

As the objective of the research is to analyse the Demand Side Management adopted by the Kerala State Electricity Board Ltd. and to study its influence on the domestic consumer behaviour in Kerala, the sample is selected from the 25 electrical circles of KSEB Ltd. Four electrical circles are selected at random from the 25 electrical circles (clusters). Cluster sampling method is used for the study.

Kerala State Electricity Board Limited comprises of three profit centres namely Generation Profit Centre (GPC), Transmission Profit Centre (TPC) and Distribution Profit Centre (DPC). The operations of distribution profit centre of KSEB Ltd. are carried out through four zones namely South, Central, North and North Malabar Region.

Table 1.8

Sampling Frame

Region	**Headed by**	**Number of Ele. Circles**	**Circles selected for the study**
North	Chief Engineer (Distribution North)	7	Kozhikode
North Malabar	Chief Engineer (Distribution North Malabar)	4	Kannur
Central	Chief Engineer (Distribution Central)	7	Ernakulam
South	Chief Engineer (Distribution South)	7	Thiruvananthapuram
	Total	**25**	**4**

One electrical circle each is selected from north, north malabar, south and central zones of KSEB Ltd. to make the sample more representative.

1.6.9 Sample Size

The population of the study is 93,84,957 domestic consumers, while the total number of consumers of KSEB Ltd. is 1,19,94,816 (Power Sytem Statistics 2016-17). Domestic consumer means a household (a domestic connection). Sample size for the study was calculated as 666. From each circle, 200 domestic consumers are selected. Thus a total 800 domestic consumers are selected for the study. A total of 800 Interview Schedules were issued out of which 783 were received completed.

Table 1.9

Sample Size

Sample Size (cochran's formula)	666
Confidence level	99%
Margin of error	5%
Number of Interview Schedules issued	800
Number of Interview Schedules returned filled	783
Sample size for the present study is 783 domestic consumers	

The difference or error that arise when we draw inferences about population parameters from the statistic is known as sampling error or level of precision.The level of precision in this study is 5%.

The degree of confidence or risk level is taken as 99% which means if 100 samples are taken from the same population, then 99 out of the 100 samples will provide an estimate within the precision.The degree of variabilty in the study is 50%. It is the distribution of attributes in the population. The formula for calculating the sample size by Cochran (1977) and Sarmah and Choudary (2013) is given below :

$$\text{Sample Size} = \frac{Z^2 p\, q}{e^2}$$

Z is the Critical value of desired confidence level, (2.58)

p is the proportion of attribute,(0 .5)

q is 1-p

e is the desired level of precision,(.05)

The Sample Size is 666

1.6.10 The Tools and Techniques Used for the Study

The data collected were analysed using appropriate statistical tools as described below :

a. **Mean and Percentage**

Mean provides a single value to represent the characteristics of the whole group. Percentage represents the data as percent (part of 100). Mean and percentage were used to analyse the consumption pattern of the domestic consumers in Kerala using secondary and primary data.

b. **Garrett Ranking**

Henry Garrett Ranking method was used to find out the most significant factor considered by the domestic consumers while purchasing the home appliances. The percentage score was calculated and converted into Garrett scale values using Scale Conversion Table. The total scores of each rank for every factor and mean score was calculated to know the order of preference given by the respondents for the factors.

c. **Independent Sample ‘t’ test**

Independent sample ‘t’ test is used to compare two groups to know whether there is any significant difference between the two groups. In the present study, the tool was applied to test the significant difference in the level of satisfaction in practising DSM between the rural and urban domestic consumers of KSEB Ltd.

d. **One Sample ‘t’ Test**

One sample‘t’ test is used to test whether the mean of the sample differ significantly from the population mean. In the study, the tool is used to test the significance of electricity saving potential of the households, awareness and opinion of the domestic consumers regarding DSM and the problems faced by the domestic consumers in practising DSM.

e. **Chi-Square Test of Independence**

Chi square test of independence is used to test whether two variables are independent of each other. In the present study the test is used to analyse the significance of association between the demographic profile and level of electricity consumption and the location of residence and the usage of lighting appliances and ceiling fans.

f. **Correlation**

Correlation is used to analyse the relationship between two variables. Coefficient of correlation varies between -1 (perfectly negative correlation) and +1 (perfectly positive correlation). In this study, the income level and the expenditure for electricity of the domestic consumers of KSEB Ltd. is analysed using correlation.

g. **Multiple Regression Analysis**

Multiple Regression Analysis is a method for studying the relationship between a dependent variable and two or more independent variables. In this study the multiple regression analysis for domestic consumer behaviour towards electricity (Y) was performed with 10 independent variables of demarketing strategies of KSEB Ltd. like Energy Education Programmes, Public Awareness Campaigns, Sponsored Programmes and Advertisement, CFL/LED Distribution, Retrofitting Energy Efficient

Equipment, Increase in Tariff Rates, Promotion of BEE Star Rated Equipment, Promotion of Alternative Sources, Load Shedding and Statutory Measures.

h. **Structural Equation Modelling**

Structural Equation Modelling is a multivariate analysis technique used to analyse the relation between measured variables and latent constructs. In this study SEM is used to analyse the effect of Demand Side Management measures on the future electricity consumption.

Statistical packages used in the study are IBM SPSS Statistics 20.0 (Statistical Package for social sciences), SPSS Amos 20.0 (Structural Equation Modeling software) and excel 2007.

1.7 Operational Definitions

The process of demand reduction is called 'Demarketing' or 'Demand Side Management' by many marketing practitioners and academicians. Some authors consider Demarketing and DSM as similar terms, while others think that 'Demarketing' leads to 'Demand Side Management'. The researcher has used demarketing strategies as a means to promote Demand Side Management by influencing the consumer perception and behaviour. Important terms and concepts used in the study are given below:

a) Demand Side Management

Demand Side Management or Energy Demand management means managing the demand variables of energy. DSM is not simply reducing demand. Eventhough there are various dimensions for the concept of DSM, only those aspects that are widely practised in Kerala like Load Management, Energy Efficiency and Energy Conservation are included in the present study.

b) Load Management

Load management includes Demand Response, Load Shedding and Load Shifting. Demand response means adjusting the usage pattern in response to the feedback of their electricity use. Load shedding is a deliberate reduction of load in a particular region in the form of powercuts or voltage reduction by the supplier of electricity. Load shifting means changing the use of electricity from peak hours to off-peak hours.

c) Energy Conservation

Energy Conservation means reducing the use of electricity. It means less comfort or discomfort or no use of an energy service.

d) Energy Efficiency

Energy Efficiency means optimum utilisation of electricity through technological changes. It refers to availing the same service and comfort with less cost and without wastage

e) Demarketing

Marketers have to manage the demand for goods and services. Different demand situations require different marketing strategies. Demarketing is the strategy used in the situation of over demand. Demarketing refers to the use of marketing techniques to change the consumer perception and behaviour towards electricity, in order to reduce the demand. Electricity utilities use the tools of marketing - Product, Price, Place / Physical Distribution, and Promotion to establish Demarketing. In the present study, ten Demarketing Strategies adopted in the Electricity Sector of Kerala are identified and used. They are Energy education programmes, Public awareness campaigns, Sponsored programmes/Advertisements in various media, Increase in tariff rates and slab system (Differentiated pricing and price hike), CFL /LED distribution, Promotion of BEE star rated equipment, Retrofitting Energy efficient equipment, Promotion of alternative sources, Powercuts/Load shedding and Statutory measures.

f) Kerala State Electricity Board Limited

Kerala State Electricity Board Ltd. is the public utility responsible for generation, transmission and distribution of electricity in Kerala. Energy Management activities are carried out by KSEB Ltd. in association with other organisations and agencies.

g) Domestic Consumers of KSEB Ltd.

Domestic Consumer is a person who is a 'Low Tension Consumer' supplied with electricity for his own use by the Board at low or medium voltage and belongs to LT 1A (Low Tension 1 A) category and whose average monthly consumption is less than 500 kWh.

h) Consumer Perception

Consumer behaviour to a large extent is influenced by the perception of consumers. Consumer perception means how a consumer receives and interprets a situation, or stimuli through six senses which activates his thinking process leading to action. In the present study, consumer perception means the perception of domestic consumers of KSEB Ltd.

i) Household

Household means individuals related or unrelated, who occupies a housing unit. This term is different from the term 'Family'. A family means two or more individuals who are related to each other by blood, adoption, marriage and by residing together. Households constitute the residential or domestic sector.

j) Consumer Behaviour

Consumer behaviour towards electricity means the time, pattern and trends of electricity usage. Consumer behaviour is a very important concept because it is the core of Demand Side Management.

k) Cost Benefit Analysis

Cost Benefit Analysis of energy efficient lights and fans is made to analyse the benefits expressed as savings in electricity bill against the cost of replacing or installing energy efficient lights and fans.

1.8 Limitations of the Study

1. The present work makes a Cost Benefit Analysis of energy efficient lights and fans only. Financial benefits of other DSM measures are not considered in the present study.

2. The social and environmental impacts of DSM are not analysed in detail in the study.

3. KSEB Ltd. carries out the Demand Side Management activities in Kerala with the support of various agencies. In the present study only the role of EMC and ANERT are considered.

1.9 Scheme of the Work

Chapter 1: Introduction

The first chapter consists of Introduction, Research Problem, Scope of the Study, Objectives of the Study, Research Hypotheses, Research Methodology, Operational Definitions, Limitations of the study and Chapterisation.

Chapter 2: Review of Literature

The Second chapter consists of review of related works. Relevent literature related to the Concept of Demand Side Management (DSM) and Techniques for DSM, Demarketing Strategies adopted for the Promotion of DSM, Energy Management in India – Cases from different states, Kerala's Power Sector and Consumer Behaviour towards Electricity, Consumer Perception and Consumer Behaviour, Energy Saving Potential, Energy Efficiency, Cost Benefit Analysis and use of Alternative Sources and Problems in implementing DSM are reviewed and the research gap is identified.

Chapter 3: An Overview of the Electricity Sector

The third chapter consists of an overview of the Electricity Sector of India and Kerala.

Chapter 4: Demarketing Strategies Implemented by the Kerala State Electricity Board Limited

The fourth chapter consists of theoretical framework of 'Demand Side Management' and 'Demarketing', Demarketing Strategies implemented by Kerala State Electricity Board Ltd. for the promotion of DSM and the effect of Demarketing Strategies on the Domestic Consumer Behaviour towards Electricity.

Chapter 5: Cost Benefit Analysis of Demand Side Management

The fifth chapter consists of a 'Cost Benefit Analysis' of energy efficient lights and fans in the Domestic Electricity Sector of Kerala.

Chapter 6: Perception of the Domestic Consumers of Kerala State Electricity Board Limited towards Demand Side Management

The sixth chapter makes an analysis of Socio-Demographic Profile, Consumption Pattern of Electricity, Scope for Demand Side Management, Consumer Perception towards Demand Side Management and the Problems faced by the domestic consumers in practising Demand Side Management.

Chapter 7: Findings, Conclusion and Recommendations

The seventh chapter presents the findings and conclusions based on the study made in the previous chapters. Recommendations and the scope for further study is also presented.

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Chapter 2

Review of Literature

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2.6	Conclusion
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Chapter 2
Review of Literature

2.1 Introduction

The present work is a study on Demand Side Management (DSM) adopted by Kerala State Electricity Board Ltd. The different aspects of DSM namely, promotion strategies, consumer response, impact and constraints are included in the study. The analysis of cost and benefits is also an inevitable part of the study. The researcher makes an attempt to review all the related studies to identify the research gap. Thus the related studies made so far are divided into the following heads.

a) The Concept of Demand Side Management (DSM)
b) Energy Management in India
c) Consumer Perception and Consumer Behaviour
d) Dimensions of Energy Management

The first part, namely, the Concept of Demand Side Management (DSM) comprises of the review of studies related to the concept of DSM, techniques for DSM and the Demarketing Strategies adopted for the promotion of DSM. The second part deals with the review of DSM cases from different states in India, including Kerala's Power Sector. The third part involves Consumer Perception and Consumer Behaviour towards electricity. The fourth part involves the review of various dimensions of Energy Management namely, Energy Saving Potential, Energy Efficiency, Cost Benefit Analysis, Use of alternative sources and Problems in implementing DSM.

2.2 The Concept of Demand Side Management (DSM)

Alsamydai (2015) explains the Ostensible Demarketing strategies and its ability to improve the image of the product in the minds of customers. The study analyses the various methods like decreased offer, increased price, limited distribution and limited advertisement. The influence of these ostensible demarketing methods on the customer perception towards product quality and how they improve the reputation of products in the minds of customers are analysed. The information was collected using primary exploration study from 312 customers for constructing and designing a study model.

Bradley and Jim (2013) state that demarketing is the deliberate attempt by the marketers to reduce demand for a product by using the same tools as are normally used to increase demand. They observe that social marketing is the motivating factor for demarketing, especially in government departments. Demarketing is the only solution used in the situations of limited supply or to avoid undesirable customers. The authors also analyses the potential and limitations of the concept of demarketing.

Cheng (2005) tries to identify energy efficiency strategies and load reduction strategies implemented for DSM in the Shadong Province of China. The technologies used and policy options for carrying out DSM are also studied. The study also examines how to achieve substantial reductions in electricity demand through DSM by developing a computer-based modelling tool and long-term projections for demand analysis. The recommendations regarding DSM policies include management of temperature sensitive loads, improving building technology and appliance efficiency, adopting load management and behavioural management strategies, urbanization policy management etc.

Dabur et al. (2012) reviews the concept of Demand Side Management, objectives, different types of DSM measures and problems confronted in implementing DSM. Authors also point out that the promotion of DSM is influenced by the policies taken and subsidies provided by the government, and the incentives provided by utility companies to consumers who are using non-conventional energy sources. Awareness about demand management, motivation and research in the area will provide prospects for developments in DSM in the future.

Dadzie (1989) analyses the relationship between economic shortages and demarketing activities adopted in six African countries. Author outlines the different methods that the firms should use to adapt their marketing programmes according to the shortage marketing environment. The marketing activities during the period of over demand or shortages are also significant. The data for the study was collected from the firms in the six African countries using mailed questionnaire.

Gallagher (1994) states that, ‘demarketing’ is the term used by many academics for the process of demand reduction while many marketing practitioners call it as ‘Demand Side management’. Author cites the example of Electric utilities trying to encourage energy conservation. The study involves the use of habit change strategies in demarketing and reducing discretionary consumption. The data for the study was collected from 340 households of British Columbia.

Gerstner (1993) considers Demarketing as a differentiation strategy and states that demarketing is a financially profitable option when differentiation through product improvements is not at all economically viable. A firm can use demarketing strategy as a differentiation strategy to differentiate itself from its competitor. The authors also analyse the impact of demarketing on the demand of the product, market share of the product and on the consumers.

Glanzn et al. (2012) present several strategies to promote healthful eating and to check obesity by encouraging healthful food items and restricting or de-marketing unhealthy food. Authors suggest that for assessing consumer behaviour, electronic sales data and individually linked sales information from loyalty card holders, can be used to improve the scientific rigor of field research. 125 articles were reviewed which consist of observations and experiments and was categorised into Four Ps of marketing mix namely, Product, Price, Place and Promotion.

Gondane (2016) identifies the following benefits of Demarketing; to make demand and supply parallel, to manage demand to strengthen the brand, to create an emotional bonding between the brand and the customers and product positioning by creating a space for the product in the minds of the customers.

Gupta et al. (2014) state that Demarketing is a vital decision for a firm. It discourages the customers from buying their product. This is done by influencing the consumer behaviour and decision making process through the strategies of demarketing. It is a 360° process including maximising profit, demand and supply, satisfaction and development. Demarketing is a cost effective alternative to product improvements. These strategies help the firm to sustain consumers.

Harvey and Roger (1977) analyse the perspectives on Demarketing during the period of energy crisis and examine the reasons for gasoline shortage in the US and the case of two oil corporations - Shell oil and Exxon. The authors observe how the firms successfully managed the energy crisis by implementing various demarketing strategies and reduced the demand for gasoline temporarily.

IIT, Bombay (2015) in the report on DSM and demand response assesses that there is a wide gap between energy demand and supply in Kerala. DSM is a solution for power crisis. The majority of the consumers of KSEB are domestic consumers. The study outlines that in the case of domestic sector, voluntary options are better than mandatory programmes, because Demand Response activities using technology deployment in this sector results in more cost with less benefits.The commercial and industrial sector on the other hand should concentrate on Demand Response activities as they would be a very good alternative.

Khanna et al. (2016) conclude that DSM measures have great influence on the consumption behaviour of consumers. The study was about 1450 households in China. The DSM measures used were Electricity Pricing, Energy Labelling programme, and Information Feedback. The findings were that the DSM measures have considerably reduced the electricity consumption in the household sector of China.

Lefebvre and Kotler (2011) state that demarketing is demand reduction. It is a vital part of demand management. The four situations that necessitate demarketing are:

1) Managing an existing shortage – eg. Energy and water shortage.
2) Avoiding potential shortage- eg. Overfishing is checked to ensure the supply of fish.
3) Minimizing harm to individuals- eg. Reducing smoking and alchohol consumption and

4) Minimizing harm to nature- eg. Restricting the number of visitors to the national parks.

Mayakrishnan (2011) observed that the domestic consumers, except those belonging to higher and middle income groups, use inefficient electrical appliances due to the higher cost of the appliances. The study reveals that income level of the consumers is a major factor that influences the adoption of energy efficiency. Energy standards, energy labelling etc. helps to attain energy efficiency and to reduce green house gases. DSM helps to bring down the peak demand for electricity.

Mikl ́os-Thal and Juanjuan (2010), employ a new perspective to describe the merits of demarketing. They examine whether the sellers can use demarketing strategy to manage the quality perceptions of the customers. “Demarketing”, is a practice that deliberately suppresses marketing efforts to discourage the demand. Marketer adopts costless strategies to reduce the level of demand for the short term. This in turn, helps to increase the long term product image in the minds of the consumers.

Panigrahi (2013) explains that, in the context of changing natural environment, an organisation can become more effective and competitive only through the implementation of demarketing strategy. The author presents a few cases of this strategy in India. Indian Petrochemicals Corporation Limited reduces promotion expenditure and increases the product prices in order to maximise the utility of the product. Demarketing strategies were used to reduce the demand of Tata Nano cars due to its shortage. These strategies were also used to control the use of tobacco in India.

Sachdev and Omveer (2015) underline that Demand side management helps to regulate the demand of end users of energy through peak clipping and load management. DSM will be effective only by combining the aspect of energy efficiency with an incentive based shifting of demand for energy. Addition of clean energy in the form of solar and wind energy to power system and adoption of Information and Communication Technology helps to modify the end use pattern of electricity.

Samal (2013) traces out that in the Indian domestic sector, major portion of lighting needs are met by inefficient incandescent bulbs. They convert 90% of the electricity into heat, and only upto 10% is used for lighting. To avoid this energy loss, DSM is essential. Bureau of Energy Efficiency (BEE) initiative –The Super Efficient Equipment Programme (SEEP) aims to replace the inefficient lamps with efficient energy saving lamps, by distributing 25 million LED bulbs. Four LEDs are given to each household in exchange of four incandescent lamps as part of the programme.

Shiu et al. (2008) represents a conceptual model, linking the 4Ps in a demarketing mix. The authors use empirical longitudinal data to test the model. The results suggest that the four demarketing mix elements affect smokers' attitudes toward the tobacco industry and smoking, as well as their intention to quit over time. Demarketing is used in this context to reduce the harmful effects of tobacco on the society.

Singh and Surabhi (2015) analyse the different techniques of load management by which DSM can be attained. Load management means managing the demand for electricity. It means reducing peak demand, shifting demand from peak hours to off-peak hours, increasing demand during off-peak hours etc. The techniques include Valley filling, Peak Clipping, Load Shifting, Strategic Load Growth, Flexible Reliability and Strategic Conservation (reducing the demand for electricity irrespective of the time of use).

Zhang and Ignacio (2015) state that, DSM can be analysed from two perspectives, from the perspective of the grid operator and from the perspective of the consumer. The objective of the grid operator is to increase the efficiency and reliability in the power grid by reducing the demand for electricity and through load management. This helps to delay investments in the Power Sector. On the other hand, the objective of the electricity consumer is to reduce the electricity charges by reducing its consumption. Both perspectives are examined in this study.

2.3 Energy Management in India

Bahuleyan (1992) makes a detailed study about the energy consumption pattern and demand for energy in Kerala, with special reference to the rural domestic sector. The study reveals that there is a wide gap between energy demand and supply in Kerala. Author also observes that the socio-economic status of the people and the income of the households influence the demand for energy.

Bai (2016) points out that there is a giant increase in the electricity demand in Kerala, due to the heavy consumption of different categories of consumers. KSEB and the Government aims to generate more electricity, to prevent its misuse and to make people aware of the wise use of electricity. Kerala government also attempts to generate electricity from non-conventional sources instead of depending on the hydroelectric projects which possess threats to the environment.

Centre for Development of Imaging Technology (C-DIT) (2013) conducted an energy survey in the Chendamangalam Grama Panchayat, Eranakulam district, Kerala and observed that 97% of the domestic consumers in the panchayat are using less than 400 kWh of electricity bi-monthly. Out of the 3000 ‘majority energy demanding’ households coming under this category, 55% have the rooftop potential to generate more power than they actually consume. Equipment like television, ceiling fan, refridgerator, water pump, washing machine and mixer are present in more than 50% of the houses which consume above 80 kWh a month. In the study, the time based demand pattern of the domestic consumers is also analysed. The entire day was split into 4 time slots 6 PM to 10 PM (peak hours), 10 PM to 7AM (off-peak hours), 7 AM to 12 noon and 12 noon to 6 PM. This study helps to understand the need for load management.

Dash (2013) gives an overview regarding the difference between the rural and urban consumption of electricity and the difficulties faced by the rural people in Rourkela, Sundergarh District of Odisha. The author also analyses the hardships due to the lack of support from the government officials mainly the electricity department. The study helps in solving the problems and in framing strict laws and regulations to ensure judicious use of electricity.

Devi (1985) in her thesis examines the financial performance of KSEB from 1957- 58 to 1980-81 and makes a detailed analysis of the costs of production and supply of electricity and the pricing practices followed by KSEB Ltd. The research reveals that, the relative share of industrial consumption is declining and the relative share of domestic consumption and exports are increasing. The domestic consumers are the subsidised groups. The industrial consumers are the main source of revenue for the board. So the change in the relative share of industrial and domestic consumers will affect the revenue of KSEB Ltd.

Energy Management Centre (2010) states that on the basis of energy audit conducted in 22 Government Buildings in Kerala, the energy saving potential of 18 % of the present energy consumption was identified. Pay Back Period of 1.5 years is expected for the energy saving project investment. The audit was conducted during 2008-09 under the nation wide programme of BEE under the Ministry of Power, Government of India.

Forum of Regulators (FOR), Regulatory Economics Advisory, India (2010) reports that Time of Day (TOD) tariff is an important tool for DSM. High Tariff rates are charged for the use of electricity during the peak period. This motivates the consumers in load management by shifting their loads from peak times to off-peak times. The KSEB Ltd. introduced differential pricing for EHT consumers from 1998 and for HT consumers from 2002.

Gupta et al. (2012), in the publication by the Energy and Resources Institute gives an overview of the DSM initiatives, electricity usage pattern, load pattern and statutory measures in the area of energy conservation in the state of Tamilnadu. The study makes an indepth examination of the electricity consumption of different categories like domestic, industrial, commercial and agricultural consumers.The objective of the study was to analyse the effectiveness of DSM in reducing the peak demand for electricity. Five regions of TamilNadu, namely, Chennai north, Chennai south, Trichi, Erode and Coimbatore were selected for the study.

Jain et al. (2007) presents the pattern of electricity usage in the household sector of Delhi. The study reveals that, by replacing one ordinary bulb with a CFL, one tube light with copper choke replaced with tube light with electronic choke and switching over geysers from peak to off-peak period, the annual energy savings per household will be Rs 650 to Rs 1050. The benefit to the utility is a reduction of 650 MegaWatts, which is equal to Rs 840 million per year.

Jisana and Basheer (2014) analyse the attitude and perception of consumers towards different electrical home appliances. They collected the primary data using personal and telephone interviews with the help of a structured interview schedule to analyse the consumption pattern. The study reveals that almost all the home appliances were changed to necessary from luxury status and the customers are satisfied with the electrical home appliances.

Jose (1999) tries to analyse the micro level factors that influence the rural household energy behaviour in Kerala and the demand and supply aspects of energy in Kerala. The limiting factors in practising energy conservation and adoption were also studied. The limiting factors are unaffordability, lack of financial assistance for adopting energy efficient technologies and the difficulty in handling the complicated equipment.

Joseph (2014) examines the consumer behaviour towards electricity in Kerala's Power Sector. Three major factors considered in the study are the consumers' awareness of their electricity consumption, the usage pattern of electric appliances and consumer behaviour or electricity consumption pattern. Primary data collected from 207 respondents, from different parts of Kerala are analysed. The study reveals that lack of awareness of consumers regarding the need to reduce electricity consumption and the practical ways of reducing consumption.

Joseph et al. (2015) conducts an experimental study of different energy saving methods, in a college campus in Kerala. A detailed energy audit was carried out to find out the electricity consumption and saving potential. The techniques used include walk through survey, building and utility data analysis, setting base line for building energy use and evaluation of the energy saving measures.

Kerala State Planning Board committee on energy (2015) recommended that in the context of unavailability of sources of energy, Demand management is very important. Energy saving potential in Kerala's domestic sector is 20-25%. Demand side management may be promoted through awareness campaigns, restricting low quality gadgets, promoting energy efficient appliances, etc.

Lajina (2008) in her Ph.D Thesis made an analysis of 12 common industries for the period from 1980-81 to 2002-2003 based on Annual Survey of Industries (ASI). The author states the different methods that can be adopted for managing demand for energy. The author observes that energy intensity can be minimised through structural changes, energy efficiency, energy audit, energy management, promoting energy conservation, new technologies etc.

Manoj (2010) made a case study of KAMCO- a Kerala based agro-machinery manufacturing company and analysed the trends over the years. The study shows that energy management has helped the company to a great extent to increase its profitability and competitiveness. The company reduced electricity cost by shifting its use from peak hours to off-peak hours and through its wise use.

Mathews (1998) conducts an analysis of micro and macro level impacts of the energy prices. Micro analysis of the energy consumption pattern of the households in Kerala was carried out. A macro level econometric simulation was also made to analyse the changes in the energy market, and the implications of administered energy price in the context of liberalisation/ globalization.

Murthy et al. (2001) investigates into the end use pattern of electricity in the households in Karnataka and penetration of energy efficient appliances. Authors also make a comparative study of the consumption pattern of rural and urban households. A study of 1165 households from the four districts of Karnataka is made. ANOVA test is used in the study to find out the differences in the electricity used by the households across different slabs of electricity usage and across districts. They point out that, the policy makers shall take corrective actions by promoting efficiency improvements in certain end-use devices.

Pavithran (2005) made a case study of power generation, transmission and distribution in Kerala and traced out the unique features and problems confronted by the Power Sector by analysing the performance of ten major hydropower projects of Kerala. The problems include exclusive dependence on hydropower stations, zero fuel cost for power generation, transmission and distribution losses higher than the national average, internal maximum demand exceeding the installed power capacity etc.

Pillai (2015) examines the role of celebrity endorsements in the energy conservation campaigns and the impact of other energy education and awareness programmes conducted by the KSEB Ltd. as part of Demand Side Management like Spandhanam (a TV show in Doordarshan), radio jingles, exhibitions, theatre ads, brochures etc. The study reveals that, celebrity endorsements definitely have impacts on the public awareness campaigns.

Sangamesh et al. (2012) delves into the pattern of electricity consumption by 252 households in the state of Karnataka and usage pattern of LT I and LT II (Low Tension Households) to identify the opportunities of energy conservation and design suitable DSM measures. The Demand Side Management process consists of measuring the base load pattern, analysing the usage pattern and estimating the energy saving potential.

Sharma et al. (2003) conducted a two round Delphi study to analyse various problems in the Kerala Power Sector. The study emphasised the need for using the DSM initiatives to overcome the future energy crisis. Expert opinion reveals that there is high potential for energy management in Kerala. The study also underlines the need for an integrated energy planning in Kerala.

Shereef and Ganesh (2013) investigate into the pattern of electricity usage of domestic consumers of KSEB. They state that the prime factor that influences the demand for electricity is household income. The study also claims that, the domestic consumers are willing to reduce their electricity usage further. This study represents that, there is great opportunity for electricity conservation in Kerala's domestic sector.

Sreekanth et al. (2011) gives a regression model for forecasting domestic consumption of energy in Kerala. The study was made, on the basis of survey data collected from residential sector at micro level. The study reveals the influence of various factors on the domestic consumption of energy. Demographic, geographic, socio-economic and family attributes influence the domestic energy requirements significantly.

Sreekumar (2011) establishes the fact that, an efficient Power Sector is inevitable for the industrial growth of the State. This industrial growth in turn results in the development of the state in general and the Power Sector in particular. The industrial electricity consumers consume about 28% of the total energy sales of KSEB Ltd. and contribute about 37% to the total revenue from tariff.

USAID (2009) report on DSM in Gujarat aims to analyse the opportunities of energy savings and penetration of energy efficient appliances in the residential sector of Gujarat. The savings arising from this sector can be distributed as additional power to commercial and industrial consumers which would pay higher rate than the domestic sector. The residential sector is the subsidised group. DSM is not restricting the use of energy, but optimising its use.

2.4 Consumer Perception and Consumer Behaviour

Anvekar (2005) tries to analyse the service quality and customer satisfaction of public utility service which belongs to the aspect of social marketing in the Indian railways, by applying the Servqual model of service quality.This analysis helps to understand the ways and means of establishing a mechanism which is commercially viable and sustainable for effective customer satisfaction.

Barbu et al. (2013) stated that the households can reduce their energy usage without giving up comfort. The various factors that influence the consumer behaviour are economic, environmental and technological factors, cultural traits, belief systems, social norms and marketing strategies. The author concludes that, behavioural changes can lead to energy efficiency in the household sector.

Bearden et al. (1979) present different aspects of customer satisfaction or dissatisfaction with the performance of service sector i.e, electric utility company. The study also attempts to analyse the psychographic, demographic and media usage profiles of these satisfied or dissatisfied persons. This analysis helps the management and policy makers in strategic decision making in the Power Sector.

CEAMA (2014) delves into the penetration levels, market sizes and growth rates of home appliances and consumer electronics manufactured in India. The report also helps to understand the impact of Free Trade Agreements (FTA), World Trade Organisation (WTO) and government policies on the electronics industry in India.

The study reveals that the inputs required for the Electronics and Home Appliances are to be imported as they are not available through indigenous sources. This adds to the cost of manufacturing the appliances. Great support is required from the Government to overcome the situation. If the inputs are available at cheap rates, it will reduce the cost of appliances.

Hetesi (2011) observes that the deregulation and the other changes in the market of public utility services necessitated new marketing tools. Strong relationship with customers has to be maintained through communication and information technology. Factorial analysis of the various dimensions of customer relationship, communication and information was carried out in the study.

Kasthala and Rajitha (2015) observe that consumers should be aware of the fact that, the increasing demand of the energy and its shortage, negative impacts of the power projects etc. will restrict the development of the nation. Consumers and the electric utilities should co-operate, to overcome the power crisis. The study also reveals that the residential sector has huge electricity saving potential.

Kristin (2011) focuses on sustainable consumption in Germany and states that Sustainable Consumption is the result of a decision-making process of the consumer, taking his/her social and environmental responsibility in accordance with the personal needs and desires. The research methodology used is an indepth review of the scientific papers and case studies related to the topic.

Kumar and Vimala (2016) try to trace out the various types of energy sources used in India and the impact of the energy usage pattern on the economic growth of the nation. The annual data regarding energy consumption and GDP at constant prices from 1990-91 to 2013-14 is examined and analysed using simple statistical tools as part of the study. Gross production of energy in India, global energy use, sectorwise energy consumption, generation of electricity in India etc, were also analysed in the study.

Larsen (2013) conducts an exploratory research towards the phenomenon of green electricity. A qualitative research was adopted in the study where data was collected from 83 electricity consumers from five different countries to analyse consumers' perceptions. It was observed that the consumers perceive the concept 'green' in quite different ways from traditional definitions.

Leuthauser and Edward (2005) state that most of the utilities implement DSM for resource acquisition. But these programmes also influence customer satisfaction. A case study from Mid American Energy shows that, DSM programmes contribute to improved customer satisfaction ratings from 2001 to 2005. This study highlights that, DSM may be carried out not only for resource acquisition but also to ensure customer satisfaction.

Lim (1991) examines the marketing activities of five public utilities in Hong Kong and how these utilities became successful by effectively providing services at lesser rates. The study reveals that with the slow down in economy, future marketing in public utilities will become difficult and for this, the marketing strategies of the utilities should be reviewed from time to time.

Manjunatha et al. (2013) in a field study which covered almost all parts of Goa, observes that the consumer and his demand for electricity are important. We have to focus on human behaviour, while studying the electrical system because it is the consumer who is using the commodity. Load management activities will be complete, only if the technological analysis is supported by the behavioural aspects.

Mansurali and Swamynathan (2014) observe the existing level of awareness of households towards CFL. A total of 200 samples were collected through survey from the city of Coimbatore, Tamilnadu using quota sampling technique. The study shows that awareness plays an important role in the purchase decision of CFL bulbs. The study also highlights the future of CFLs and its Market Potential.

Martiskainen (2007) states that the consumer behaviour is a mixture of emotions, morals, habits, social and normative factors. Measures such as feedback displays, better billing etc. can make consumers more aware of energy consumption. A real time billing system helps to influence the habits of the consumers and to bring behavioural modification in the consumption pattern towards electricity.

Mburu & Sathyamoorthi (2014) analysed the consumer perceptions after conversion of electricity billing from post-paid to pre-paid model by Botswana Power Corporation and the customer satisfaction towards the service provided by the utilities. The findings of the survey using non-probability type of sampling show that the customers recognised the benefits of the pre-paid model of billing system.

Pursley (2014) attempts to measure the impact of Demand Side Management (DSM) programmes and the changes in the consumer behaviour towards energy usage. Data was used from the Nebraska Energy Office. Econometric and survey techniques employed for DSM programmes were analysed. The result was that, a distinct behavioral change was observed, particularly, among the lower income households and the DSM investments exhibited diminishing returns to scale.

Rai et al. (2012) examine the perception of customers towards Havells' lighting products and the products of its competitors. The data collected was analyzed using various statistical tools and a perception map was plotted. The findings indicate that the customers consider Havells lighting products to be of excellent quality and of good after sales service. Customers prefer Philips products due to its price and availability as compared to Wipro lighting products.

Rani (2013) tries to analyse the perception of students towards the problems related to generation, distribution, and conservation of electricity in the State of Haryana using a sample of 50 students comprising of 24 rural and 26 urban from the campus of Maharishi Dayanand University, Rohtak. The researchers found that the gap between demand and supply of electricity can be filled through conservation.

SEE Action working group (2011) in the technical report conveys that energy efficiency programmes help to improve customer satisfaction and to avail the financial and non-financial benefits of efficiency. The report is based on the data collected from nation-wide customer satisfaction surveys and two case studies from United States. The study underlines the need for promoting energy efficiency programmes.

Shah and Ankur (2016) states that higher disposable incomes, pay hikes of 7th Pay Commission, increased supply of power, government support on low cost housing and changes after GST implementation will be the key growth drivers for Light Electricals. Entry of new products, rising advertising expenditure, increasing distribution and focus on energy efficiency are the key themes in this sector.

Shankar (2012) tries to develop marketing mix for marketing of green fertilizers and their impact on purchase decision. The Six Ps that constitutes green marketing mix are Product, Price, Place, Promotion, Packaging and Purchasing. The author underlines the importance of maintaining sustainability through the use of green or organic fertilizers. The data was collected from 300 farmers and executives of fertilizer companies in Maharashtra and Andrapradesh. Statistical tools like correlation, percentage analysis, factor analysis etc were used in the study.

Sharma and Leela (2014) state that, sustainability refers to economic, social and environmental dimensions. Authors conduct an exhaustive review of the literature available on environmentally sustainable Consumption. Environmental sustainability means making responsible decisions that will reduce negative impact on the natural environment. Sustainable practices can be inculcated in people only through education from childhood itself.

Somasekhar and Nagesha (2013) conducted an empirical study of the process of decision making in choosing energy technologies in urban house holds. Consumption pattern and purchase behaviour of the households was analysed in the study. It is observed that, cost savings is the prime factor which influence the energy saving behaviour of Indian households in the Urban group.

Stamminger and Verena (2013) observe that flexible energy tariffs are an important tool for DSM. The behaviour of 41 residential consumers of Germany and their motivation to use and accept flexible tariffs and smart appliances are intensively studied using experimental design. The result of the study was that, the prime motivating factor is the possibility of individual energy savings.

Stenner (2017) conducted a survey experiment to analyse the householders' willingness to participate in a direct load control programme offered by an Australian energy company. He points out that the consumer distrust may reduce the willingness to participate in direct load control programmes. Efforts by a utility to regain customer trust may increase the willingness to participate.

Velayudhan (2014) states that the issues that the marketing community needs to address as a result of the growing markets include analysing the changes in the consumer behaviour for marketing decisions, shopping behaviour, satisfaction after purchase and use, the various research methods used for different consumer segments and the ability of consumers to process information.

2.5 Dimensions of Energy Management

Alluwalia and Alok (2009) state that improving energy efficiency helps in promoting sustainable development and making the economy competitive. Improving the energy efficiency means reducing the energy losses at every point of conversion and transmission. India's energy saving potential as identified by the tenth five year plan, if practised, can reduce the investment in energy by 20%.

Bassi (2015) reports that, there is a huge electricity savings potential in the Indian buildings sector in India through the use of energy efficient appliances and better building design and systems. As per a World Bank study, electricity savings of 75,356 GWh can be achieved in 2021 by using efficient household appliances. The study underlines the need for benchmarking and energy conservation building codes for the commercial buildings in India.

Bhusal (2009) conducts a comparative analysis of traditional lighting and new LED lighting in the villages of Nepal. The study reveals that, inorder to attain sustainable growth, a combination of renewable energy sources and efficient lighting technology shall be used. Technical analysis of three different types of lighting control methods were applied by the author in the study.

Brown (2001) examines the market failures and barriers that prevent consumers from obtaining energy services at least cost in the United States. The author also analyses the impacts of more than 50 public policies framed for promoting energy-efficient and clean energy technologies. Public interventions can help to overcome these obstacles and barriers to a great extent.

Catherine and Soundarrajan (2016) delve into the methodologies available for reducing energy consumption and to reduce peak demand. They are financial and incentive based measures, regulatory and control measures, load scheduling, framework policy and economic / market based instruments, energy conservation and mandate least cost planning.

Chandra (2006) analyses the different non-conventional sources of energy and suggests that there is a great potential of using geothermal energy in India. Our nation has already started producing electricity from the thermal springs of Manikaran in Himachel Pradesh and Thattapani in Chattisgarh.

Chatterjee and Suresh (2012) in the report "Energy Efficient Products and Indian Consumers" conduct both desk research and field research of 20,166 household consumers, 50 producers and 550 traders to analyse ownership pattern and trend in penetration/electricity consumption by the energy efficient appliances and the challenges faced by the consumers.The survey covered 19 states and three Union Territories in India.The findings were that, consumer awareness on energy efficiency is increasing and willingness to buy energy-efficient products is high. Consumers have also shown their willingness to pay premium for energy-efficient products.

Cherian and Haris (2013) analyse how a petroleum refining organization became successful in conserving energy from management as well as technical aspects. Management aspect deals with identifying the barriers to energy efficiency. Technical aspect identifies the energy saving potential.

Dev (2009) observes that commercial energy sources like coal, petroleum, natural gas and nuclear fuel posses various difficulties and to overcome all these short comings, man is endeavouring to renew his dependence on natural sources of energy. The author emphasis the importance of wind energy as an alternative source.

Dev (2009) summarises the various organizations sponsored by the Government of India to set up application of bio energy in India. Development and installation of such plants will help in the growth of economy, generate employment opportunities and minimise pollution. The study also analyse the scope of bio energy in India.

Diwan and Sarkar (2009) analysed the concepts of energy conservation and energy efficiency. Energy conservation is achieved when growth of energy consumption is reduced, in physical terms. Energy efficiency is achieved when energy intensity in a specific product, process or consumption is reduced without affecting comfort levels.

Ganandran et al. (2014) in their article, "Cost-Benefit Analysis and Emission Reduction of Energy Efficient Lighting at the Universiti Tenaga Nasional", presents the result of an investigation of the lighting systems at selected buildings of the Universiti Tenaga Nasional. The main objectives of this investigation were to find out the electricity saving potential, the Pay Back Period and the benefits to the environment by retrofitting the old lighting system with the new energy saving LEDs. The result was that by replacing 100% of the existing lights with the LED lights, around 44% of energy savings can be attained with 4.01 years. T5 tube with electronic ballast saves upto 22% in 3.8 years. Eventhough the initial investments required for LED lights are higher, it is more beneficial than T5 electronic ballast in the long run.

Gaur et al. (2016) reviews the problems in implementing DSM .They are: Influence of regional politics on the electricity price level structure, lagging government policies, low awareness and literacy of consumers, costly energy efficient appliances, lack of communication and trust between the utilities and the consumers, lack of energy audits and lack of available funds for research and experimental work.

Gosh (2007) suggests that India and the world is facing a great danger of global warming, concentrated efforts are being made to control the process. Non-conventional sources of energy are the solution for the problem. In the pursuit to advocate renewable energy use, new ventures in solar, wind, biomass and hydel power are launched.

Gunatilake and Padmakanthi (2008) conduct a Cost Benefit Analysis of replacing inefficient lamps with the CFLs. Net Present Values were positive and cost benefit ratio was more than 1 which underline that adoption of energy-conserving technology in the residential sector in Sri Lanka is economically viable. Demand side management helps to overcome the problem of energy crisis. The economic benefits of energy conservation is analysed in detail in this study.

Illeperuma (2014) conducted a Cost Benefit Analysis of energy efficiency in a fitness facility, Harold Alfond Athletic Center and Swimming Pool, at Colby College. This study focuses on four major areas of energy consumption in a building including Heat Ventilation and Air Conditioning (HVAC), water heating, illumination and appliances. The study analyzed the initial costs and benefits in the form of energy savings in units and in monetary terms, of improving the energy efficiency in the fitness centre. The result was that improving the energy efficiency can bring benefits within less than one to four years that could cover the high initial costs.

Kannan and Pillai (2002) analyses the reasons for inefficiency of the Power Sector and state the importance of improving the efficiency in the Power Sector and makes a detailed examination of the ways to attain efficiency like, energy audit, scientific tariff structuring, entry of private power producers, improving T & D efficiency, etc.

Karlin et al. (2014) conducts a meta-analysis of 42 feedback studies published between 1976 and 2010 to know when and how feedback about energy usage is most effective. The study helps to estimate the effect of energy feedback on energy conservation and to study the potential impact of treatment and study variation.

Khan et al. (2016) explores the main problems in implementing DSM in Pakistan. They are the non availability of load profile and lack of digital devices like smart meters that will do in real time monitoring of the electricity consumption. Measurement of base load pattern and technological interventions along with behavioural changes are inevitable in the implementation of Demand Side Management.

Kumar (2004) makes a review of electric power systems in Punjab and Haryana and various technical and non technical losses in the system. He state that Transmission and Distribution losses pose threat by creating huge financial loss to State Electricity Boards. The reasons for the technical and financial inefficiency of the electricity boards were also analysed. A survey was conducted to examine the perception of consumers and employees of the board towards the electricity theft.

Mills (2009) highlights the importance of solar energy. Solar Thermal electricity collection involves the direct conversion of heat collected by a solar array for the generation of electricity. It usually involves the use of heat engines to take solar heat and convert it to mechanical energy and then to electricity using a conventional generator.

Nagamani et.al (2015) reviews the emergence and growth of renewable power generation in India, with particular reference to wind and solar sectors. The energy demand is increasing due to growing population and industrialization. Fossil fuel resources are depleting and this necessitated power generation from renewable energy sources.

Panchal (2014) traces out the potential of energy savings that can be attained by simple house keeping measures, better instrumentation and more efficient machinery. A close watch of specific energy consumption pattern can help to measure the energy saving potential in the industrial sector.

Pramod et al. (1991) had made an attempt to conceptualise the decentralized energy planning process and to evolve a general methodology on the basis of which planning exercises at the grass root levels can be made more meaningful. Ripple effect of the local activities spread to regional as well as national level.

Raparthi (2013) points out that the major barriers of energy efficiency in India are distorted electricity pricing mechanism, high initial investment required in case of energy efficient devices, unavailability of energy efficient equipment in the local market, low level of awareness of consumers and the electricity utilities, lack of financing options and lack of incentive for the utilities.

Solanki et al. (2011) explore the benefits, barriers and challenges of demand side management and the appropriate policies to overcome these barriers in the electrical sector of Oman. The main problems are inadequate permitted tariffs, less competitive energy cost in market and lack of information and communication technology infrastructure etc.

Sonavane (2013) states that Demand Side Management program requires manual intervention, consumer contact, communication and infrastructure support at consumer end. Measurement & verification of individual consumers and deriving base line data is a challenge. The present status of DSM regulations and the policies required for the successful implementation of DSM in Maharashtra is also analysed.

Yang et al. (2014) makes an analysis of opportunities for energy efficiency, energy efficiency investment gaps and the constraints that cause investment gaps. He also examines various factors like government policies, capacity building, technology transfer, co-finance, etc. to fill this gap.

Yaseen (2008) conducted a research to determine the energy saving potential in Palestinian industrial sector. He suggested introducing technical training for energy conservation practices in schools, vocational colleges and universities and recommended an energy conservation fund.

2.6 Conclusion

Review of the related works in the area of Demand Side Management reveals that there are many works related to the concept of DSM and techniques for DSM, various demarketing stategies used for the promotion of DSM, Energy Management in the various states of India, Consumer behaviour towards electricity in Kerala and overview of Kerala's Power Sector, consumer perception and consumer behaviour, energy efficiency, load management, Cost Benefit Analysis, energy saving potential, use of alternative sources of energy and problems in implementing DSM.

2.7 Research Gap

It is clear from the review that there are only a few studies in the area of energy management in Kerala especially those dealing with demand side variables. Little work was there about demarketing strategies adopted in Kerala for the promotion of Demand Side Management. Even though there were many works about consumer perception and behaviour, studies about consumer perception and behaviour towards demarketing were absent. Cost Benefit Analysis of DSM and problems in practising DSM in Kerala was also not present. So the researcher makes a novel attempt to fill the research gap through this study.

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Chapter 3

An Overview of the Electricity Sector

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Chapter 3
An Overview of the Electricity Sector

3.1 Introduction

An efficient and sustainable Electricity Sector is essential for the social and economic development of a nation. In India, the demand for electricity is ever on the increase, due to several reasons like increase in population, improved standard of living, industrial and economic development etc. Compared to this increase in demand, the supply of electricity is almost stagnant. The net result is, a wide gap between the demand and the supply of electricity, which is a hinderance to the growth of the nation.

The present chapter makes an overview of the different variables of the Electricity Sector namely, electricity requirement, availability, installed capacity, per capita consumption, different categories of consumers, sales of electricity, revenue from the sale of electricity, Transmission and Distribution losses and comparative statement of profit and loss of the Electricity Board.

3.2 The Electricity Sector in India

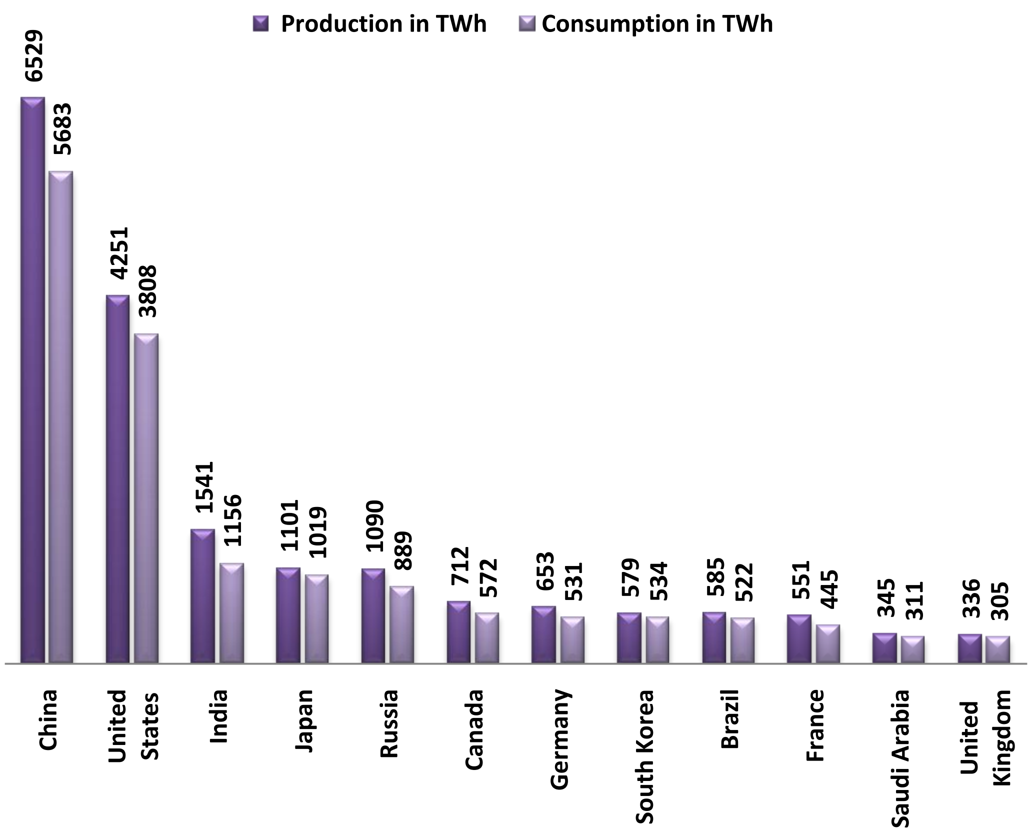
The Electricity Sector of India comprises of three divisions namely generation, transmission and distribution. Generation is again divided into three sectors namely Central, State and Private Sector. Central Sector or Public Sector Undertakings include National Hydroelectric Power Corporation Limited (NHPC),National Thermal Power Corporation Ltd (NTPC) and Nuclear Power Corporation of India (NPCIL). State level corporations like MSEB (Maharashtra State Electricity Board), KSEB Ltd. (Kerala State Electricity Board Limited), Jharkhand State Electricity Board etc are responsible for intrastate generation of electricity. The Private Sector is also engaged in the generation of electricity.

Power Grid Corporation helps in the transmission of electricity between different states in India. State Transmission Utilities (State Transmission companies or State Electricity Boards) conduct transmission of electricity within the state. The distribution division is the connecting link between the State Transco/ SEBs and the consumers.

The following figure 3.1 shows the production and consumption of electricity in the world for the year 2017 in Terrawatt hours (TWh)

Figure 3.1

Global Electricity Production and Consumption for the Year 2017



Source: Compiled from the Reports of the Global Energy Statistical Yearbook, 2018

India is the world's third largest electricity producer and consumer following China and the US. The electricity production in China is 6529 TWh, In US it is 4251TWh and for India, 1541 TWh (As per The Global Energy Statistical Yearbook, 2018). China is the leading consumer of electricity in the world i.e; 5683 TWh. India's electricity consumption is 1156 TWh for 2017.

The following table 3.1 shows the installed capacity of electricity generation in India. Installed Capacity refers to the amount of electricity that the country is capable to produce.

Table 3.1
Installed Capacity of Electricity Generation in India as on 31-12-2017 (Sector-wise)

Sector	MW	Percentage
State Sector	80,677	24.38
Central Sector	103,058	31.15
Private Sector	147,125	44.47
Total	**3,30,861**	**100**

Source: Compiled from the Reports of the Central Electricity Authority (CEA)

The total installed capacity of electricity generation in India is 330,861 MW as on 31-12-2017. This capacity is contributed by the State, Central and Private Sectors.

In India, the major share of the installed capacity of electricity generation is held by the Private Sector. It is 147,125 MW which is 44.4673 % of the total Installed Capacity in India. Share of State Sector is 80,677 MW i.e, 24.384 % of the total. 103058 MW which comes to 31.1484 % of the total is held by the Central Sector.

The table below shows the installed capacity of electricity generation in India as on 31-12-2017 (on the basis of fuel used). The different fuels used for electricity generation in India are thermal, hydro, nuclear and renewable energy sources. The thermal source refers to the fossil fuels namely coal, gas and oil.

Table 3.2

Installed Capacity of Electricity Generation in India as on 31-12-2017

(On The Basis Of Fuel Used)

Fuel	**MW**	**Percentage**
Coal	1,92,972	58.32
Gas	25,150	7.60
Oil	838	.25
Total Thermal (coal, gas and oil)	**2,18,960**	**66.18**
Hydro	44,963	13.59
Nuclear	6,780	2.05
RES* (MNRE)	60,158	18.18
Total	**330,861**	**100**

Source: Compiled from the Reports of the Central Electricity Authority (CEA)

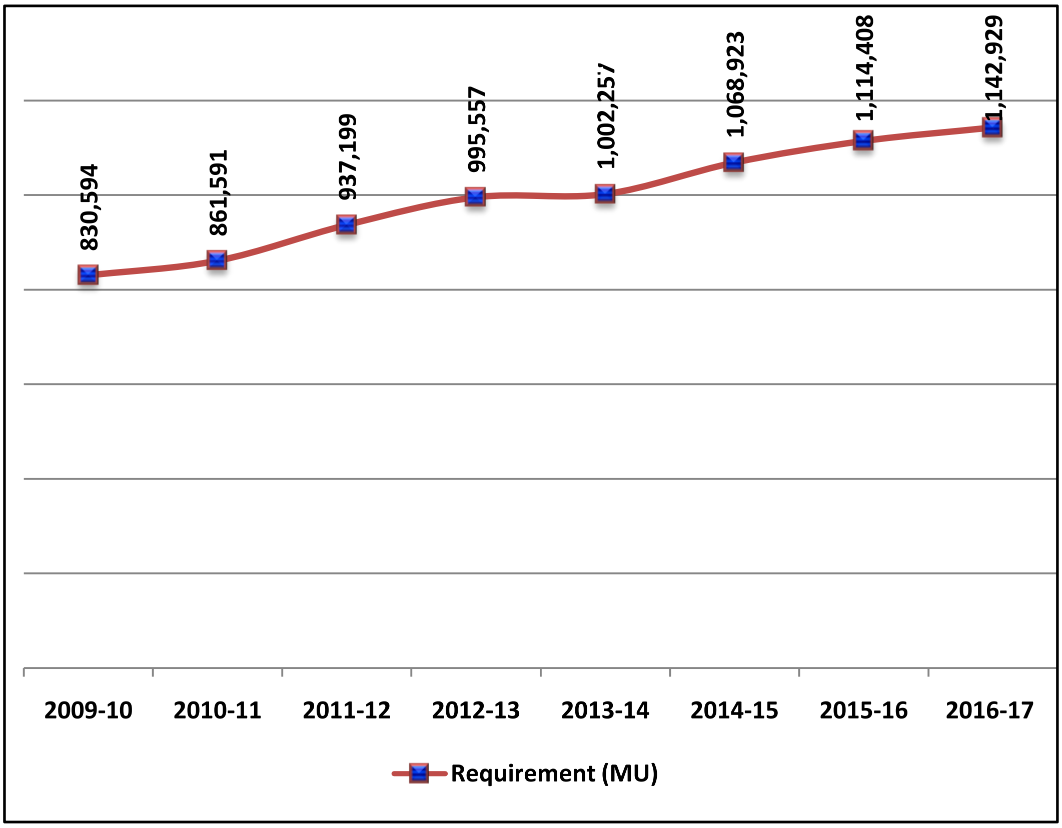
On the basis of fuel/energy source used, the major portion of installed capacity is of thermal energy i.e, 2,18,960 MW (66.1788 % of the total capacity). The Thermal energy consists of the energy generated from coal (192972 MW) 58.3241%, gas (25,150 MW) 7.6013 % and oil (838 MW) 0.2532%. The renewable energy sources come to about 60,158 MW (18.1822% of the total capacity). Second important source after thermal source in India for electricity generation is hydropower. It is a renewable source of energy and constitutes 44,963 MW (13.5897% of the total). Nuclear energy is only 2.0491 % (6780 MW).

Thus in India, out of the total installed capacity more than 66 % is thermal sources, based on fossil fuels. This is not a favourable situation. Fossil fuels have negative impact on the environment and will get exhausted with use. The proportion of hydroelectric potential also cannot be increased as these projects affect the biodiversity. The solution is to increase the share of renewable sources and energy management.

The following figure 3.2 shows the electricity requirement in India for a period of 8 years from 2009-10 to 2016-17 in Million Units (MU)

Figure 3.2

Requirement of Electricity in India from 2009-10 to 2016-17



Source: Compiled from the Reports of the Central Electricity Authority (CEA)

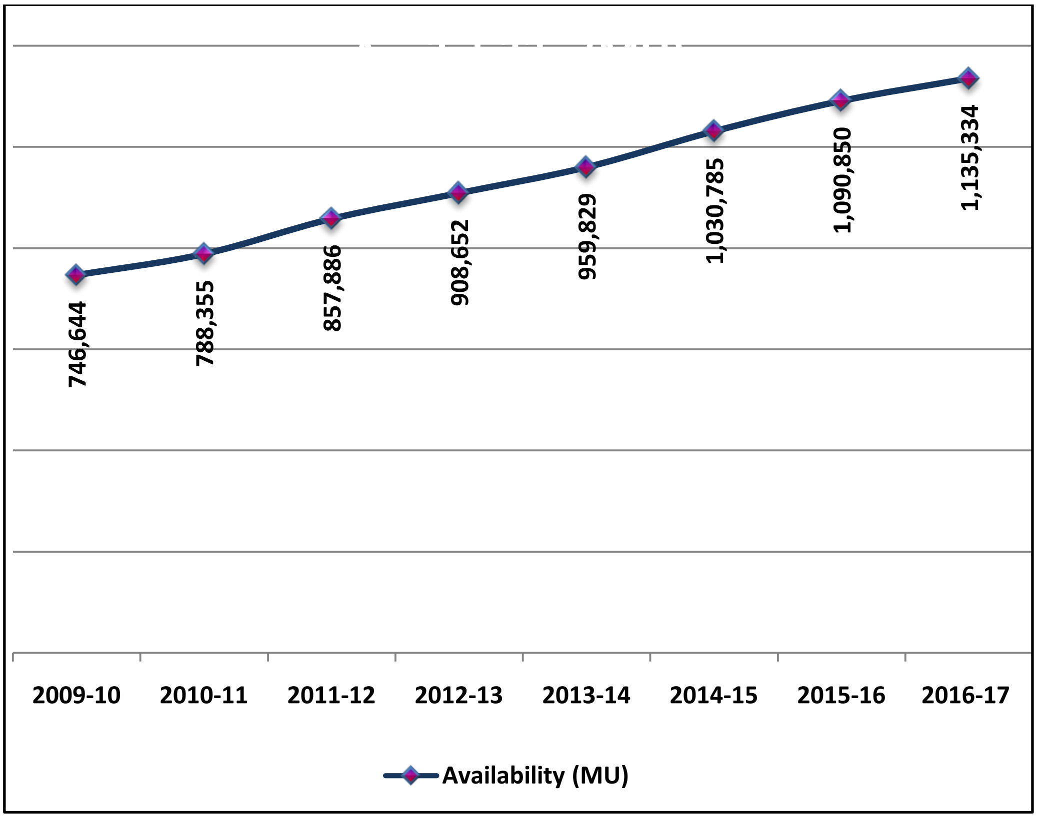
The power supply position in the country from 2009-10 to 2016-17 shows that the electricity requirement is going up every year. The requirement of electricity for the year 2016-17 is 11,42,929 MU. The electricity requirement for the year 2009-10 was 830594 MU.

The requirement for electricity is increasing every year due to many reasons like new electricity connections owing to increase in the population, change in life style (life style which demands greater consumption of electricity with the use of electronic gadgets), starting new industries and commercial institutions, etc.

The following figure shows the availability of electricity in India for a period of 8 years from 2009-10 to 2016-17 in Million Units (MU)

Figure 3.3

Availability of Electricity in India from 2009-10 to 2016-17



Source: Compiled from the Reports of the Central Electricity Authority (CEA)

The data regarding the power supply in the country from 2009-10 to 2016-17 shows that the availability of electricity is increasing every year though at a slow rate. The availability of electricity for the year 2016-17 is 11,35,334 MU. For the year 2009-10 it was 746644 MU.

The gap between the requirement and availability of power is decreasing every year. The Electricity Sector have made great attempt to supply electricity according to the increasing demand.

The following table 3.3 makes an analysis of the growth rates of the availability and requirement of electricity and deficits in India for a period of 8 years from 2009-10 to 2016-17.

Table 3.3

Annual Growth Rate of Electricity Requirement, Availability and Deficits in India from 2009-10 to 2016-17

Year	Requirement Growth Rate %	Availability Growth Rate %	Deficts(-) (MU)	Deficits Growth Rate %
2009-10	0	0	-83,950	0
2010-11	3.73	5.59	-73,236	-12.76
2011-12	8.78	8.82	-79,313	8.30
2012-13	6.23	5.92	-86,905	9.57
2013-14	0.67	5.63	-42,428	-51.18
2014-15	6.65	7.39	-38,138	-10.11
2015-16	4.26	5.83	-23,558	-38.23
2016-17	2.56	4.08	-7,595	-67.76
Average Annual Growth Rate	**4.7**	**6.18**	**Average Annual Growth Rate**	**-23.17**

Source: Compiled from the Reports of the Central Electricity Authority (CEA)

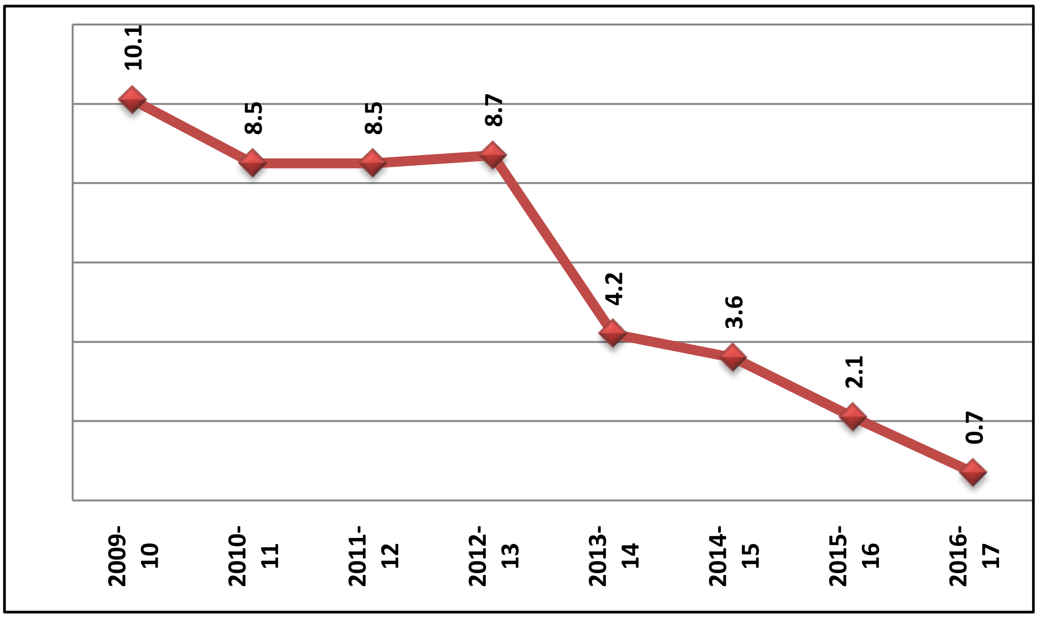
The above table 3.3 presents the growth rate of electricity requirement and availability in India from 2009-10 to 2016-17. The average annual growth rate of electricity requirement is 4.7% and the average annual growth rate of electricity availability is 6.18%. For the years 2011-12, 2012-13 and 2014-15 the growth rate is above AAGR.

The sudden increase in the deficit of electricity by the end of 11th Five Year Plan was due to fuel shortage, transmission and distribution losses and mass rural electrification programmes. New capacity additions and addition in transmission lines were made during this period to meet the increasing demand. India's energy policy during the 12th Five Year Plan is focusing on renewable energy resources.

The following figure 3.4 shows the difference between the requirement and availability of electricity from 2009-10 onwards as a percentage on the total requirement of electricity.

Figure 3.4

The Deficit Percentage Calculated on the Total Requirement of Electricity in India from 2009-10 to 2016-17



Source: Compiled from the Reports of the Central Electricity Authority (CEA)

The above line graph shows that the deficit percentage is coming down every year. The deficit for 2016-17 is only 0.7%, where as it was 10.1% for 2009-2010. The chart shows that electricity is made available according to the demand. This does not mean that the energy demand management is efficient in India. This is because the electricity supply is made mainly from fossil fuels, which is not sustainable. The share of renewable sources is very small.

The following table makes an analysis of the Per Capita Consumption of Electricity in India (in Kilowatt hours) and the growth rates for a period of 8 years from 2009-10 to 2016-17.

Table 3.4

Per Capita Consumption of Electricity in India from 2009 to 2017

Year	Per Capita Consumption (In Kilowatt-hours)	Growth Rate
2009	734	0
2010	779	6.13
2011	819	5.13
2012	883.6	7.89
2013	914.4	3.49
2014	957	4.66
2015	1010	5.54
2016	1075	6.44
2017	1122	4.37
	AAGR	**5.46**

Source: Compiled from the Reports of the Central Electricity Authority (CEA)

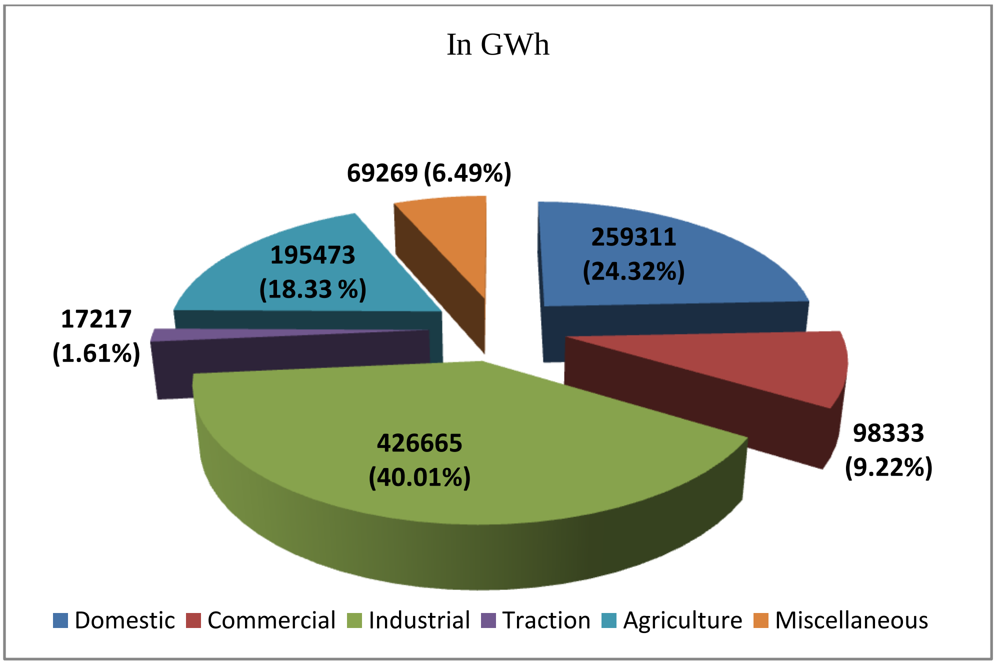
The per capita consumption of electricity in India for the year 2017 is 1122 kWh. The AAGR of per capita consumption of electricity in India is 5.46 %. The growth rate of per capita consumption for 2017 was 4.37%, unlike the previous years, which exhibited an increasing trend.

The per capita consumption of electricity for 2009 was 734 kWh, the per capita consumption for 2012 (after 3 years) was 883.6 kWh. The per capita consumption for previous year 2016 was 1075 kWh and the growth rate of per capita consumption for 2016 was 6.44%.

The per capita consumption of electricity for 2015 was 1010 kWh, and the growth rate of the per capita consumption for 2015 (after 5 years) was 5.54%. The per capita consumption for the year 2014 was 957 kWh and the growth rate of per capita consumption for 2014 was 4.66%.

Figure 3.5

All India Electricity Consumption, Sector-wise as on 31-03-2017



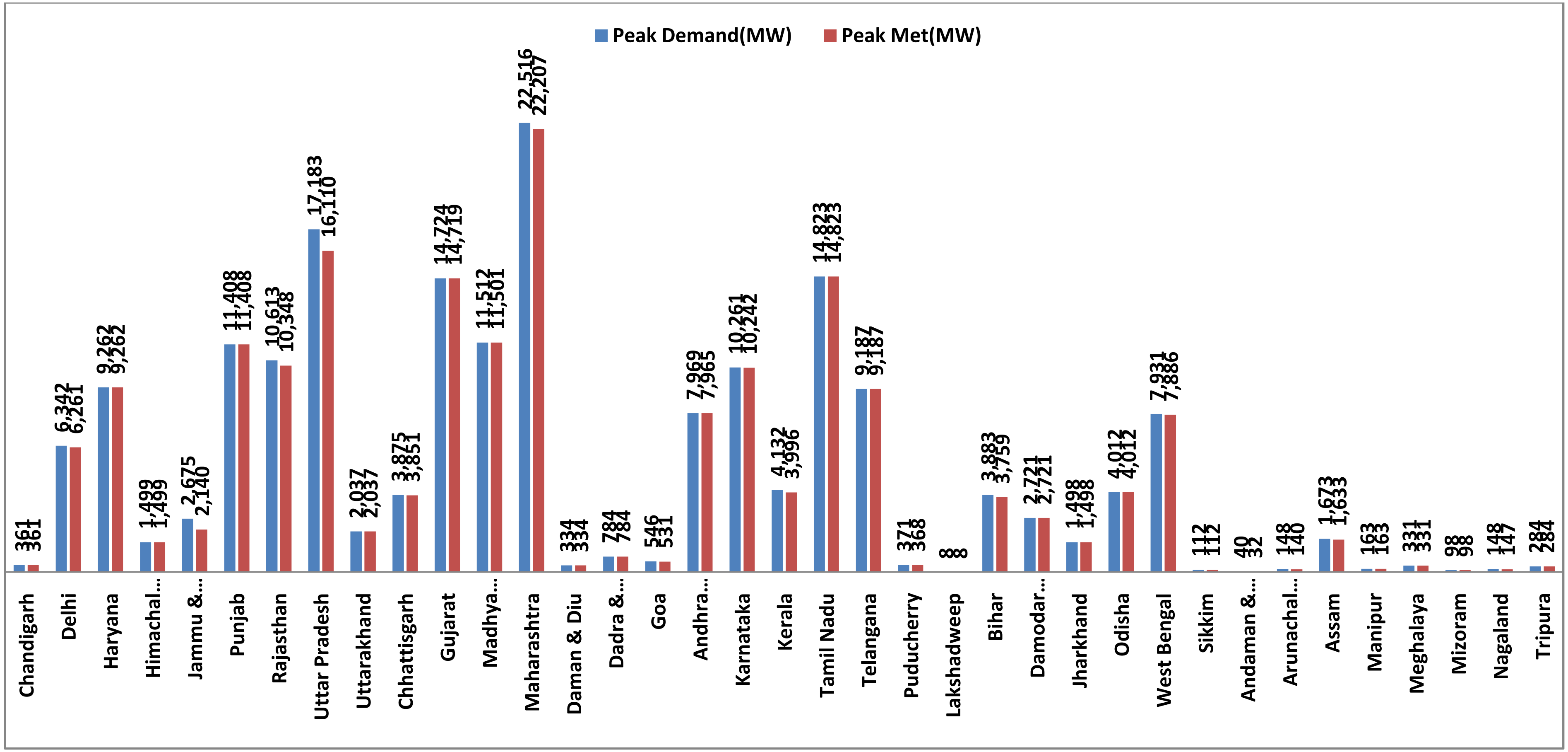
Source: Compiled from the Reports of the Central Electricity Authority (CEA)

The above pie diagram 3.5, represents the share of different categories of consumers in the consumption of electricity expressed in GWh and as a percentage. The highest share of electricity is consumed by the Industrial Sector which is about 40.01% of the total. While the Domestic Sector use 24.32% and the Traction consumes only 1.61% of the total.

The following figure 3.6, represents the power supply position in India in terms of peak demand and peak met for the period of 2016-17. Peak Demand is the highest point in the electricity demand expressed annually, daily or seasonal basis and is an important aspect of Demand Side Management.

Figure 3.6

Power Supply Position in India in Terms of Peak Demand and Peak Met for 2016-17



Source: Compiled from the Reports of the Central Electricity Authority (CEA)

The chart 3.6 represents the peak demand and peak met of the power supply position of various states in India for the period of 2016-17. The peak demand of electricity in Kerala is 4132 MW and the peak met is 3996 MW. The highest point of electricity demand and peak met is contributed by Maharashtra followed by Uttarpradesh.

3.3 Kerala Scenario

Kerala is facing severe power crisis. The state depends mainly on its hydro sources for electricity. It imports electricity from outside sources at a higher price to meet the increasing demand.

3.3.1 Kerala State Electricity Board Limited

Kerala State Electricity Board Ltd (KSEB Ltd.) was constituted on 31-3-1957 under the Electricity Supply Act of 1948. It became an incorporated Government Company under the Companies Act 1956 on 14-01-2011. KSEB Ltd. started its functions as an independent company w.e.f 1-11-2013. It comprises of Generation, Transmission and Distribution profit centres.

a. Generation Profit Centre

The first hydroelectric project in Kerala was started at Pallivasal, with an initial installed capacity of 13.5 MW. Later major hydel stations namely Neriamangalam, Sengulam, Panniar, Sholayar, Peringalkuthu, Kuttiyadi, Sabarigiri, Idukki and Lower Periyar were commissioned. At present, 16 major Hydel stations, 15 Small Hydel stations, 2 Thermal stations namely BDPP and KDPP and one wind farm are operating under KSEB Ltd. The utility relies on the central share, the power purchased from the Kayamkulam Thermal Power Plant and other private stations in addition to its own stations for meeting the demand. According to the Annual Administration Report of KSEB Ltd., the total installed capacity is 2704.065 MW with the total generation of 4369.54 MU for 2016-17.

b. Transmission Profit Centre

The Transmission Profit Centre of KSEB Ltd. transfers electricity from generating stations to the load centres. It consists of two zones, northern zone with headquarters at Kozhikode and the southern zone with headquarters at Thiruvananthapuram. The transmission wing of KSEB Ltd. has 393 Substations with a total power transfer capacity of 17,548 MVA (Mega Volt Ampere) according to the reports of KSEB Ltd.

c. Distribution Profit Centre

The distribution Profit Centre of KSEB Ltd. is responsible for distributing electricity in the state of Kerala. The distribution wing of KSEB Ltd. is divided into four zones namely, Northern, North Malabar, Southern and Central zones for operational conveniences.

3.3.2 Distribution of Electricity in Kerala

Kerala State Electricity Board Limited is engaged in the generation, transmission and distribution of electricity in the State. KSEB Ltd. is the state transmission utility and a deemed distribution licensee.

There are other distribution licensees in the State namely, Kannan Devan Hills, Thrissur Municipal Corporation, Munnar Plantations Company Limited, Cochin Port Trust, Cochin Special Economic Zone Authority, Technopark, Infopark, Rubber Park India Limited, KINESCO Power Utilities Pvt. Ltd etc. These distribution licencees purchase electricity from KSEB Ltd. and supply it to their consumers. A common uniform retail tariff is applicable for various categories of consumers.

The following figure shows the requirement of electricity in Kerala in Million Units for a period of 8 years from 2009-10 to 2016-17

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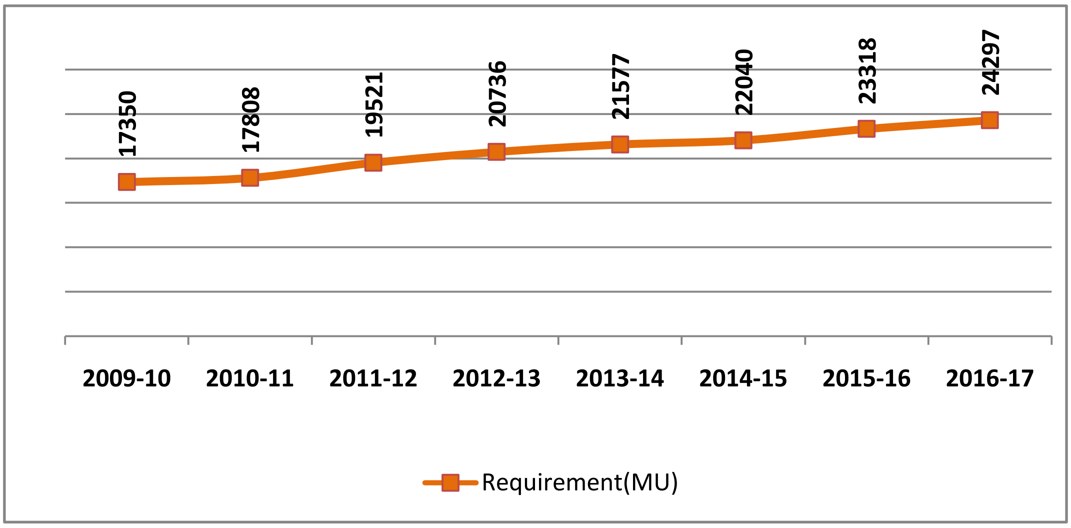
Figure 3.7

Electricity Requirement in Kerala from 2009-10 to 2016-17

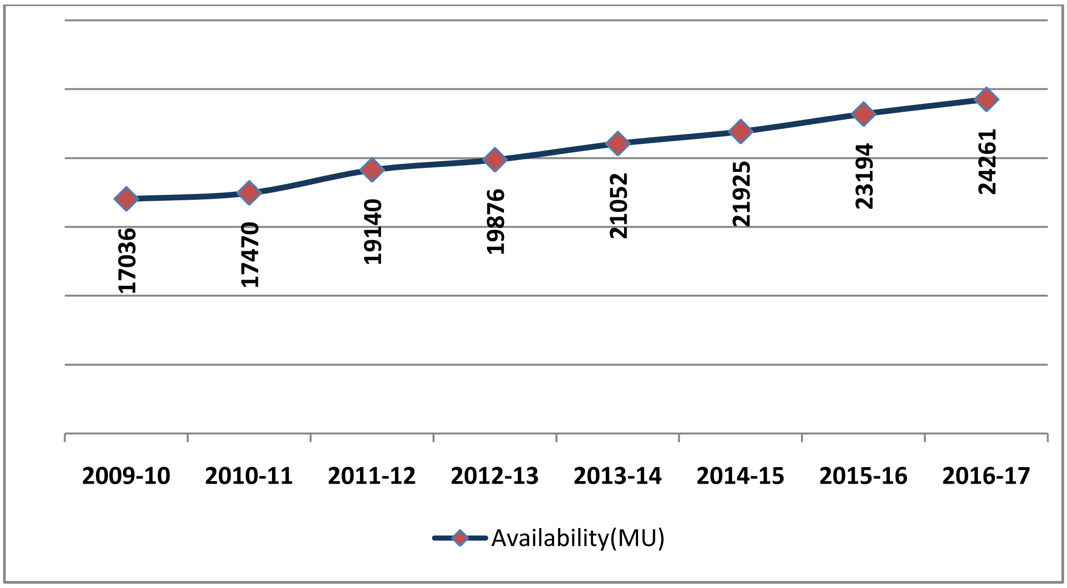


Source: Compiled from the Reports of the KSEB Ltd.

The above line graph 3.7, shows that the electricity requirement shows an increasing trend during this period. The electricity requirement in Kerala for 2016-17 is 24297 MU, where as it was only 17350 MU in 2009-10.

Figure 3.8

Electricity Availability in Kerala from 2009-10 to 2016-17



Source: Compiled from the Reports of the KSEB Ltd.

The above line graph represents that the supply of electricity is increasing. For the period 2016-17, the availability of electricity was 24261 MU. This supply is made on the basis of imports at higher costs. KSEB Ltd. purchases power from the Central Generating Stations, Independent Power Producers (IPPs), Traders and through energy exchanges from generating stations outside Kerala at a higher cost to meet the power deficit.

The following table 3.5, analyses the growth rate of electricity requirement and availability in Kerala for eight years from 2009-10 to 2016-17.

Table 3.5

Annual Growth Rate of Electricity Requirement and Availability in Kerala from 2009-10 to 2016-17

Year	**Electricity Requirement Growth Rate %**	**Electricity Availability Growth Rate %**
2009-10	0	0
2010-11	2.64	2.55
2011-12	9.62	9.56
2012-13	6.22	3.85
2013-14	4.06	5.92
2014-15	2.15	4.15
2015-16	5.80	5.79
2016-17	4.20	4.60
Average Annual Growth Rate	**4.96**	**5.20**

Source: Compiled from the Reports of the KSEB Ltd.

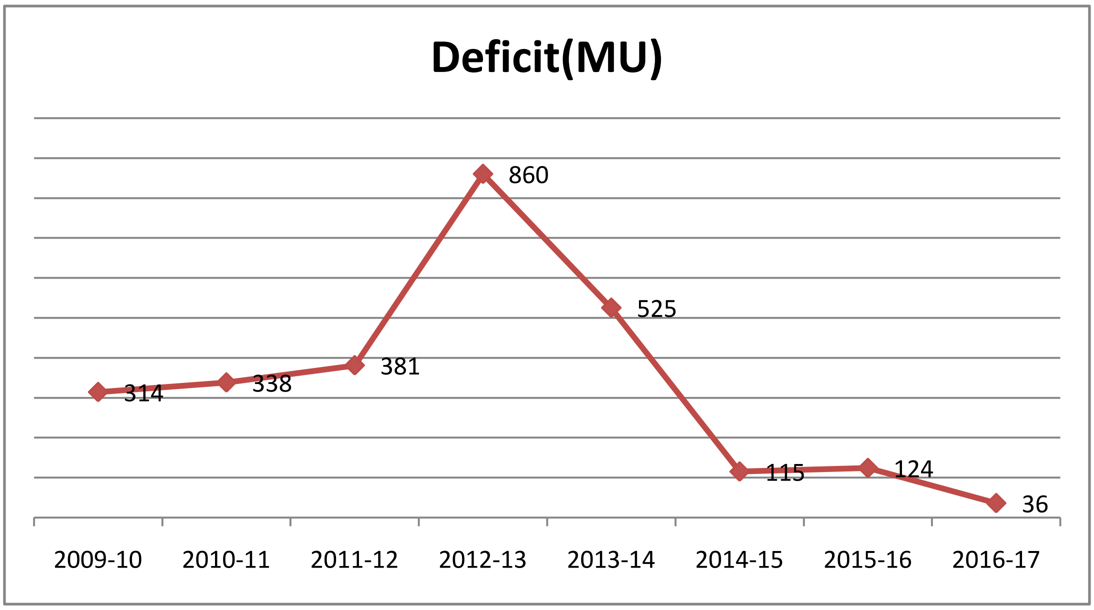
The above table shows that the Average Annual Growth Rate of electricity requirement is 4.96 % and electricity availability is 5.20%. The Annual Growth Rate of electricity requirement is 4.20 % and electricity availability is 4.60% for the year 2016-17.

The Annual Growth Rate of electricity requirement is 5.80 % and electricity availability is 5.79 % for the year 2015-16. The Annual Growth Rate of electricity requirement is 2.15 % and electricity availability is 4.15 % for the year 2014-15. The growth rates of electricity requirement for the years 2011-12, 2012-13 and 2015-16 are higher than the average.

The growth rates of electricity availability for the years 2011-12, 2013-14 and 2015-16 are higher than the average. The following line chart shows the deficit of electricity in Kerala for eight years in Million Units from 2009-10 to 2016-17.

Figure 3.9

Electricity Deficit in Kerala from 2009-10 to 2016-17



Source: Compiled from the Reports of the KSEB Ltd.

The above line chart reveals that there is a wide gap in the electricity demand and supply in Kerala during the year 2012-13 (860 MU). In this year, the electricity requirement growth rate is 6.22%, the electricity availability growth rate was only 3.85%. This was because the KSEB Ltd. could not provide electricity to meet the demand.

To meet the increasing electricity requirement, the KSEB Ltd. made capacity additions and Power Purchase Agreements with Central Generating Stations and Independent Power Producers.

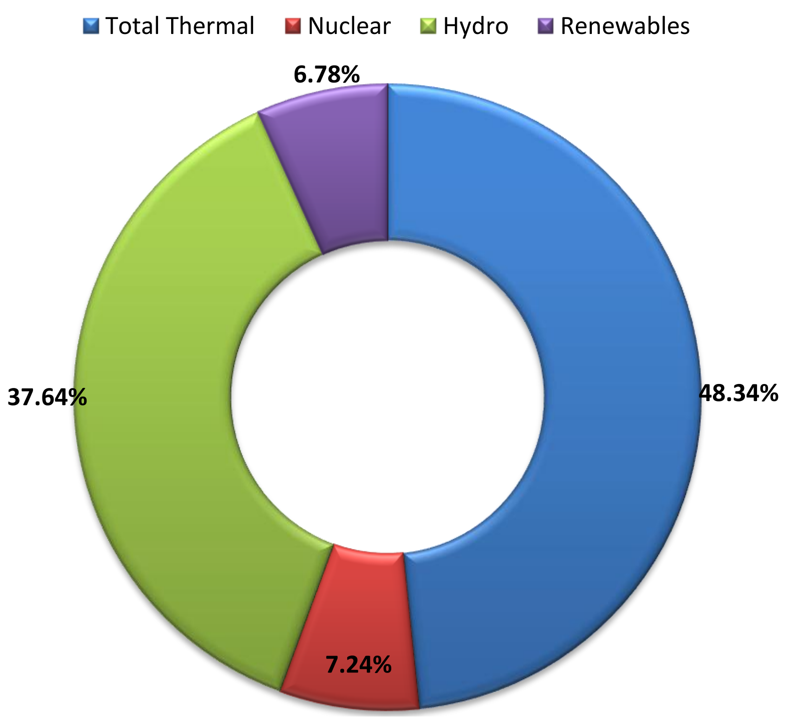
3.3.3 The Total Installed Capacity of Electricity Generation in Kerala as on 30-04-2017, Fuel-wise

The total installed capacity of electricity generation in Kerala as on 30-04-2017 is 4998.94 MW which comprises of thermal, nuclear, hydro and renewable sources.

The thermal source of electricity consists of 1723.18 MW of coal, 533.6 MW of gas and 159.96 MW of diesel. Total thermal sources contribute 2416.72 MW of electricity. The nuclear sources constitute 362MW, hydro sources constitute 1881.5 MW and renewable sources constitute 338.72 MW.

Figure 3.10

Relative Share of Different Fuels in Electricity Generation in Kerala as on 30-04-2017



Source: Compiled from the Reports of the KSEB Ltd.

The above diagram 3.10 represents the relative share of source of electricity used in Kerala. It is clear that 48.3446% of the electricity is generated from the thermal sources (2416.72MW). 37.6379% of the electricity is from hydro sources (1881.5MW), 7.2415% is from nuclear sources (362MW) and 6.7758% is from non-conventional sources i.e, 338.72 MW.

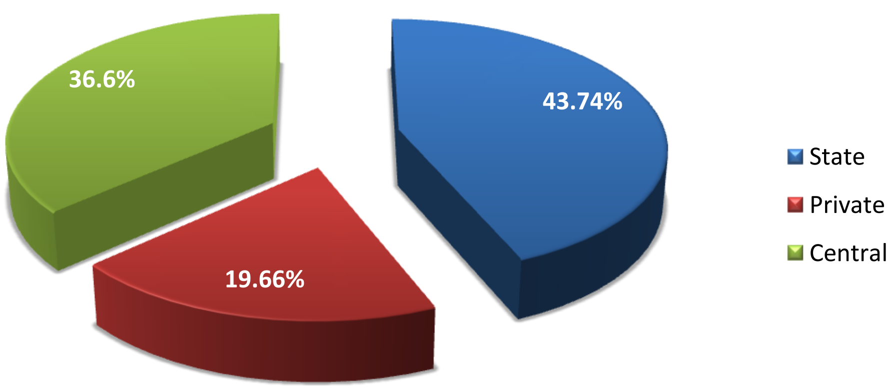
3.3.4 The Total Installed Capacity of Electricty Generation in Kerala as on 30-04-2017 , Sector-wise

The total installed capacity of electricty generation is 4998.94 MW which is contributed by State, Private And Central Sectors. The State Sector provides 2186.48 MW, Private Sector provides 982.7 MW and the contribution of the Central Sector is 1829.76 MW as per the reports of Central Electricity Authority.

Figure 3.11

Relative Share of Each Sector in the Electricity Generation in Kerala

As on 30-04-2017



Source: Compiled from the Reports of the KSEB Ltd.

The above pie diagram 3.11 shows the share of State, Private and Central Sectors in the generation of electricity. The major share is contributed by the State

Sector i.e. 43.7388% of the total. The share of the Central Sector is 36.6029% and the share of the Private Sector is only 19.6581% of the total.

3.3.5 Renewable Sources of Energy in Kerala

The renewable sources of electricity generation in Kerala include solar energy, wind energy, small hydroelectric stations etc. The following table shows the annual generation of electricity from small hydro stations for a period of 2009-10 to 2016-17.

Table 3.6

Generation of Electricity from the Small Hydro Stations from 2009-10 to 2016-17

Station	**Installed Capacity (MW)**	**Annual Generation (MU)**							
		2009-10	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
Small Hydro (KSEB)	132.4	330.4	378.4	323.2	308.1	438.5	402.3	397.4	358.9
Small Hydro (CPP)	33.0	68.0	88.3	81.1	44.4	82.2	79.2	79.6	15.7
Small Hydro (IPP)	25.1	19.8	33.2	40.8	33.1	64.1	73.7	75.7	61.1
Total	190.5	418.2	499.8	445.1	385.6	584.9	555.2	552.7	435.7
Annual Growth Rate		**0.0**	**19.5**	**-11.0**	**-13.4**	**51.7**	**-5.1**	**-0.4**	**-21.2**

Source: Compiled from the Power System Statistics 2016-17

The above table 3.6 shows the annual generation of electricity in Million Units and Installed Capacity in Mega Watts from the small hydro stations of KSEB, Independent Power Producers (IPP) and Captive Power Producers (CPP). The 18 small hydro stations of Kerala State Electricity Board Ltd are Kallada, Peppara, Chembukadavu, Malankara, Madupetty, Urumi, Malampuzha, Poringalkuthu, Neriamangalam, Poozhithode, Ranni Perinadu, Peechi, Vilangad, Chimmony, Lower Meenmutty, Kuttiyadi, Barapole and Adyanpara as per the reports of KSEB Ltd. The small hydro stations of Captive Power Producers (CPP) are Kuthungal and Maniyar.

The small hydro stations of Independent Power Producers (IPP) are Iruttukkanam, Meenvallom, Ullunkal, Karikkayam and Pambumkayam. The major share of electricity from the small hydro station is made by KSEB Ltd.

Wind energy is another major alternative source of electricity in Kerala. The following table shows the annual generation of wind energy in Kerala for a period of 2009-10 to 2016-17.

Table 3.7

Generation of Wind Energy from 2009-10 to 2016-17

Station	**Installed Capacity (MW)**	**Annual Generation (MU)**							
		2009-10	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
Wind (KSEB)	2.0	1.8	1.5	2.0	1.8	1.8	1.1	1.4	1.7
Wind (IPP)	32.9	67.6	62.9	67.0	69.0	74.1	67.1	47.4	92.6
Total	34.9	69.5	64.4	69.0	70.7	75.9	68.2	48.8	94.3
Annual Groth Rate	0	0	-7.3	7.2	2.5	7.3	-10.1	-28.4	93.2

Source: Compiled from the Power System Statistics 2016-17

The above table 3.7 shows the annual generation of wind energy in Million Units and Installed Capacity in Mega Watts from the stations of KSEB Ltd. and Independent Power Producers (IPP). The wind station of Kerala State Electricity Board Ltd is Kanjikode wind station and that of Independent Power Producers (IPP) are Agali, Ramakkalmedu, and Ahalia Alternate Energy Ltd. The IPPs are contributing the major share of wind energy i.e., 92.6 MU. Solar energy is a commonly used alternative source of electricity used in Kerala.

The following table shows the annual generation of solar energy by KSEB and IPP for the year 2016-17.

Table 3.8

Generation of Solar Energy for the year 2016-17

Solar (KSEB)	**Generation (MU)**	**Solar (IPP)**	**Generation (MU)**
Kanjikode	0.87	Cochin International Airport Ltd	10.99
Chaliyoor Colony, Agali	0.05	Hindal co Generation	1.61
Poringalkuthu	0.04	ANERT, Kuzhalmandam	0.93
Banasurasagar, Wayanad	*	Ambalathara -Solar Park	7.55
Total	**0.96**	**Total**	**21.08**

Source: Compiled from the Power System Statistics 2016-17 * New Initiative

Solar energy is generated from the stations of KSEB Ltd. and Independent Power Producers (IPP). The IPPs are contributing the major share of solar energy.i.e, 21.08 MU

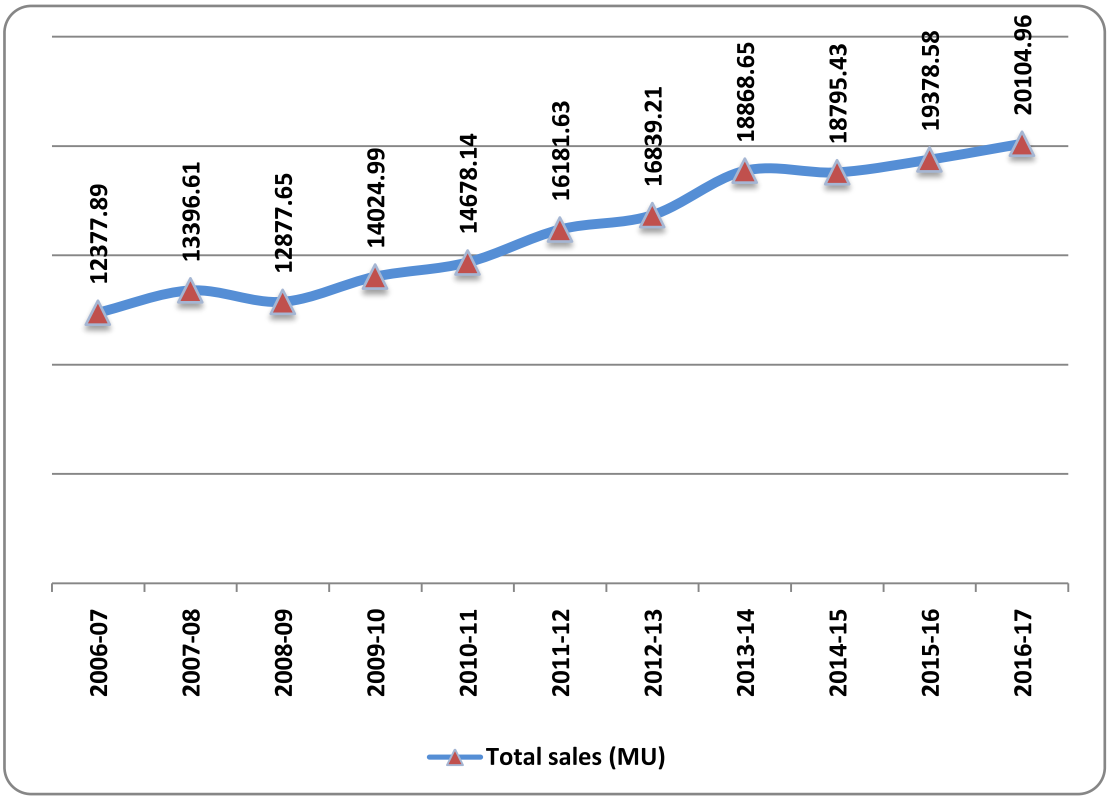
3.3.6 Demand Side Variables of Electricity in Kerala

The demand side variables of electricity used in Kerala viz., sales of electricity, revenue from sales, per capita consumption, different categories of consumers etc. are analysed in this part of the chapter.

The analysis was made on the basis of secondary data provided by Kerala State Electricity Board Limited. This helps to understand the consumption pattern of electricity of different categories of consumers especially the domestic consumers.

Figure 3.12

Sales of Electricity in Kerala from 2006-07 to 2016-17



Source: Compiled from the Power System Statistics 2016-17

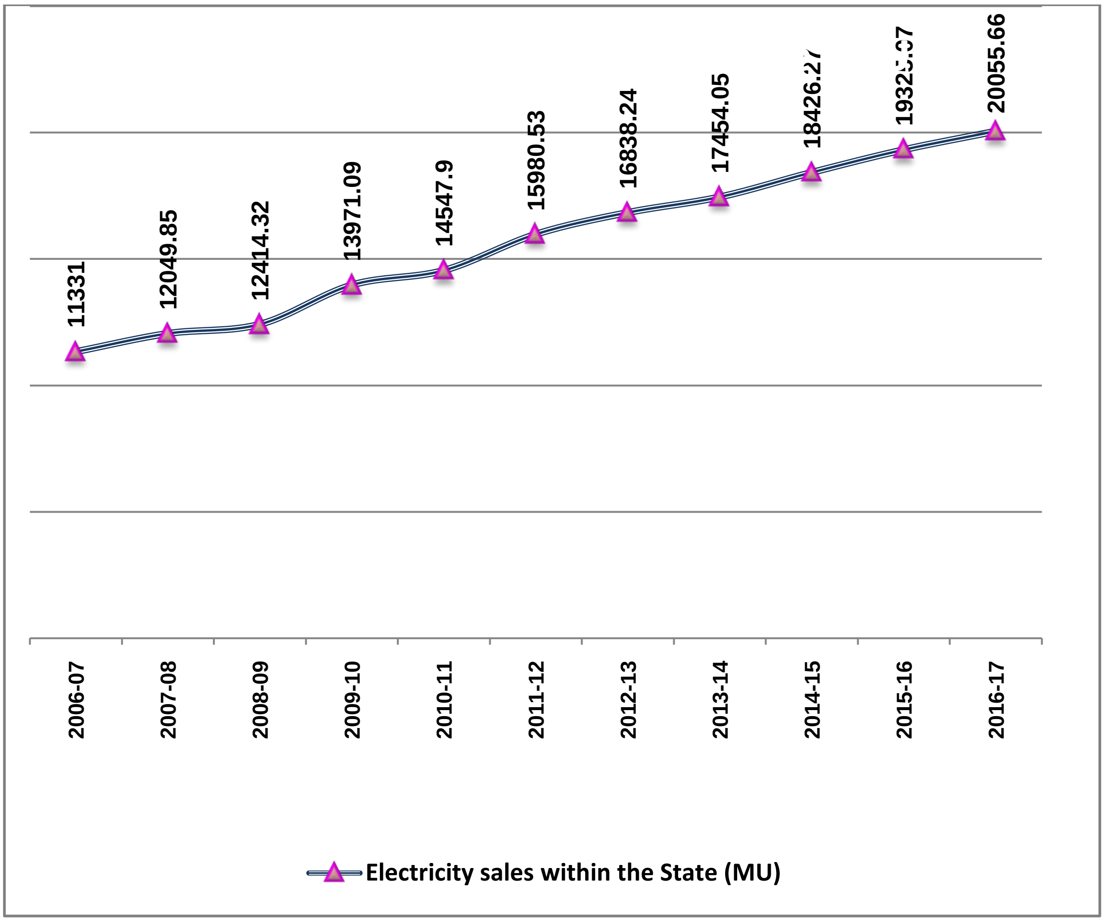
All the electricity generated will not be available for sale. There will be auxiliary consumption (electricity used by the power stations for various purposes) and T&D losses. Total sales include sales within Kerala and outside.

The above line chart 3.12 shows the total electricity Sales in Million Units for eleven years starting from 2006-07 to 2016-17. The total sales show an increasing trend from 2006-07 onwards, except for 2008-09 period (12877.65MU) and for the period 2014-15 (18795.43).

The following line chart shows the electricity sales within Kerala in Million Units for eleven years starting from 2006-2007 to 2016-17.

Figure 3.13

Electricity Sales within the State from 2006-07 to 2016-17



Source: Compiled from the Power System Statistics 2016-17

The above chart reveals that the electricity sales within Kerala for 2016-17 is 20055.66 MU and 11331 MU for 2006-07. The electricity sales within the state shows an increasing trend. This may be due to the increase in the new electricity connections, increase in the standard of living of the people, etc.

The following table 3.9, analyses the growth rate of total sale of electricity and the electricity sales within the state for a period of 11 years from 2006-2007 to 2016-17.

Table 3.9

Annual Growth Rate of Sales of Electricity in Kerala from 2006-07 to 2016-17

Year	Growth Rate (%) of Total Electricity Sales	Growth Rate (%) of Electricity sales within the State
2006-07	0	0
2007-08	8.23	6.34
2008-09	-3.87	3.02
2009-10	8.91	12.54
2010-11	4.66	4.13
2011-12	10.24	9.85
2012-13	4.06	5.37
2013-14	12.05	3.66
2014-15	-0.39	5.57
2015-16	3.10	4.88
2016-17	3.75	3.78
AAGR	**5.07**	**5.91**

Source: Compiled from the Power System Statistics 2016-17

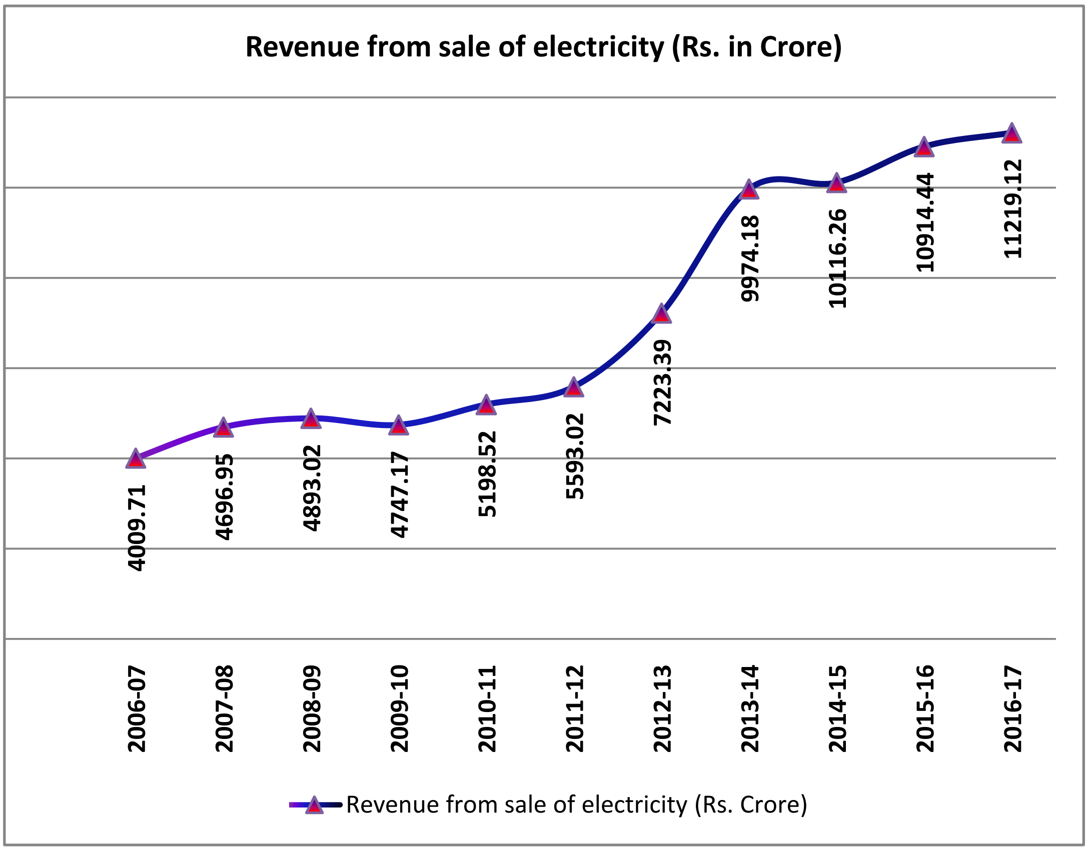
The above table 3.9, shows that the average annual growth rate for total electricity sales is 5.07 %. The annual growth rate for 2013-14 was above the AAGR, 12.05% and for 2011-12, the growth rate was 10.24%.

The growth rate for 2014-15 and 2008-09 is very low (-0.39% and -3.87%). The average annual growth rate in the sales of electricity within Kerala is (5.91%). The year 2009-10 and 2011-12 shows a significant increase in the sale of electricity (12.54% and 9.85%).

The following line chart represents the revenue from the sale of electricity raised from the consumers for 11 years from 2006-07 to 2016-17.

Figure 3.14

Revenue from the Sale of Electricity to Different Categories of Consumers of KSEB Limited from 2006-07 to 2016-17



Source: Compiled from the Power System Statistics 2016-17

The above figure reveals that, up to 2012-13 period, there was only a slow increase in the revenue from the sale of electricity. During the period 2013-14 onwards, there is a sudden increase in the revenue. This was mainly due to the tarriff hike introduced in this period and increase in the sales of electricity.

The following table analyses the annual growth rate of revenue from the sale of electricity raised from the consumers for 11 years from 2006-07 to 2016-17.

Table 3.10

Annual Growth Rate of Revenue from the Sale of Electricity from 2006-07 to 2016-17

Year	**Growth Rate (%)**
2006-07	0
2007-08	17.14
2008-09	4.17
2009-10	-2.98
2010-11	9.51
2011-12	7.59
2012-13	29.15
2013-14	38.08
2014-15	1.42
2015-16	7.89
2016-17	2.79
AAGR	**11.48**

Source: Compiled from the Power System Statistics 2016-17

The above table shows that the Average Annual Growth Rate of sales revenue is 11.48%. The growth rate is above average for the years 2007-08, 2012-13 and 2013-14. The year 2013-14 shows the highest growth rate 38.08%. The growth rate was less during the period of 2009-10 (-2.98%). The sales revenue for the year 2016-17 is ₹11219.12 crores and the growth rate for this period is 2.79 %. The revenue of KSEB Ltd. comprises of tariff and non tariff revenue. The above table represents the revenue from tariff generated through sale of power.

As KSEB Ltd. is purchasing around 60% of the power to meet the deficit, the tariff rates were increased at a rate of 25-30 percentage for the period 2012 to 2013, 5-10 percentage for the period 2013 to 2014 and 10-20 percentage from 2014 to 2015. This is the reason for increase in the sales revenue for 2012-13 and 2013-14.

The sales for 2014-15 was only 18795.43 MU. So the revenue growth rate was only 1.42%.

Table 3.11

Annual Growth Rate of Per Capita Consumption of Electricity in Kerala from 2006-07 to 2016-17

Year	**Percapita consumption (kWh)**	**Growth rate (%)**
2006-07	345	0
2007-08	366	6.09
2008-09	375	2.46
2009-10	420	12
2010-11	436	3.81
2011-12	478	9.63
2012-13	501	4.81
2013-14	516	2.99
2014-15	544	5.43
2015-16	565	3.86
2016-17	592	4.78
AAGR		**5.59**

Source: Compiled from the Power System Statistics 2016-17

The above table 3.11, reveals that the Average Annual Growth Rate is 5.59%. The period 2009-10 shows an increase in the per capita consumption of electricity, i.e. 12% and where as, it was only 9.63% for 2011-12. For all the other years, there is no significant variation.

3.3.7 Consumers of KSEB Ltd.

Consumers of electricity consist of LT, HT and EHT categories. An LT Consumer avails electricity at low or medium voltage. An HT Consumer avails supply at High Voltage and an EHT Consumer avails electricity from the Board at Extra High Voltage. Tension means Voltage. LT is Low Tension, HT is High Tension and EHT means Extra High Tension. LT supply means voltage not exceeding 250 Volts. HT means 650 Volts to 33kV and EHT supply is above 33kV. Connected Load means the total rated capacities of all the appliances connected to distribution and expressed in kW or kVA.

Low Tension consumers consist of the following :

LT I - Domestic category of consumers (households with less than 500 kWh)

LT III A - Temporary Connection

LT VA - Agricultural Connections for lift irrigation, pumping, dewatering etc.

LT VB - Livestock, Poultry Farms, Aquarium, Nursery etc

LT VI A - General category of Government and Aided Educational Institutions, Hospitals, Laboratories , Blood Banks, Primary Health Centres of Central, State or Local Self Government, Temples, Mosque, Churches, Convents, etc.

LT VI B - Offices and Institutions of Central, State and Local Self Governments, Kerala State Water Authority, KSRTC Offices ,Village Offices, Zoo, Museum, Offices of Chartered and Cost Accountants, Management Consultants etc.

LT VI C - ATMs, Offices of Income Tax, Excise and Customs Authorities, Light Houses, Banking and Financing Institutions etc.

LT VI D - Orphanages, Anganwadis, SOS villages, Rehabilitation Centres etc

LT VI E - Sports and Arts Clubs, Gymnasiums, Offices of Political Parties recognised by the Election Commission etc.

LT VI F - General Computer Training Institutes, Private Coaching Tution Centres, Offices of Mobile Connections, Offices of Akasavanis, Doordarsan, Other Broadcasting Companies, Insurance Companies etc.

LT VI G - Private Hospitals, Clinics, Labs, X Ray units etc.

LT VII A - Commercial Shops, Showrooms, Hotels, Restaurants (more than 1000 watts), Petrol and Diesel Bunks , Marble and Granite Cutting Units, Private Hostels, Lodges, Share Brokers, Cold Storages etc

LT VII B (upto 1000 watts connected load) - Shops, Hotels, Restaurants, Internet Photocopy Institutions etc.

LT VII C (above 2000 watts) – Cinema Theatres, Circus, Sports and Arts Club, Gymnasiums etc.

LT VIII B - Street Lights and Traffic Signal Lights.

LT IX - Display Lights, Hoardings, Illumination for Commercial Purposes etc.

High Tension and Extra High Tension consumers include the following

HT - IT and IT enabled services, Domestic, Agricultural, Commercial and Industrial HT

EHT - Industrial, Commercial and General 66Kv, 110kV, 220kV Railway traction, Kochi Metro Rail Corporation (110kV).

The following table 3.12 presents the number of consumers belonging to different categories and their connected loads as on March 2017 expressed in Megawatts and as a percentage of the total.

Table 3.12

Number and Connected Load of Different Category of Consumers of KSEB Limited as on March 2017

Category	Number of consumers	Percentage	Connected Load (MW)	Percentage
Domestic	9384957	78.24	14206.25	64.45
Commercial LT	1360200	11.34	1852.58	8.41
Industrial LT	141683	1.18	1688.59	7.66
HT and EHT	5335	0.04	1436.42	6.52
Public lighting	20350	0.17	140.95	0.64
Agricultural	447551	3.73	874.17	3.97
Licencees	12	0.0001	111.17	0.50
Railway Traction	12	0.0001	91	0.41
General	634716	5.29	1639.49	7.44
Total	1,19,94,816	100.00	22,040.62	100.00

Source: Compiled from the Power System Statistics 2016-17

The above table shows that the domestic consumers are the majority. They are 9384957 in number, which is about 78.24% of the total. They have a connected load of 14206.25 MW (64.45% of the total). The second highest is the commercial LT consumers who are 1360200 in number (11.34%) and have a connected load of 1852.58 (8.41%). Agricultural consumers are 447551 in number (3.73%) and have a connected load of 874.17 (3.97%). Industrial consumers come to 141683 (1.18%) and have a connected load of 1688.59 (7.66%). The LT consumers form the majority.

The following table presents the category-wise sales and revenue of electricity in Kerala for the year 2016-17 expressed in Million Units and as a percentage of the total.

Table 3.13

Sales and Revenue of Electricity in Kerala

Category-wise for 2016-17

Category	**Sales** (MU)	**Revenue** (Rupees In Crores)
Domestic	10280.74	3953.34
Commercial	1523.87	1356.61
Industrial LT	1131.906	754.72
HT & EHT	4128.21	2854.08
Public Lighting	375.76	156.64
Agricultural	321.98	102.01
Licencees	612.1	363.25
Railway Traction	229.58	130.52
Export	49.3	12.27
General	1434.09	1352.44
Total	**20087.54**	**11,035.88**

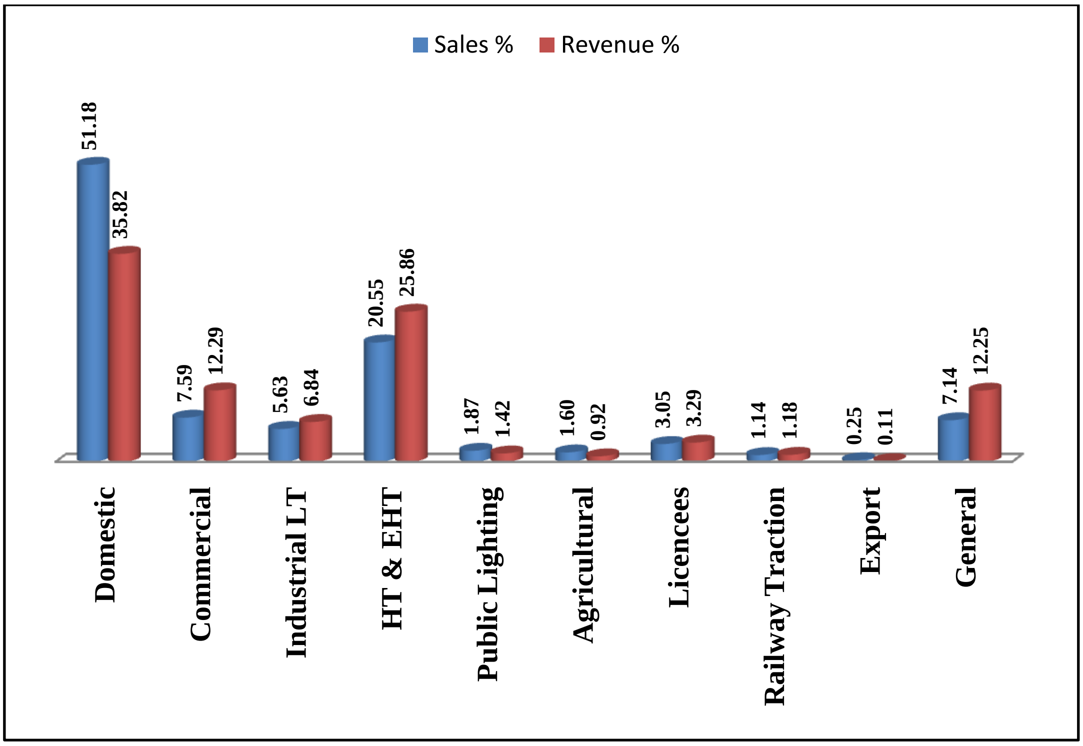
Source: Compiled from the Power System Statistics 2016-17

The table 3.13, reveals that the total sale in Million Units for the year 2016-17 is 20087.54 MU and the total revenue is 11,035.88 crores. The total sales to domestic consumers is 10280.74 MU and the revenue generated is ₹3953.34 crores. The second position is of the HT and EHT consumers. The total sales to this category is 4128.21MU and the revenue received is ₹2854.08 crores.

The following figure shows the sales and revenue of electricity generated from different categories of consumers of KSEB Limited expressed in percentage for the year 2016-17.

Figure 3.15

Sales and Revenue of Electricity Generated from Different Categories of Consumers of KSEB Limited for the year 2016-17



Source: Compiled from the Power System Statistics 2016-17

The above chart 3.15, reveals that 51.18 % of the sales to domestic consumers contribute only 35.82 % to the revenue. While 1.6 % sales to agricultural consumers provide 0.92 % of the revenue, 1.87 % of public lighting provides only for 1.42 % of the revenue.

Sales to Licencees, Railway Traction and Export category of consumers though a small percentage (3.05 %, 1.14%, .25 %) contributes 3.29 %, 1.18% and .11 % of the revenue.

The following table analyses the annual growth rate of number of domestic consumers of KSEB Limited for 11 years from 2006-07 to 2016-17.

Table 3.14

Annual Growth Rate of Number of Domestic Consumers of KSEB Limited from 2006-07 to 2016-17

Year	**Number of Domestic Consumers**	**Growth Rate**
2006-07	6880500	0
2007-08	7137739	3.74
2008-09	7481601	4.82
2009-10	7790132	4.12
2010-11	8092072	3.88
2011-12	8324961	2.88
2012-13	8573938	2.99
2013-14	8788916	2.51
2014-15	8987947	2.26
2015-16	9124747	1.52
2016-17	9384957	2.85
Average Annual Growth Rate		**3.16**

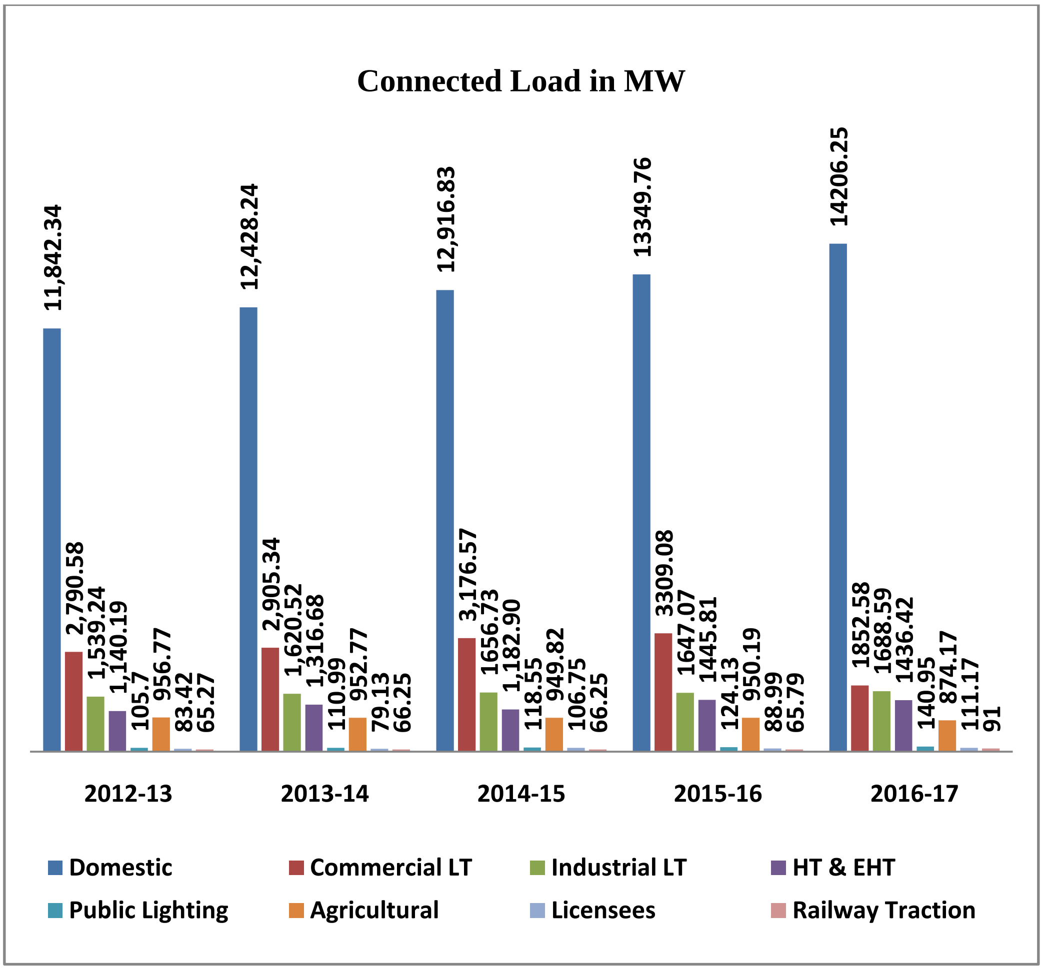
Source: Compiled from the Power System Statistics 2016-17

The above table 3.14, reveals that the annual growth rate was above the Average Annual Growth Rate for the period starting from 2007-08 to 2010-11. This may be due to the mass electrification programmes carried out during the period.

The following figure represents the connected load of different categories of consumers from 2012-13 to 2016-17 in Mega Watts.

Figure 3.16

Connected Load of Different Categories of Consumers of KSEB Limited from 2012-13 to 2016-17



Source: Compiled from the Power System Statistics 2016-17

The figure 3.16, shows that the domestic consumers are having a connected load of 11842.34 MW for 2012-13 and 14206.25 for 2016-17. Railway Traction is having the lowest connected load. The connected load for Railway Traction is 65.27 MW for 2012-13 and 91 MW for 2016-17.

3.3.8 Transmission and Distribution (T&D) Loss

Transmission and Distribution (T&D) Loss can be classified into Technical and commercial loss. Technical loss refers to the loss in the Transmission and Distribution system and Commercial loss means the loss arising due to errors in billing and collection, power theft etc. These losses should be reduced, to improve the power supply position. The technical losses can be reduced by strengthening the distribution system. The commercial losses can be reduced by energy audit, anti power theft squads etc.

Transmission and Distribution (T&D) Loss of electricity in Million Units for 11 years from 2006-07 to 2016-17 is given below.

Table 3.15

Transmission and Distribution Loss of Electricity from 2006-07 to 2016-17

Year	**(MU)**
2006-07	3096.96
2007-08	3015.3
2008-09	2879.09
2009-10	3011.2
2010-11	2792.37
2011-12	2958.27
2012-13	3038.92
2013-14	3071.63
2014-15	3142.43
2015-16	3267.02
2016-17	3310.66

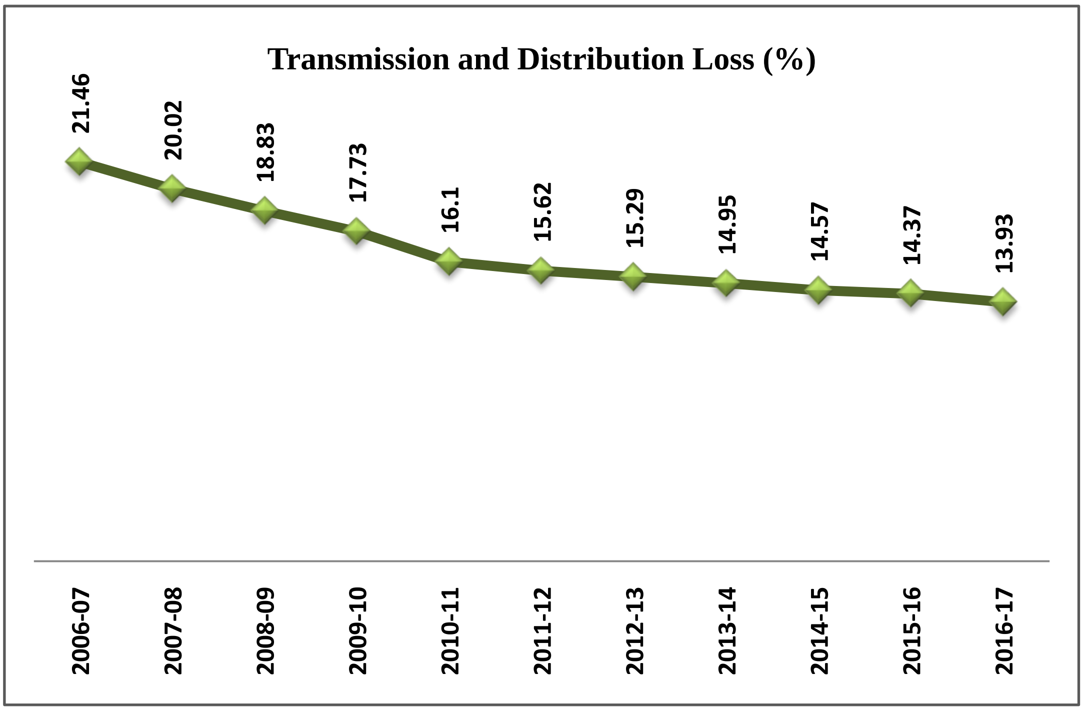
Source: Compiled from the Power System Statistics 2016-17

The above table reveals that the T & D Loss for 2016-17 is 3310.66 MU. The Transmission and Distribution loss is the difference between the electricity available for sale within the state and the actual electricity sales within the state. The efficiency of electricity transmission and distribution has improved because less T&D loss means more power available for consumption.

The proportion of T&D loss to the electricity available for sale in Kerala for 11 years from 2006-07 to 2016-17 is given in the following figure.

Figure 3.17

Transmission and Distribution Loss of Electricity



Source: Compiled from the Power System Statistics 2016-17

The line graph reveals that the T&D Loss percentage for 2016-17 is 13.93. The percentage of T&D losses has decreased. The T & D loss percentage is calculated as the proportion of T&D loss in million units to the electricity available for sale in Kerala in million units. For the period 2015-16, the T&D loss was 14.37%, while for 2014-15 it was 14.57% and 14.95% for 2013-14.

3.3.9 Transmission and Distribution System in Kerala

Transmission and Distribution network consists of substations and lines.The inter state and intrastate transmission and distribution lines should be powerful and the capacity of transformers should be increased along with the load growth. Regular maintenance of network is also essential. Electricity is transmitted at very high voltages, usually at 220/110/66 kV.The electricity generated at low voltages is converted into high voltage before transmission using step up transformers at the substations. Proper management of power network is known as Grid Management. Grid Management is an important part of DSM.

Table 3.16

Growth of Transmission and Distribution System in Kerala

Particulars	**As on 31-03-13**	**As on 31-03-14**	**As on 31-03-15**	**As on 31-03-16**	**As on 31-03-17**
220 kV Lines in km	2761.57	2765	2801.2	2801.89	2801.8
Growth Rate	0	0.12	1.31	0.02	0
110 kV Lines in km	4178.55	4260.27	4299.67	4345.52	4460.75
Growth Rate	0	1.96	0.92	1.07	2.65
66 kV Lines in km	2166.51	2202.81	2202.81	2220.56	2154.75
Growth Rate	0	1.68	0	0.81	-2.96
33 kV Lines in km	1599.7	1719.28	1761.57	1826.66	1902.43
Growth Rate	0	7.48	2.46	3.69	4.15
HT lines (11 kV & 22 kV) in km	53,068	53,740	55,547	57,650	59496
Growth Rate	0	1.27	3.36	3.79	3.20
LT lines in km	2,63,620	2,64,117	2,68,753	2,85,970	291328
Growth Rate	0	0.19	1.76	6.41	1.87
Step up transformer capacity (MVA)	2,612.00	2,615.00	2659	2691.05	2699.05
Growth Rate	0	0.11	1.68	1.21	0.3
Step down transformer capacity (MVA)	17,408	17,913	18,461	18,779	19143.4
Growth Rate	0	2.90	3.06	1.72	1.94
Number of EHT substations	241	244	244	250	258
Growth Rate	0	1.24	0	2.46	3.2
Number of 33 kV substations	129	133	134	137	144
Growth Rate	0	3.1	0.75	2.24	5.11
Number of Distribution transformers	64,972	67,546	71,198	73,460	75580
Growth Rate	0	3.96	5.41	3.18	2.89
Distribution transformer capacity (MVA)	7,940.37	8,329.11	8,694.20	8950.02	9141.12
Growth Rate	0	4.9	4.38	2.94	2.14

Source: Compiled from the Power System Statistics 2016-17

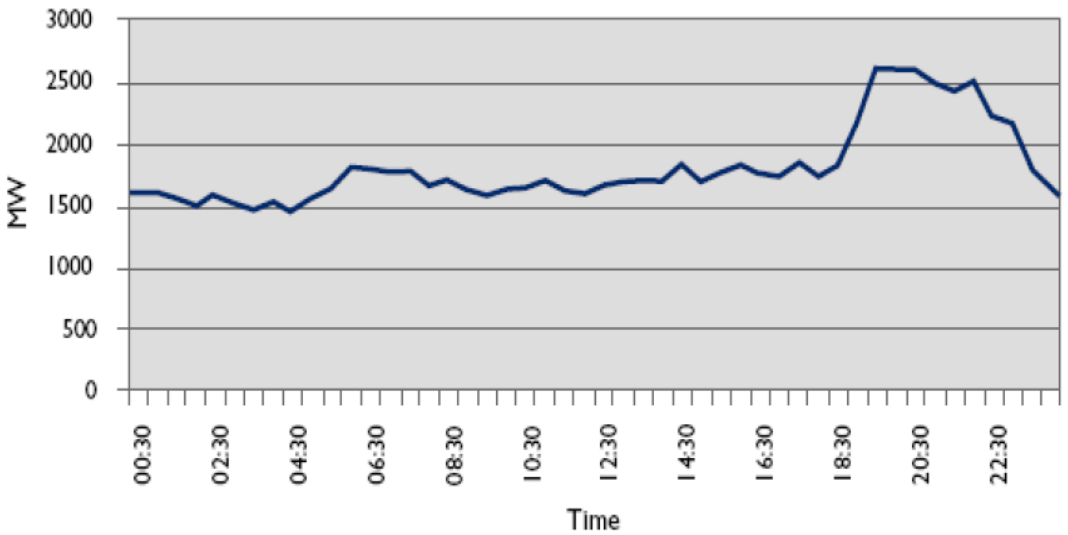
The above table represents the growth of the Transmission and Distribution system in Kerala.The number of step up and step down transformers, distribution transformers, capacity of transformers, number of substations and the length of the kV lines shows an increasing trend. An efficient transmission and distribution network is essential to ensure quality and reliability of power and to reduce T&D losses.

3.3.10 Load Curve

Load Curve refers to the electricity demand pattern in Kerala during different time range. The consumers shall shift the use of their electricity from the peak hours to the off-peak hours, so that additional investments need not be made by the utility which remain idle during the off- peak hours.

Figure 3.18

Load Curve – Kerala Power System



Source: The Report on Establishment of Kerala State Energy Conservation Fund by the International Resources Group Ltd.

The above figure depicts a significant increase in the use of electricity use from 6.30 pm to 10.30 pm. The KSEB Ltd. has to meet this peak demand by capacity augmentation or power purchase. Both require huge cost. So Load management is necessary to meet this peak demand. Load management involves load shifting and load shedding.

3.3.11 Power Purchase Agreements

KSEB Ltd. has entered into Power Purchase Agreements and Power sale Agreements with Central Generating Stations, Independent Power Producers and Traders for short term (1 year), medium term (3 years) and long term periods (25 years).

3.3.12 Profit and Loss Statement of the Kerala State Electricity Board Limited

A comparative Statement represents the absolute and relative changes in the figures of profit and loss accounts as on 31/03/2016 and 31/03/2017. This helps to make a horizontal analysis of the profitability of the firm.

Table 3.17

Comparative Statement of Profit and Loss of the KSEB Ltd.

	(Rupees In Lakhs)			**Percentage**
Particulars	**As on 31/03/2016**	**As on 31/3/2017**	**Increase/ Decrease**	**% of Increase/ decrease**
Revenue from operations	1091443.61	1121911.94	30468.33	2.79
Other Income	33271.34	36775.39	3504.05	10.53
Total Revenue	**1124714.95**	**1158687.33**	**33972.38**	**3.02**
Expenses				
a) Purchase of Power	633681.62	766440.39	132758.77	20.95
b) Generation of Power	10425.53	2344.63	-8080.9	-77.51
c) Repairs and Maintenance	25975.64	26690.1	714.46	2.75
d) Employee Cost	310453.25	337375.67	26922.42	8.67
e) Administration and other Expenses	32787.59	37872.09	5084.5	15.51
f) Finance costs	85140.75	92292.75	7152	8.40
g) Depreciation and Amortisation	49122.12	52066.22	2944.1	5.99
h) Others	8898.01	7650.24	-1247.77	-14.02
Total Expenses	**1156484.51**	**1322732.08**	**166247.57**	**14.38**
Add Prior period credit/charges	440.09	1200.55	760.46	172.80
Loss for the period	**31329.47**	**165245.3**	**133915.83**	**427.44**

Source: Compiled from the Power System Statistics 2016-17

In the above table, revenue from operations represents tariff revenue and 'other income' means non tariff revenue. The tariff revenue and non tariff revenue of KSEB Ltd. has increased as compared to the previous year, (2.79 % and 10.53 % respectively). Tariff revenue means income from the sale of power from different category of consumers in Kerala, i.e, meter rent, service line rental etc. and from outside sources. Other income includes interest from banks, income on investments, interest on staff loans, income from sale of scrap etc.

The expenses consists of cost of electricity generation, purchase, administration expenses, repairs and maintenance, finance costs, depreciation and amortisation cost, employee cost etc. The cost of generation has decreased as compared to the previous year (-77.51%). The repairs and maintenance, employee cost and administration expenses show an increase of 2.75%, 8.67 % and 15.51% respectively. The repairs and maintenance cost includes cost of repairing plant and machinery, lines, cable networks, office equipment etc. Employee cost refers to salary, DA, pension and other benefits given to the employees. Administration expenses include rent, rates, taxes, communication and travelling expenses etc. Finance cost include interest on long term borrowings, interest on working capital, interest payable to consumers on security deposit, rebate to energy traders to make quick payment etc. Finance costs increased by 8.4 %. Depreciation on the assets of KSEB Ltd. increased by 5.99 %. Thus the total expenses show an increase of 14.38 %. The loss for the year 2016-17 has increased by 427.44%. This was due to the increase in the expenses of KSEB Ltd. as compared to the previous year.

3.4 Conclusion

India is the world's third largest electricity producer and consumer following China and the US. The total installed capacity of electricity generation in India is 330,861 MW. This capacity is contributed by the State, Central and Private Sectors. The major share of the installed capacity of electricity generation is held by the Private Sector. Out of the total installed capacity, largest portion is from the thermal sources, which is based on fossil fuels. The requirement of electricity for the year 2016-17 is 11,42,929 MU and the availability of electricity is 11,35,334 MU. The per capita consumption of electricity in India for the year 2017 was 1122 kWh.

The total installed capacity of electricity generation in Kerala as on 30-04-2017 is 4998.94 MW which comprises of thermal, nuclear, hydro and renewable sources. 48.34% of the electricity is generated from the thermal sources. The analysis of the share of State, Private and Central Sectors in the generation of electricity reveals that the major share is contributed by the State Sector. The main source of renewable energy in Kerala is the small hydro plants. The domestic consumers are the majority category among the total consumers of KSEB Ltd. They are 78.24% of the total and have a connected load of 64.45% of the total. 51.18 % of the sales to the domestic consumers are contributing only to 35.82 % of the revenue. The T&D Loss percentage for 2016-17 is 13.93%. The electricity demand pattern in Kerala during different time range shows that, there is a significant increase in the use of the electricity from 6.30 pm to 10.30 pm.

On the basis of the above observations, it can be concluded that, Kerala is a power deficit state and is buying electricity at a higher price. The utility is generating 4369.54 MU out of which 44.46 MU is used for auxiliary consumption. 19050.17 MU is purchased as per the Annual Administration Reports of KSEB Ltd. (2016-17). Electricity generated from the hydropower stations owned by KSEB Ltd. is inadequate.

KSEB Ltd. is distributing electricity to 119 lakhs of consumers in Kerala. There is also a wide gap between the peak and off-peak demand of electricity. The additional capacity created for meeting the peak requirement of electricity remains idle during the off-peak hours. Increase in tariff revenue helps to reduce the loss of KSEB Ltd. But, as a public utility KSEB Ltd. continues to provide electricity at subsidised rates to LT categories of consumers. Thus the utility gives equal importance to social objectives also. Major portion of electricity is generated from thermal sources. Thermal sources are not eco-friendly. So the Demand Side Management should be focused among the domestic category of consumers in Kerala.

The mission of KSEB Ltd. is “To provide quality electricity to customers adequately, safely and sustainably at affordable cost”.

— The Utility provides electricity at affordable rates to the LT consumers.

- KSEB Ltd. focuses on sustainability or clean energy / non-conventional sources of energy.
- It gives stress to Energy Management, to provide quality power to all.

The analysis of the chapter reveals that the availability of electricity is far less than the requirement. Hence the Demand side Management of electricty appears to be the only solution to attain the Mission of KSEB Ltd.

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Chapter 4
Demarketing Strategies Implemented by the Kerala State Electricity Board Limited

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Chapter 4
Demarketing Strategies Implemented by the Kerala State Electricity Board Limited

4.1 Introduction

The Demand Side Management of Electricity is promoted in Kerala with the help of 4 P's of (De) Marketing, namely- Product, Price, Place/Physical Distribution and Promotion. This chapter deals with the Demarketing Strategies implemented by KSEB Ltd. for the promotion of Demand Side Management among the domestic category of consumers. The first and the second objectives of the study are dealt with in this chapter. The first objective makes use of qualitative analysis and the second objective is based on quantitative analysis.

In qualitative research non numeric data is collected. For this, relevent literature in marketing, economics and management was reviewed to gain familiarity regarding the concept of 'Demarketing' and 'Demand Side Management' at the first stage. Further desk research regarding its relevence in Kerala was carried out at the second stage. After collecting the data, in depth interviews and discussions with experts and academicians were held to gain an in depth knowledge of the phenomena and its dimensions. The data collected was validated by cross checking it with multiple sources like academicians, experts in the field, literature review, focus groups and pilot study in order to ensure the trust worthiness and credibility of data. On the basis of qualitative data collected, the quantitative data regarding the exposure of domestic consumers towards the demarketing strategies and the effect of demarketing strategies are collected and analysed using statistical tools, namely, Mean and Multiple Regression.

This chapter comprises of 'Theoretical framework' developed on the basis of study carried out to explore the phenomenon of 'Demand Side Management' and 'Demarketing', 'Demarketing Strategies implemented by Kerala State Electricity

Board Ltd. for the promotion of DSM' and the 'Effect of Demarketing Strategies on the Domestic Consumer Behaviour towards Electricity'.

4.2 Theoretical framework

Energy is a crucial factor. It should be properly planned, monitored and managed to know the current usage level and the energy saving potential. Energy Management helps to protect the environment, to reduce the wastage of energy and to ensure energy efficiency. This part of the chapter deals with the theoretical framework of Demand Side Management.

4.2.1 Energy Management

"Energy management refers to the optimum utilisation of energy without compromising performance and quality".

The following are the elements of energy management:

a) Energy Targeting or setting the standards of energy consumption
b) Recording the actual energy usage pattern
c) Comparing the actuals with the standards/targets set
d) Controlling the deviations between actual performance and standards
e) Reporting the significant variances.

4.2.1.1 Energy Management Information System (EMIS)

EMIS is an efficient inter connected managerial system in an organisation which facilitates energy monitoring, energy audit and energy targeting with the help of information system. EMIS helps to carry out energy management effectively.

4.2.1.2 Energy Audit

Energy Audit is a tool used for measuring energy efficiency. Energy Audit is a comprehensive approach in energy management. It is a detailed study regarding the energy flows. It consists of,

I) Preliminary Audit and

II) Detailed Audit which involves a detailed analysis on matters requiring immediate attention, observed during the preliminary audit.

4.2.1.3 Energy Management and Energy Demand Management (Demand Side Management)

Energy Management and Energy Demand Management are not the same. Demand Side Management manage only the demand factors of energy i.e, at the point of distribution. Energy management considers both the demand and supply aspects of energy.

4.2.2 Demand Side Management

The concept of Demand-Side Management (DSM) originated in US in the 1970's. Earlier it was known as Demand Side Load Management, but now it is practised in various forms throughout the world. In narrow terms, DSM is energy conservation and not simply reducing demand. Demand Side Management also known as Energy Demand Management is the modification of consumer behaviour towards electricity through various activities undertaken by electric utilities.

Veronika and Clark (1988) explain the concept of Demand Side Management as "the planning and implementing of the activities of electric utilities, so as to influence the end use pattern of consumers and thereby create a change in the load shape. Electric utilities try to manage the load pattern by shifting the electricity use of consumers from the peak hours to off-peak hours and through strategic conservation."

The following table reviews the various dimensions of Demand Side Management as stated by different authors.

Table 4.1

Dimensions of Demand Side Management

Author	Dimensions / Strategies Used	Description
Gellings (1992) Electric Power Research Institute (EPRI)	Strategic conservation, peak clipping, valley filling, load shifting, strategic load growth, and flexible load shape.	Change the utility's load shape — i.e., changes in the time pattern and magnitude of load / demand.
Samuel, et al. (2009)	Variable pricing and direct load control	These strategies can be used in the residential sector in order to reduce the demand for electricity during the peak hours.
Aoife, et.al (2010)	Regulatory and incentive based measures, voluntory agreements and partnerships , market based mechanisms, and information/ capacity building	Strategies can be used in the residential sector for Demand Side Management
Arup et al. (2011)	Load shedding	Used in India to solve the problems of power shortage.
Peter (2011)	Smart energy tariffs with incentives, improving energy efficiency and real-time control of energy resources.	DSM is a portfolio of measures used to optimize the Energy system.

Source : Secondary Data

4.2.2.1 Demand Side Management Regulations, 2010

The Ministry of Power (MOP) 2010 , Government of India has defined DSM as 'actions of a utility, beyond the customer's meter, to alter the end-use of electricity - whether it be to increase demand, decrease it, shift it between high and low peak periods, or manage it when there are intermittent load demands - in the overall interests of reducing utility costs'. (based on State Electricity Regulatory Commission (Demand Side Management) Regulations, 2010)

4.2.3 Dimensions of Demand Side Management

Demand Side Management adopted in Kerala includes three dimensions - Energy Conservation (EC), Energy Efficiency (EE) and Load Management (LM).

Energy Conservation and Energy Efficiency

Energy Conservation and Energy Efficiency are the two terms that are used interchangeably. Both are required for making the nation self-sufficient in energy. The following are the differences between the two:

a) Energy Conservation (EC) is a broad term and Energy Efficiency (EE) is an element of Energy conservation.

b) EC means behavioural changes in energy consumption, whereas EE includes technical changes.

c) Energy Conservation means less comfort or discomfort or no use of an energy service. EE refers to availing the same service and comfort with less cost and without wastage.

d) EC is a traditional method, whereas EE is a modern concept or improvisation of technology or production process.

e) EE projects are quantifiable but EC measures are not quantifiable.

f) EE measures involves initial investment, but they can be paid back in a short period , EC measures are long term projects.

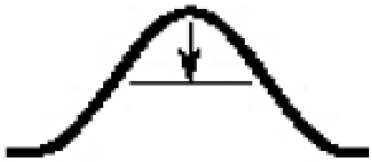
g) Energy Conservation means switching of appliances when not in use, using natural light and ventilation. Energy Efficiency means using energy efficient and quality electric appliances like CFLs, LED lamps, star rated equipment etc.

Load Management

Load Management consists of various utility driven methods like peak clipping, valley filling, load shifting, strategic conservation, strategic load growth and flexible reliability as given below.

Figure 4.1

Peak Clipping

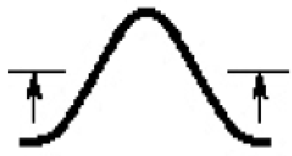


Source: Report of Utility CEO Forum on Demand Side Management

Peak clipping means reducing the peak demand for electricity either by the utilities direct control over the appliance of the consumer or by the tariff adjustments. Differential tariffs motivate the consumers to cut short the demand during the peak hours.

Figure 4.2

Valley Filling

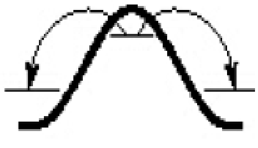


Source : Report of Utility CEO Forum on Demand Side Management

Valley filling refers to increasing the demand for electricity during the off-peak period.

Figure 4.3

Load Shifting



Source : Report of Utility CEO Forum on Demand Side Management

Load shifting means shifting the demand for electricity from peak hours to off-peak hours.

Figure 4.4

Strategic Conservation

Source : Report of Utility CEO Forum on Demand Side Management

Strategic conservation is a traditional approach of load management in which the demand for electricity is reduced irrespective of the time of use.

Figure 4.5

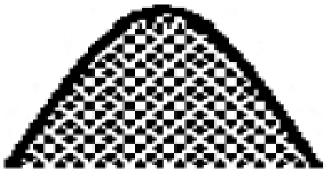
Strategic Load Growth

Source: Report of Utility CEO Forum on Demand Side Management

Strategic load growth refers to increasing the demand for electricity by introducing new uses and appliances like electric cars.

Figure 4.6

Flexible Reliability



Source: Report of Utility CEO Forum on Demand Side Management

Flexible reliability refers to the agreements with the Utilities in exchange of incentives provided to the customers in which Utility can curtail the customers' demand for electricity whenever required.

Among the above said strategies, elements of demand response, load shifting and load shedding practised in Kerala and used for load management is given in detail in the following section of this chapter.

The following table shows the electricity saving potential of the different sectors in Kerala through DSM expressed in million units and percentage:

Table 4.2

Energy Saving Potential in Kerala through Demand Side Management

Sector	**Saving Potential in %**	**Savings in MU**
Agriculture	30-40 (replacing pumps with BEE Star Rated)	75
Commercial	20-26.4	325
Domestic	Replacing with CFLs and BEE star rated equipment 20-25 (Rural-40-50 and Urban 15-20)	1500
Public Lighting	25	70
Industries	9.5	520
	Total	2500

Source: Compiled from the Report of Expert Committee on Energy –Kerala State Planning Board

The above table 4.2 compiled from the energy report reveals that, the energy savings which can be achieved by replacing inefficient equipment with CFLs and BEE Star rated equipment is 1500MU. But there is difference in the energy saving potential of the rural and urban consumers. The potential is high in the case of rural consumers. Among the different categories of consumers, the energy saving potential is high among the domestic consumers.

The agricultural sector also presents energy saving potential of 30% to 40%. It comes to 75MU. This is attained by replacing inefficient pumps with BEE star rated pumps. The energy saving potential of public lighting is 70 MU and industries 520MU. In commercial sector the potential for energy savings is 325MU. The study of the report reveals that the relatively higher share of energy saving potential is in the domestic sector.

4.2.4 Demarketing for Demand Management

Marketers adopt demand management. According to Kotler (2000). "Eight demand states are possible. To change a demand state, marketing mix elements have to be changed. That requires expenditure or investment on the part of an organization. If the return on investment is positive, marketers recommend marketing investment. Eight States of Demand are:

a) Negative demand
b) Nonexistent demand
c) Latent demand
d) Declining demand
e) Irregular demand
f) Full demand
g) Overfull demand and
h) Unwholesome demand".

"Four specific demand states make up under-demand: negative demand, no demand, latent demand, and faltering demand. Two specific demand states make up adequate demand: irregular demand and full demand. Finally, two demand states make up over-demand: overfull demand and unwholesome demand. The task of reducing overfull demand is called demarketing”.

4.2.5 Concept of Demarketing

Demarketing means using marketing techniques to modify consumer perception and behaviour towards products and services in order to reduce the demand. The same tools of marketing - Product, Price, Place / Physical Distribution and Promotion are used to establish Demarketing also. Electric Utilities encourage Demarketing so that they can delay or avoid huge investments in electricity generation projects. Kotler and Levy (1971) define demarketing as “that aspect of marketing that deals with discouraging customers in general or a certain class of customers in particular on either a temporary or permanent basis. Authors describe three different types of demarketing:

1. General demarketing: This is required when a company wants to shrink the level of total demand. Suppliers of electricity and water use advertisements and publicity campaigns during the period of excess demand.
2. Selective demarketing, which is required when a company wants to discourage the demand coming from certain customer classes.
3. Ostensible demarketing, which involves the appearance of trying to discourage demand as a device for actually increasing it.”

Thus the general demarketing is used by the electricity distributors during the period of excess demand.

Kotler (1973) also elaborated that in the context of marketing, there is “adequate demand, under-demand and over-demand” and different situations require different marketing approaches. Obviously, when there is over-demand in the market, the marketing approach is to reduce demand by “demarketing.” Demarketing means un-selling or marketing in reverse without impugning the product, “Countermarketing” on the other hand destroys the demand for a product. Kotler explains the meaning of the term “unsell” as an effort to sell something else.” In a democracy, unselling/demarketing is socially justifiable as selling.” Lefebvre and Kotler (2011) also underline that Demarketing is a blending of all the 4 ‘P’s of the marketing mix.

4.2.6 Marketing Mix

It was N.H.Borden, who coined the term marketing mix. Marketing mix is an important tool used to design the marketing process. It is a combination of all the marketing resources and marketing efforts used to influence the target market. In the words of Borden, (1964). "Marketing Mix is the combination of fair inputs which constitute the core of a company's marketing system." Marketing process is a combination of both controllable and uncontrollable variables. The Controllable variables means internal forces. They are within the control of the organisation. These internal factors are grouped into four variables 4 'P's of marketing mix. This classification was given by Edmund Jerome McCarthy.

McCarthy (1960) defined the 4 'P's conceptual framework for marketing decision-making which used Product, Price, Place (or distribution) and Promotion in the marketing mix as given in the following figure 4.7

Figure 4.7

McCarthy's 4Ps Conceptual Framework

Source: McCarthy's Marketing Mix

The four controllable variables in the marketing mix is given in the above figure. McCarthy's marketing mix involves four controllable variables that an organisation manages, in order to satisfy its objectives and the needs of the target market. The 4Ps of marketing mix and its components are represented in the following table:

Table 4.3

4 Ps of Marketing Mix

4 Ps	Meaning	Components
Product	Product means anything that a purchaser gets in exchange of money and that possess utility or that can satisfy consumer wants and needs.Product may be tangible(goods) or intangible(services)	a) Product planning and development b) Product mix c) Branding d) Packaging and labelling e) Guarantees and warranties
Price	Price refers to the exchange value of products and services in terms of money.	a) Pricing policy b) Credit policy c) Discount
Place	Place refers to all the activities involved in the movement of products from producers to consumers.	a) Physical Distribution-Transport, warehousing and logistics b) Channels of distribution
Promotion	Promotion means communication between the buyer and the seller. It further involves: A) Advertising – any paid form of non personal presentation by an identified sponsor B) Public relations- All non sales communication with the audience, it is an extended form of publicity. C) Sales promotion means all the promotion activities other than advertising, public relations and personal selling D) Personal selling means face to face communication with the prospective buyer for making sales.	a) Message and frequency

Source: McCarthy's Marketing Mix

The four controllable variables are Product, Price, Place and Promotion. The various techniques used for each element are also demonstrated in the above table.

4.2.7 4Ps in Demarketing

Ulchi (2015) presents the Marketing Mix, "(4P) in De-Marketing as follows: (For FMCG, Tobacco, alchohol consumption etc).

Product: Restrict availability of the product

Price: Increase pricing

Place: Decrease Consumption Space

Promotion: Decrease marketing space and mandatory warning"

The 4Ps in demarketing mix is given in the following figure:

Figure 4.8

Marketing Mix - 4Ps in Demarketing

Source: Ulchi Venkata Sumalatha (2015)

The 4Ps used in marketing is applied in Demarketing also. The components or techniques used for each element of the mix are given in the above figure.

4.2.8 Counter Marketing, Social Marketing and Demarketing

In some studies counter marketing, social marketing and demarketing are used interchangeably. But they are different terms. Counter marketing is a strategy used to destroy demand. Social marketing is used to increase the acceptability of a social idea. Whereas demarketing is used in the situations of over-full demand of a product.

A case of Social marketing - Use of 4Ps in the case of cigarette smoking.

Product

a) Producers are asked to make cigarettes with filter fitters
b) Cigarette may be produced with less harmful ingredients
c) The attention of smokers can be diverted to alternatives

Promotion

a) To make smoker health conscious
b) To make smokers aware of the fatal consequences
c) Mandatory warnings on the packets

Place/ Physical Distribution

a) Availability is reduced
b) Induce the sellers not to sell cigarettes in residential areas near schools and educational institutions
c) Charge extra price for retail sellers for selling cigarettes

Price

a) Increase the price of the products
b) Non cash incentives for non smoking

4.2.9 Consumer Behaviour

Consumer behaviour is the process by which consumers determine what to purchase, when to purchase, from where and from whom to purchase and how to purchase it. Consumer behaviour is a very important concept in marketing because it helps to study the attitudes, preferences, motives and purchase decision of the consumers.

Consumer purchase decision involves the following steps:

1. Recognition of a need

2. Identification of alternative

3. Evaluation of the alternatives

4. Purchase decision or selecting the best alternative and

5. Post purchase behaviour due to the satisfaction/dissatisfaction arising from the purchase decision.

4.3 Demarketing Strategies Implemented by the Kerala State Electricity Board Ltd. for the Promotion of Demand Side Management

Demarketing is a significant strategy adopted in the circumstances of over demand. It is the reverse of marketing and is used in the Electricity Sector of Kerala as a tool for managing the demand for electricity.

The following table makes a review of the demarketing strategies implemented for the domestic consumers of KSEB Ltd.

Table 4.4

Demarketing Mix in the Electricity Sector of Kerala

4 P's	**Strategies Used**	**Tactics and Innovative Programmes Implemented**
Product	CFL / LED distribution BEE Star Rated Equipment Retrofitting Energy efficient Equipment Alternative Sources of Energy	a) Bachat Lamp Yojana, Domestic Efficient Lighting Programme, LabhaPrabha b) Energy Labelling c) Super Efficient Equipment Programme d) Solar, Bio mass, etc. are the commonly used alternative sources in households
Price	Increase in Tariff Rates	a) Tariff Hike b) Telescopic billing c) Time Of Use billing d) Subsidies and financial incentives
Physical Distribution	Load Shedding	a) Load Management b) Load Shifting c) Smart Metering d) Smart Grids e) Demand Response

Promotion	Sponsored Programmes/ Advertisements in Various Media	a) TV b) Radio c) Printed Media d) Online e) Cinema theatres f) Other media
	Energy Education Programmes	a) Energy Conservation Classes, Talkshows, Skit, Seminars, Video Clippings, Power Quiz, Essay Writing Competition, Poster Making, Smart Energy Programme for students , ‘Nalekkithiri Urjam’, Serve As a Volunteer of Energy (SAVE) Programmes etc. are carried out through schools, colleges and other educational institutions and agencies.
	Public Awareness Campaigns	a) Rally, Camps, Exhibition, Energy Management clinics for housewives, etc. for creating awareness. b) Distribution of materials like Brochures, Leaflets, Posters, Name slips, Printed Hats, shirts etc. as reminders.
	Statutory Measures	a) Anti Power Theft Squad b) Energy Standards c) Energy Audit

Source: Compiled by the Researcher

The elements of demarketing mix used in the Electricity Sector of Kerala, namely, Product, Price, Physical Distribution and Promotion are explained below:

4.3.1 Product

Promotion of alternatives to electricity like solar energy, biogas etc. and energy efficient appliances is vital for energy saving.

4.3.1.1 Compact Flourescent Lamps /Light Emitting Diode Lamps Distribution

KSEB distributed 12.7 million CFL lamps in association with EMC as part of Bachat Lamp Yojana (BLY). Two CFL lamps of 14 watts were given in exchange of two incandescent bulbs of 60 watts to the domestic consumers. Bachat Lamp Yojana (BLY) was initiated by the Bureau of Energy Efficiency (BEE) under the Ministry of Power of Indian Government. This scheme is a part of the Clean Development Mechanism (CDM of the Kyoto Protocol). The scheme was based on a partnership between Electricity Distribution Companies, Government of India and Private CFL Manufactures (Philips). Bachat Lamp Yojana Project aimed at 80% energy savings (500-750 MW) by distributing 13 million CFLs. The scheme covered all the 23 Electrical divisions of KSEB and energy savings of 300MW was achieved.

Labhaprabha scheme was launched by KSEB as part of the Demand Side Management initiatives targeting domestic consumers. Season-1 of Labhaprabha offered financial incentives and a variety of other prizes like CFLs, LED bulbs, water heaters, solar lamps, etc. Season - 2 of Labhaprabha-2014 of KSEB targeted the domestic consumers especially the school students to spread the message of energy conservation. Under, Labhaprabha Season - 3 (2016) two 9 watt LED bulbs were given to around six lakh domestic sector consumers whose average consumption is less than 40 units a month. Two LED bulbs were also given to the rest of the domestic consumers at a concessional rate of ₹ 95 each.

As part of DELP programme, two LED bulbs (9 watts each) were distributed to 75 lakhs consumers of KSEB Ltd. at ₹ 95 to ₹ 105 against a market price of ₹ 350 to ₹450 in association with Energy Efficient Services Limited (EESL) with three years replacement warranty. The bulbs were given at ₹10/- and the balance was paid by DISCOM from energy savings.

4.3.1.2 Bureau of Energy Efficiency Star Rating

Energy Labelling means the display of energy ratings as recommended by Bureau of Energy Efficiency (BEE). It is mandatory in the case of refridgerators, air conditioners, fluorescent lamps and distribution transformers. Star labelling implies "More Stars, More Energy". Energy Label provides the details of energy consumption of the appliance and the projection of annual energy requirements in units.

4.3.1.3 Alternative Sources

Alternative sources of electricity commonly used in households in Kerala are solar and biogas energy. Distribution of solar equipment is carried out by KSEB as part of DSM.

4.3.1.4 Retrofitting

Retrofitting in households refers to replacing the existing inefficient appliances with energy efficient appliances or components. As part of Super Efficient Equipment Programme (SEEP), super efficient fans that consume less electricity is to be retrofitted shortly by KSEB Ltd.

4.3.2 Pricing Policy of KSEB Ltd.

Differential pricing policy is followed by KSEB Ltd. for different categories of consumers, varying levels of consumption and time slots of usage of electricity.

4.3.2.1 Increase in Tariff Rates

Electricity prices of domestic consumers are revised from time to time. Billing System of KSEB Ltd. for Domestic category of consumers (LT1A) w.e.f 18.04.2017 to 31.3.2018 is as follows:

In KSEB Ltd. slab system is followed for preparing bills of the consumers. Energy charge is determined according to slabs (Units consumed). Rate goes up along with progression in slabs. This system is known as telescopic billing. The telescopic billing system is applicable for energy consumption upto 500 units only. For 500 units and above, Non telescopic billing method is used.

Table 4.5

Bi- monthly Electricity Charges

	Units	**Rate per Unit**
Telescopic Billing	0-80 (BPL ctegory ,*CL<1000)	1.50 (No fixed charge)
	0-100	2.90
	101-200	3.40
	201-300	4.50
	301-400	6.10
	401-500	7.30
Non Telescopic Billing (Flat rate for all the units)	501-600	5.50
	601-700	6.20
	701-800	6.50
	801-1000	6.70
	Above 1000	7.50

Source: Ready Reckoner, KSEB Ltd. CL < 1000 : Connected Load less than 1000

This method of differentiated pricing encourages the domestic consumers to bring down their energy consumption to the lower slabs. For the units above 500, flat rate is applicable. The following table 4.6, represents the minimum charge and duty.

Table 4.6

Minimum Charge and Electricity Duty (Bi-monthly) In ₹

Fixed Charge(Minimum Charge)	
Single phase	60
Three phase	160
Electricity Duty(10% on Fixed charge)	
Single phase	6
Three phase	16
Meter Rent	
Single phase	12
Three phase	30
Three phase CT (Current Transformer)	60

Source: Ready Reckoner, KSEB Ltd.

On the basis of details given in the above tables, bill amount is calculated as follows:

Bill amount = Energy Charge + Fixed Charge - Subsidy if any + Duty + Meter rent,Details of Subsidy for the domestic consumers is given in the following table.

Table 4.7

Subsidy for Domestic Consumers

Subsidy for Domestic Consumers	
Energy charges	
Monthly consumption upto 40 units	35 paise per unit
Monthly consumption 41-120 units	50 paise per unit
Fixed Charge	
BPL category (CL<1000 watts) Bi-monthly consumption 0-80 units	No fixed charge
Single Phase consumers, monthly consumption less than 120 units	₹ 20 given as subsidy in fixed charge per consumer per month.
Single Phase consumers, bi-monthly consumption less than 40 units, connected load less than 500watts	Exempted from payment of electricity charges

Source: Ready Reckoner, KSEB Ltd.

The above table shows the details of Subsidy given to consumers whose bi-monthly consumption does not exceed 240 units. This subsidy includes Fixed charge ₹40 also.

4.3.2.2 Time of the Day (TOD) Billing Scheme for Domestic Consumers

Domestic consumers with three phase connection and who consumes more than 1000 units is Charged ₹7.50 per unit and TOD tariff structure as given below is applicable.

Table 4.8

Time of the Day (TOD) Tariff

Monthly consumption	**Normal Period (6 hours -18 hours)**	**Peak Period (18 hours to 22 hours)**	**Off-peak Period (22 hours to 06 hours)**
Above 500 units	100% of the ruling tariff	120 % of the ruling tariff	90 % of the ruling tariff

Source: Ready Reckoner, KSEB Ltd.

KSEB Ltd. follows differential pricing method. The following table shows the bi-monthly bill amount calculation for the domestic consumers.

Table 4.9

Bi-monthly Electricity Bill Amount Calculation

Bill Amount Calculation (Bi-monthly)		
Units Consumed		190 Units
Bill amount = Energy Charge + Fixed Charge - Subsidy if any + Duty + Meter rent+ GST		
Energy Charge for 190 Units	= (100 Units *2.90) + (90 Units *3.40)	596.00
Fixed Charge (Minimum Charge)	60.00 for Single Phase	60.00
Subsidy (0.35 for 40 Units and 0.50 on 150 Units) and 40.00 on Fixed charge	=(40*0.35)+(150*0.5)+40	129.00
Duty is 10% of (Energy Charge- Subsidy) + 10% on FC	= (596-89) *10% + 6	56.70
Meter Rent	12.00 for Single Phase	12.00
GST =CGST (9% on Meter Rent)+ SGST(9% on Meter Rent)	1.08+1.08	2.16
Surcharge		1.00
Payable Amount		**598.86**

Source: Compiled by the Researcher

The above table presents the calculation of Bi-monthly Electricity Bill for a domestic consumer if the units of electricity consumed is 190 Units

4.3.3 Place/ Physical Distribution

In the case of domestic sector, existing technolgical deployment is insufficient as compared to industrial and commercial sector, more over it is not financially viable in the domestic sector.

4.3.3.1 Demand Response (DR)

Demand response means altering the electricity consumption pattern by adjusting the time of use or total electricity consumption. DR programmes may be incentive based program and price based programme. In the case of incentive based programmes, customers give the control over their electrical equipment to the DR provider and get rewards as incentives. Direct Load Control (DLC) is applied by the Utility to different appliances at the customer's premises. The second method namely, price based programme includes time of use pricing, critical peak pricing, and real time pricing.

4.3.3.2 Load Management

Load Management refers to load shifting and load shedding. Load shifting helps to shift the electricity use from peak hours to off-peak hours.This helps to provide electricity at base load cost and also to avoid additional cost of generation capacity building. Load shedding is also imposed as part of load management. It can be in the form of power cuts or voltage reduction.

4.3.3.3 Smart Metering and Smart Grids

Advanced Metering Infrastructure (AMI) helps both the utilities and consumers to avail the data about electricity usage and pricing. KSEB Ltd. introduced the Smart Metering Programme for the Low Tension Industrial connections also. By providing real time feedback of their electricity usage, the consumers themselves can adjust their energy usage. Smart Grids help to strengthen the electricity transmission and distribution system.

4.3.4 Promotion

Promotion measures involves all the programmes adopted for promoting Demand Side Management in the Electricity Sector of Kerala, viz. Sponsored programmes / Advertisements, Public Awareness Campaigns and Energy Education Programmes

4.3.4.1 Energy Education Programmes

Energy Education Programmes refer to the programmes for enhancing the knowledge regarding energy management through energy conservation classes, talkshows, skits, seminars, video clippings, power quiz, essay writing competition, poster making, smart energy programme for students , 'Nalekkithiri Urjam', Serve As a Volunteer of Energy (SAVE) programmes etc. organised in schools, colleges and other educational institutions and agencies. SAVE is an awareness programme conducted by Malayala Manorama Newspaper and KSEB Ltd. which motivate school children by giving them prizes for energy savings in their households.

These programmes can bring behavioural changes in the minds of people especially the students, who have great influence on their family.

4.3.4.2 Public Awareness Campaigns

Programmes like rally, camps, exhibition, energy management clinics for housewives, etc. and distribution of materials like brochures, leaflets, posters, name slips, printed hats, shirts etc. as reminders are carried out for creating awareness in an informal way.

4.3.4.3. Sponsored Programmes / Advertisements

Sponsored programmes and advertisements in various media like TV, radio, printed media, online media etc are used as part of DSM. Advertisements led by Malayalam actors like Dileep, Mohanlal, Jayasurya, Suresh Gopi, et al., were given in visual media to promote energy conservation.

4.3.4.4 Demand Side Management (DSM) Cell

Demand Side Management (DSM) Cell in KSEB started functioning in July 2002. The cell was constituted according to the directions of the Ministry of Power under the Central Govt. The cell was constituted for conducting awareness programmes on a large scale for Demand Side Management with the support of Government and Non Govt organisations**.**

KSEB formed the Energy Savings Co-ordination (ESCO) team in 2014. Its aim is to conduct energy audits and to co-ordinate energy conservation programmes.

The public relations wing of KSEB Ltd. is responsible for the Demand Side Management Campaigns through traditional and new media. The department has an internet based channel namely www.ksebmedia.in. [https://www.facebookcom/ksebl] is the Facebook page managed by Public Relations Department having around 1.16 lakh subscribers. It also uses Twitter (https://twitter.com/KSEBLtd) for DSM activities. In addition to these non-conventional methods, KSEB Ltd. presents a television programme (Spandanam) in Doordarshan. The 'Labhaprabha' campaigns and the Electrical Safety Campaigns are also carried out by the Public Relations Wing. This department also publishes booklets and other text materials as part of these campaigns. Other Public Relation tools used include campaigns through Mobile Apps, Websites of KSEB, Radio jingles etc.

4.3.4.5 Statutory Measures

Statutory Measures means rules and legal framework applicable for energy management in the Electricity Sector of Kerala.

- **Anti Power Theft Squad (APTS)**

Anti Power Theft Squad is functioning under the vigilance wing of KSEB to check power theft.

- **Energy Audits and Energy Standards**

Energy standards mean protocols for the energy performance of an appliance. Energy Audit is a tool used for measuring energy efficiency. Energy Audit is a comprehensive approach in Demand management for monitoring and targeting energy flows and ensuring energy standards.

4.3.4.6 Legal Framework

In this part of the chapter the Acts and regulations governing DSM in Kerala is discussed in detail.

a. Energy Conservation Act 2001

Energy Conservation Act, 2001 was enacted for improving Energy Efficiency and thereby reducing the gap between demand and supply. The act provides for

1. Notifying energy intensive industries as designated consumers who have to follow the energy consumption standards
2. Implementing the Standards and Labelling programme
3. Certification of energy managers and accrediting energy audit firms.
4. Providing policies for Energy Conservation Building Codes (ECBC)
5. Beureau of Energy Efficiency (BEE) for coordinating energy efficiency services and
6. Central Energy Conservation Fund for encouraging Research and Development in this area.

b. National Mission for Enhanced Energy Efficiency (NMEEE)

NMEEE was introduced in June 2008 as one among the eight missions of National Action Plan on Climate Change (NAPCC) for the promotion of energy efficiency industry in India with BEE as the designated agency.

c. Electricity Act, 2003

Electricity Act, 2003 consolidates all the existing laws related to generation, transmission and distribution of electricity. It replaced three Acts namely 'The Electricity Act 1910', The Electricity Supply Act, 1948 and Electricity Regulatory Commissions Act, 1998. The Act aims at the development of the Power Sector in India.

d. National Electricity Policy (NEP) of 2005

This policy provides various programmes to carry out the Electricity Act 2003. The section 5.9 of the National Electricity Policy (NEP) deals with energy conservation, energy efficiency and demand side management. NEP points out that there is considerable energy saving potential in India.

e. Integrated Energy Policy (IEP), 2008

The IEP is a comprehensive energy policy for encouraging Energy Efficiency (EE) and DSM and identifies the energy saving potential of Demand Side Management measures and major barriers and makes recommendations to overcome these barriers.

f. DSM Regulations in Kerala

As per the regulations of the Kerala State Electricity Regulatory Commission (2011), "Demand Side Management" means the actions of a Distribution Licensee, beyond the customer's meter, with the objective of altering the end-use of electricity - whether it is to increase demand, decrease it, shift it between high and low peak periods, or manage it when there are intermittent load demands- in the overall interests of reducing Distribution Licensee costs".

The functions of utilities as per the regulations include the following;

a) DSM Cell Formation
b) Market research to collect the data of the consumers and end usage pattern
c) Carrying out DSM programmes
d) Cost Benefit Analysis

e) Monitoring and Reporting and
f) Evaluation of energy savings

Energy conservation activities in Kerala are carried out by the KSEB Ltd. in association with the Agency for Non-conventional Energy and Rural Technology (ANERT) and the Energy Management Centre (EMC).

4.3.4.7 Agency for Non-Conventional Energy and Rural Technology (ANERT)

ANERT was established in 1986, with headquarters at Thiruvananthapuram. It is functioning under the Department of Power, Government of Kerala. The functions of

ANERT are;

-to update technology

-to gather information

-to conduct studies and research

-to implement programmes and projects and

-to carry out centrally assisted schemes in Kerala

in the area of energy conservation, renewable and non-conventional sources of energy and rural technology.

Role of ANERT

1. The ultimate aim of ANERT is to design an optimum renewable energy mix. For this, it is engaged in the assessment of potential for non renewable sources of energy in Kerala.
2. Promotion of small hydro programme.
3. Biomass gasification and electricity generation; This helps in the disposal of waste, cleaning the environment, sanitation and employment opportunity creation.
4. Wind energy programme.

5. Solar energy promotion programme; ANERT is engaged in the distribution of solar street lighting system, solar water pumping system, solar lanterns, solar home lighting system etc.
6. Provides abundant database of technical articles and website for Information dissemination on non-renewable sources of energy.
7. ANERT also undertakes Energy Audit for assessing the energy saving potential of renewable energy Sources.
8. Compact Fluorescent Lamps (CFL) are promoted in the place of ordinary incandescent bulbs. The use of electronic ballasts in tube lights are also promoted.
9. Public awareness campaigns are also conducted by ANERT. Workshops and Seminars are also conducted. Periodicals, journals and other articles are published for disseminating information regarding energy conservation and energy efficiency.
10. ANERT has bagged various national and international awards in the area of energy conservation.

4.3.4.8 Energy Management Centre

Energy Management Centre was established in 1996 under the Department of Power, Kerala as an autonomous organisation at Thiruvananthapuram for the promotion of energy management. It is also the State Designated Agency (SDA) for enforcing Energy Conservation Act, 2001.

The functions of EMC are as follows, in the area of energy Management.

1. Promoting research and development

2. Providing professional consultancy

3. Targeting women and youth

4. Enhancing energy efficiency

5. Collaborating with various national and international agencies, organisations and institutions for the transfer of energy technology

6. Enhancing the competencies of energy professionals and

7. Performing all other functions as desired by Government

Role of Energy Management Centre

1. Energy Clinic programmes are conducted for promoting energy efficiency. EMC gives training to women volunteers, who further give training to rural housewives.
2. Essay writing competition, Quiz contests etc. are conducted jointly by EMC and Malayala Manorama as part of 'SAVE energy Programme' which resulted in energy savings of 217 million units.
3. Brochures and other text materials were circulated through public libraries for promoting energy conservation.
4. CFL lamps are given to Panchayat libraries.
5. EMC bagged National awards for Demand Side Management Programmes.
6. 100 LED street lights (45 Watts) was installed in 60 Municipalities and 5 Corporations in Kerala.
7. EMC implemented smart energy programmes in schools in association with the Department of General Education, Kerala.
8. EMC got recognition for organizing various energy education programmes in India and abroad from various International Organizations like the Common Wealth, UNIDO, UN-ESCAP, US-AID, World Bank etc.
9. EMC introduced interactive touch screen energy information kiosks for school children to demonstrate energy saving methods.
10. EMC provides Kerala State Energy Conservation Award on behalf of Kerala Government for the achievements in energy conservation.
11. Energy Audit was conducted in 28 Govt. Offices and Small and Medium Enterprises for evaluating the energy saving potential.
12. Ayakkurissi in Palakkad which is the First LED village in South India, was a project carried out by EMC in association with BEE.
13. Promotes Small Hydropower in Kerala.
14. WISER (Women's Institute for Sustainable Energy Research) is a EMC/USAID/SARI/E collaborative project for promoting women participation in energy conservation. USAID is the United States Agency for International

Development and SARI/E is a network of South Asian women energy professionals.

In addition to this, policy recommendations of Central Electricity Authority (CEA), Ministry of Power, Power producers like National Thermal Power Corporation (NTPC), energy conservation awareness programme for general public through co-operative efforts of Kerala Ghandhi Smaraka Nidhi, Public libraries, All India Women's Conference, Energy Conservation Society, NGOs, Wiremen, supervisors and contractors etc, Support of Energy Service Companies like EESL under Ministry of Power, Govt. of India etc. are utilised for implementing DSM. With the aim of flattening the load curve, various Governmental and Non Governmental organisations (NGOs) are conducting energy education programmes. Every year December 14th is celebrated as Energy Conservation Day with wide publicity.

4.3.4.9 Kerala State Energy Conservation Fund

KSECF was formed as per the Energy Conservation Act (2001) for implementing energy efficiency projects through equity financing, debt financing, grants etc. for all industrial, domestic, commercial, street lighting, and agriculture sectors.

4.3.4.10 Energy Efficient Appliance Financing (EEAF)

Kerala State Energy Conservation Fund (KSECF) provides zero interest loans for the purchase of energy efficient refrigerators and air conditioners through a local financial institution. KSECF also facilitates co-operative programmes with manufacturers of energy efficient appliances for providing rebates to the domestic consumers of Kerala for the purchase of such appliances.

4.3.5 Recent Innovations by KSEB Ltd.

- **Pre-paid Coupons**

The Kerala State Electricity Board Ltd. is planning for pre-paid coupons of different rates (ranging from ₹200 to ₹5000) for consumers who use more than 100 kWh per month. Hence there will be no disconnections or electricity cutting for unpaid bills. This helps to reduce the dissatisfactions of consumers and to improve the public image of KSEB Ltd.

- **Smart Meters**

The smart meters functions using an electronic circuit. The consumers can insert a recharged card with chip in the smart meter which is linked to the data centre. This will enable electrical section offices to avoid manual meter reading and to read the real time consumption and carry out online billing with precision. This will also help to prevent power theft and meter tampering.

4.4 Effect of Demarketing Strategies on the Domestic Consumer Behaviour towards Electricity

Before analysing the effect of demarketing strategies, the exposure of the domestic consumers towards the demarketing strategies is examined.

4.4.1 Exposure towards Demarketing Strategies

Exposure refers to “an opportunity to experience or learn something. In this study the term is used to represent public participation/attention towards demarketing strategies”, Bradley (2007).

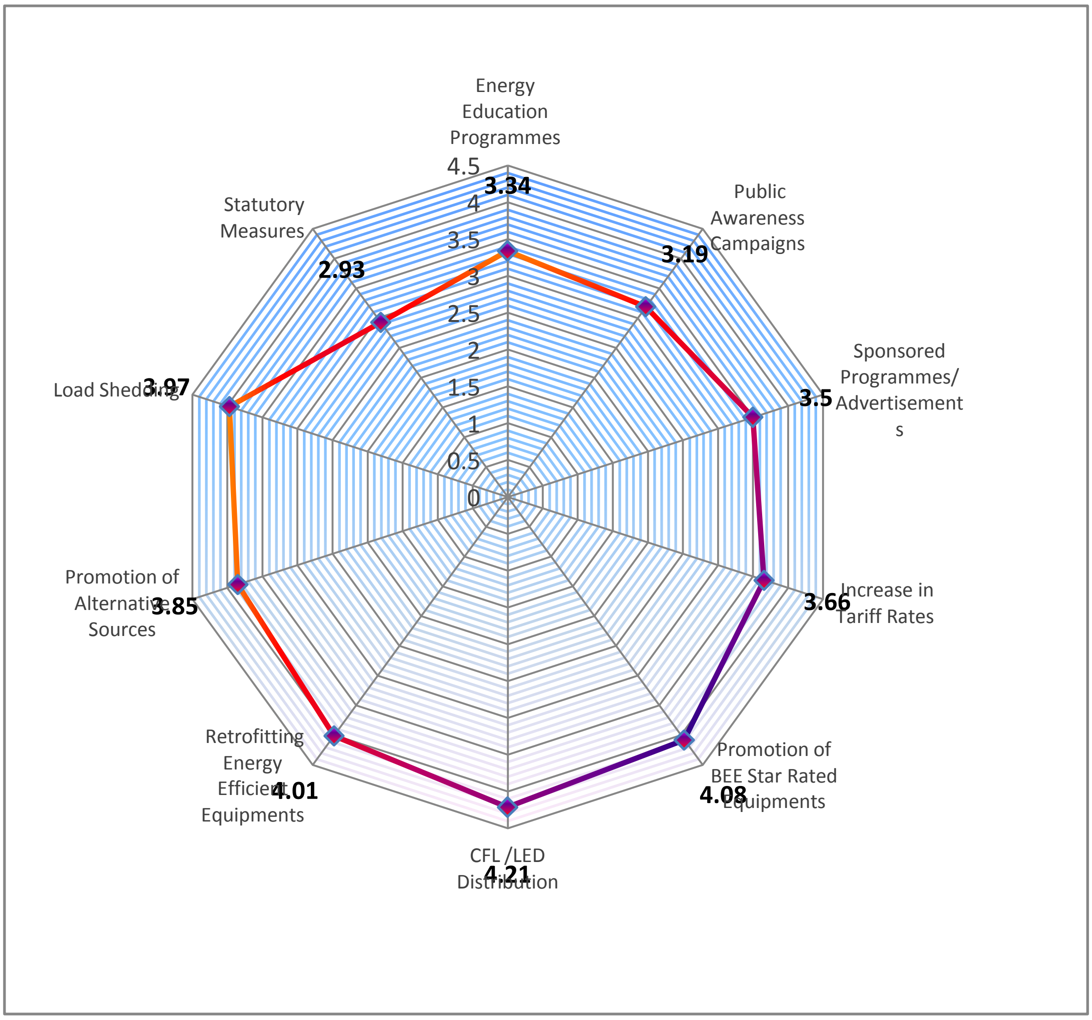
Exposure in communication refers to “the frequency or extent to which the audience have received the specific message” (Slater, 2004) and "the degree or level to which the audience can recall or recognize the message " (Valente, 2001).

KSEB Ltd. is conducting various programmes for promoting DSM. These programmes are collectively known as demarketing strategies. In this study Demarketing strategy is measured quantitatively in terms of exposure of domestic consumers towards it. The exposure towards these programmes is expressed in terms of the number of programmes participated in, media exposure, understanding, familiarity and experience of the domestic consumers. The effect of exposure is that consumers tend to prefer something when they are familiar about it according to Mere Exposure / Familiarity principle by Zajonc (2001). For instance, a domestic consumer may give preference to star rated equipment while purchasing home appliances, if he is familiar about the concept of 'Star Rating'.

The exposure of the domestic consumers towards various demarketing strategies of Kerala State Electricity Board Limited is shown in the following radar graph 4.9 :

Figure: 4.9

Radar Graph on Domestic Consumers' Exposure towards Various Demarketing Strategies of Kerala State Electricity Board Limited-



Source: Primary Data

The above figure shows that the mean score on exposure towards CFL/LED distribution is 4.21, towards promotion of BEE Star Rated Equipment is 4.08 and retrofitting Energy Efficient Equipment is 4.01. The mean score on exposure towards

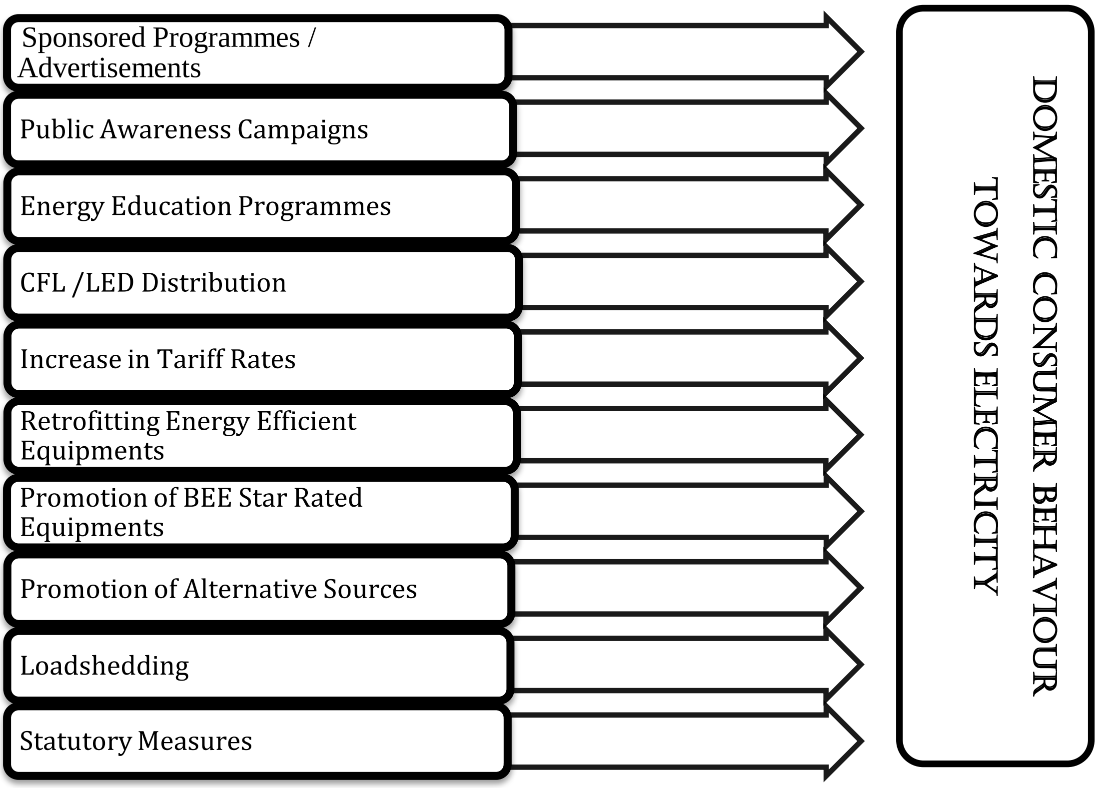
Statutory Measures is only 2.93. Hence it can be concluded that domestic consumers of KSEB have high exposure towards CFL/LED distribution, promotion of BEE Star Rated Equipment and Retrofitting Energy Efficient Equipment but have less exposure towards Statutory Measures.The domestic consumers have received exposure and are highly aware about various demarketing strategies of KSEB Ltd. except regarding statutory measures.

4.4.2 Demand Side Management from the Perspective of Kerala State Electricity Board Limited

KSEB tries to create behavioural modification using demarketing strategies. This will bring down the demand for electricity as shown below:

Figure 4.10

Demand Side Management from the Perspective of Kerala State Electricity Board Limited - Multiple Regression Model



Demand Side Management can be viewed from the perspective of KSEB Ltd. and from the perspective of the domestic consumers. DSM is the modification of consumer behaviour by the utility through financial incentives and through consumer education.

Demarketing Strategies → **Behavioural Modification**

The effect of the Demarketing Strategies of KSEB Ltd. on the domestic consumer behavior towards Electricity is analysed using Multiple Regression Analysis for hypothesis testing.

4.4.3 Effect of Demarketing Strategies of KSEB Ltd. on the Domestic Consumer Behaviour towards Electricity – Multiple Regression Analysis

Multiple regression coefficient measures the relationships between variables in such a way that it identifies the effect of independent variables on the dependent variable.

H_0.1: Demarketing strategies of KSEB Ltd. have no significant effect on the domestic consumer behaviour towards electricity.

Here the Multiple Regression analysis for domestic consumer behaviour towards electricity consumption (Y) was performed with 10 independent variables of demarketing strategies of KSEB Ltd. like Energy Education Programmes, Public Awareness Campaigns, Sponsored Programmes and Advertisements, CFL/LED distribution, Retrofitting Energy Efficient Equipment, Increase in Tariff Rates, Promotion of BEE Star Rated Equipment, Promotion of Alternative Sources, Load Shedding and Statutory Measures.

Dependent Variable (Y) = 'Domestic Consumer behaviour towards Electricity' which refers to the electricity usage pattern of the domestic consumers of KSEB Ltd.

$\mathbf{Y = a_0+b_1X_1+ b_2X_2+ b_3X_3+b_4X_4............ +b_{10}X_{10}}$ **,** Where b is the unstandardized beta coefficients of each variable and a_0 is a constant value. Inter correlation between the variables of demarketing strategies of KSEB revealed that all the predictor variables were entered simultaneously for regression equation because no multicolinearity exists among the selected 10 predictor variables.

Table: 4.10

Multiple Regression Analysis - Model Summary

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.92	.84	.702	.214
Predictors: (Constant), Energy Education Programmes, Public Awareness Campaigns, Sponsored Programmes and Advertisements, CFL/LED distribution, Retrofitting Energy Efficient Equipment, Increase in Tariff Rates, Promotion of BEE Star Rated Equipment, Promotion of Alternative Sources, Load Shedding and Statutory Measures.				
Dependent Variable: Domestic Consumer Behaviour towards Electricity				

Source: Primary Data

The model summary table shows the overall predictability of the regression model. Multiple Coefficient of Correlation is the Multiple R=.92. R^2 is the Squared Multiple Coefficient of Correlation or coefficient of determination of value 0.84 which states that all the 10 independent variables of demarketing strategies of KSEB contribute to 84 percent of variance on the dependent variable called electricity consumption. It is the proportion of variance in the dependent variable that is predictable from the predictors.

Table: 4.11

ANOVA

Model		**Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
1	Regression	193.397	10	19.339	420.413	.000**
	Residual	35.575	772	0.046		
	Total	228.973	782			
Predictors: (Constant), Energy Education Programmes, Public Awareness Campaigns, Sponsored Programmes and Advertisements, CFL/LED distribution, Retrofitting Energy Efficient Equipment, Increase in Tariff Rates, Promotion of BEE Star Rated Equipment, Promotion of Alternative Sources, Load Shedding, Statutory Measures.						
Dependent Variable: Domestic Consumer Behaviour towards Electricity						

ANOVA results reveal p-value as 0.000 (F value = 420.413) which is less than 0.01 and it indicates that regression model is statistically good fit at 1% level of significance.

It shows that, a significant relationship exist between the variables tested in the hypothesis. Thus it has been identified that the factors of demarketing strategies of KSEB are closely associated and have an effect on the domestic consumer behaviour towards electricity.

Table: 4.12

Coefficients of Multiple Regression Analysis

Model	Variables	UC		SC	t	Sig.
		B	SE	Beta		
1	(Constant)	1.326	0.252		5.26	0.000**
	Energy Education Programmes	0.616	0.086	0.605	7.163	0.000**
	Public Awareness Campaigns	0.655	0.089	0.642	7.360	0.000**
	Sponsored Programmes and Advertisements	0.766	0.049	0.716	15.633	0.000**
	Retrofitting Energy Efficient Equipment	0.833	0.074	0.762	11.257	0.000**
	Increase in Tariff Rates	0.713	0.051	0.689	13.980	0.000**
	Promotion of BEE Star Rated Equipment	0.863	0.084	0.838	10.274	0.000**
	Load shedding	0.784	0.059	0.724	13.288	0.000**
	Promotion of Alternative Sources	0.792	0.076	0.732	10.421	0.000**
	CFL/LED Distribution	0.841	0.051	0.848	16.490	0.000**
	Statutory Measures	0.277	0.038	0.261	7.289	0.000**

Source: Primary Data

a) The positive values of coefficients reveals that the effect of demarketing strategies on the domestic consumer behaviour is positive.

b) The CFL/LED distribution is the dominant demarketing strategy as it has the highest standardized coefficient value (Ranking is usually made on the basis of standardized coefficient value).

c) The effect on the domestic consumer behaviour (dependent variable) would increase by 0.616 for every unit increase in the exposure towards Energy Education Programmes (independent variable).

d) The effect on the domestic consumer behaviour (dependent variable) would increase by 0.655 for every unit increase in the exposure towards Public Awareness Campaigns (independent variable).

e) The effect on domestic consumer behaviour (dependent variable) would increase by 0.766 for every unit increase in the exposure towards Sponsored Programmes/Advertisements (independent variable).

f) The effect on domestic consumer behaviour (dependent variable) would increase by 0.833 for every unit increase in the exposure towards Retrofitting Programmes (independent variable).

g) The effect on domestic consumer behaviour (dependent variable) would increase by 0.713 for every unit increase in the exposure towards Tariff rates (independent variable).

h) The effect on domestic consumer behaviour (dependent variable) would increase by 0.863 for every unit increase in the exposure towards Promotion of BEE Star Rated Equipment (independent variable).

i) The effect on domestic consumer behaviour (dependent variable) would increase by 0.784 for every unit increase in the exposure towards Power Cuts / Load Shedding (independent variable).

j) The effect on domestic consumer behaviour (dependent variable) would increase by 0.792 for every unit increase in the exposure towards Promotion of Alternative Sources (independent variable).

k) The effect on domestic consumer behaviour (dependent variable) would increase by 0.841 for every unit increase in the exposure towards CFL/LED distribution programmes (independent variable).

l) The effect on domestic consumer behaviour (dependent variable) would increase by 0.277 for every unit increase in the exposure towards Statutory Measures (independent variable).

It is identified from the above table that the Energy Education Programmes, Public Awareness Campaigns, Sponsored Programmes and Advertisements, CFL/LED distribution, Retrofitting Energy Efficient Equipment, Increase in Tariff Rates, Promotion of BEE Star Rated Equipment, promotion of Alternative Sources, Load Shedding and Statutory Measures have significant positive effect on domestic consumer behaviour towards electricity, since all the p - values of predictor variables are less than 0.01 (Significant at 1% level) , the null hypothesis is rejected. This effect proves that the consumer is aware of the demarketing strategies promoted by the KSEB and it has an influence on the domestic consumer regarding the cautious usage of electricity.

4.5 **Conclusion**

A demarketing strategy can be considered successful only if it can influence the consumer behaviour. Demarketing strategy is measured quantitatively in terms of exposure (participation, knowledge, experience, media exposure, etc.) of the domestic consumers towards it. The programmes have influenced and modified the consumer behaviour towards electricity. This modification of consumer behaviour towards electricity is known as Demand Side Management. Thus it can be concluded that the demarketing strategies helps to promote Demand Side Management. In this chapter quantitative and qualitative analysis of the demarketing strategies is made. In the next chapter, a Cost Benefit Analysis of Demand Side Management is carried out.

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Chapter 5

Cost Benefit Analysis of Demand Side Management

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Chapter 5

Cost Benefit Analysis of Demand Side Management

5.1 Introduction

Demand Side Management was traditionally considered as the management of the peak load of energy (Demand Side Load Management). Today, the term is used to represent the process of managing (either increase or decrease) the overall energy demand. This chapter makes an attempt to measure the cost and benefits of DSM. The Cost Benefit Analysis of retrofitting selected appliances like energy efficient fans, super efficient fans and energy efficient lights in the domestic sector of Kerala is carried out. For this purpose, the existing consumption pattern of lights and fans in the domestic sector is examined. Finally the electricity saving potential of the households is calculated and the significance of saving potential is analysed.

5.1.1 Benefits of Demand Side Management to the society

a) Benefits to the Consumers

Consumers can achieve reduction in the electricity bills through energy savings. Energy savings also helps in inter-generational and intra-generational sustainability. Energy conservation may result in short term inconveniences, but in the long run, DSM increases consumer satisfaction through the supply of clean and reliable energy.

b) Benefits to the Utility

DSM helps the Utilities to delay or avoid investments for capacity augmentations in generation, transmission and distribution wings. If DSM is widely practised, the Electricity Boards need not purchase electricity at higher cost to provide to the consumers. The funds thus saved can be used to increase the performance of the Utility.

c) Benefits to the Environment

Due to the optimum use of resources, the fossil fuels will not get depleted. This inturn helps to reduce harmful emissions from thermal and nuclear plants and protects the ecological balance and bio-diversity.

5.2 Cost Benefit Analysis of Demand Side Management

Cost Benefit Analysis is an inevitable aspect of DSM. It refers to the evaluation of the money value of costs and benefits involved in a project. It is the most scientific and useful criterion for the evaluation of investments or projects. It is a sound appraisal technique to measure the financial worthiness of a project. Cost Benefit Analysis, as applied to energy, is the appraisal of all the costs and benefits associated with an energy project.

The rationale for Cost Benefit Analysis is to make a rational choice of undertaking the energy project if the benefits accruing through it exceed its costs. For this purpose, a technique known as 'discounting' is used which allows future costs and benefits to be compared with those in the present.

While planning a Demand Side Management project, various factors are to be analysed. They are :

a) The cost involved
b) The benefit derived and
c) The pay back Period.

Cost Benefit Analysis involves the following steps:

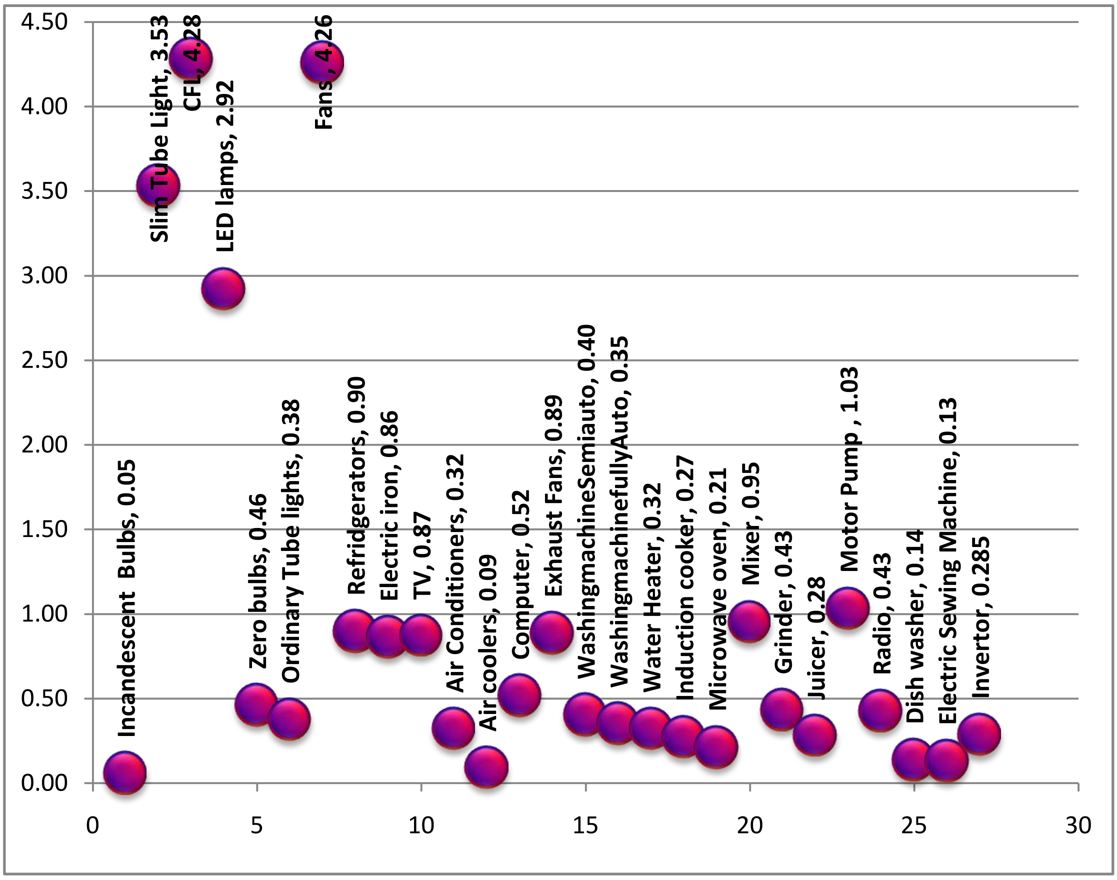
1. List the alternative projects
2. Determine the cost/investment required for each project
3. Assess the benefits derived from the alternative projects
4. To work out the discount rate or the time value of money
5. Calculate the Pay Back Period
6. Calculate the Net Present Worth/ Net Present Value and Internal Rate of Return

7. Analyse the Benefit Cost Ratio/ Profitability Index and
8. Decision Making

Before making a Cost Benefit Analysis, the penetration of electrical home appliances are analysed.

Figure 5.1

Average Number of Electrical Appliances Per Household in Kerala



Source : Primary Data

The above Scatter diagram 5.1 reveals that, among the electrical appliances lights and fans have the highest penetration. CFLs comes first with a mean score of 4.28 and fans come second with a score of 4.26. Slim tube lights are the third with 3.53 and LEDs, the fourth with 2.92 score. The incandescent lamps are having only .05 mean score as the households are purchasing either CFLs or LEDs in the case of replacement of old lamps.

Motor pumps, mixer, fridge, exhaust fans, TV and electic irons are ranked as 5, 6,7,8,9 and 10 respectively among the commonly used home appliances. Air coolers are having the lowest penetration with a mean score of 0.09. Dish washers, electric sewing machines are also less penetrated. Microwave oven, induction cookers and juicers are not commonly used.

5.3 Cost Benefit Analysis of Retrofitting Lights and Fans

As the lights and fans have the highest penetration, the Cost Benefit Analysis of retrofitting energy efficient fans and lights is made in the present study. Retrofitting means adding or replacing a component or device to the electrical system of the household. Seven retrofitting project proposals are considered and the cost and benefits and energy savings are estimated for the 783 sample households.

Projects for Retrofitting Fans:

Project Proposal A- Retrofitting Energy Efficient Fans

Replacing old fans of 110 watts

Replacing old fans of 85 watts

Replacing old fans of 65 watts

Project Proposal B - Retrofitting Super Efficient Fans

Replacing old fans of 110 watts

Replacing old fans of 85 watts

Replacing old fans of 65 watts

Projects for Retrofitting Lights :

Project Proposal I - Replacing incandescent lamps of 60 watts with CFLs of 15Watts

Project Proposal II - Replacing CFL lamps of 15 Watts with LEDs of 9Watts

Project Proposal III - Replacing 36 watt ordinary tubelights with 28 watt slim tubelights

Project Proposal IV - Replacing tubelights with LED tubelights of 16 watts

Project Proposal V - Replacing Zerowatt bulbs of 15 watts with LED lamps of 0.5watts

5.3.1 Retrofitting Fans

Energy efficient investments apply the same criteria used by other investments for Cost Benefit Analysis. The cost and benefits of retrofitting energy efficient and super efficient fans are conducted in this part of the chapter.

5.3.1.1 Energy Efficient Fans

Usually the old inefficient fans used in the households in Kerala are of 65-110 watts. If they are replaced with star rated energy efficient fans, having efficient blades and motor, the benefits are analysed as follows :

Table 5.1

Details of a Typical Energy Efficient Ceiling Fan

Usha Energia Fans 50 Watts White 1200 (Star Rated) M.R.P ₹ 1660
Air Delivery 200cmm
Power 50 watt
Revolutions Per Minute (RPM) 310
Sweep (blade size) 1200mm

Source: Compiled from the Reports of the Manufacturers of Usha Fan

Efficiency of fans is expressed as Air Flow (Cubic metre per minute) / Rate of electricity (watts). Air delivery indicates the volume of air that a fan will move per minute expressed as cubic metre per minute (cmm) or cubic feet per minute (cfm).

5.3.1.2 Super Efficient Fans

The Super Efficient Fans use a new technology called Brush Less Direct Current (BLDC) motor and efficient blade designs that makes ceiling fans far more efficient and have air delivery of 220-230 m^3/min that makes them almost the same in performance as compared to the regular ceiling fans.

Table 5.2

Details of a Typical Super Efficient Ceiling Fan

Parameter	Model: Gorilla Fan (5 STAR With Remote Control And BLDC Motor)
Sweep/Size	1200 mm
Power Rating	28 Watts
Air Delivery	230cmm (m^3/min)
Warranty	3 years
Price	₹ 3600
RPM	380

Source: Compiled from the Website of 'Bijili Bachao Initiative'

The power consumption of fans is more in the case of normal induction fans, i.e, 85 Watts and the power consumption of Energy Efficient 5 Star fans is 50 Watts and that of Super Efficient Fans is 28 Watts.

5.3.1.3 Simple Pay Back Period

Simple Pay Back Period is the time required for the total cash flows from the annual savings to cover the initial cost.The Simple Pay Back Period of the project in years is calculated as follows:

Pay Back Period= Initial Cost of the project (in ₹)/Annual savings (in ₹)

Simple Pay Back Period is a simple technique used for Cost Benefit Analysis. The smaller the Pay Back Period, the more attractive the project is., Khan & Jain (2008)

Electricity consumption in Units = Watts*hours /1000 (kWh)

Table 5.3

Simple Pay Back Period of Energy Efficient Ceiling Fans

Project Proposal A- Retrofitting Energy Efficient Ceiling Fans				
Capacity of the fan	50W (Energy Efficient)	110W (Ordinary)	85W (Ordinary)	65W (Ordinary)
Electricity consumption in Units for a year (10 hours per day)	182.5 Units	401.5 Units	310.25 Units	237.25 Units
Electricity charges, ₹ 3.77 per unit for one year (Supplied at a rate of ₹ 3.77/kWh for domestic consumers) (Above Row * 3.77)	₹688.03	₹1513.65	₹1170	₹894.43
Electricity charges For 10 years (Above Row*10)	₹6880.3	₹1513.65	₹11700	₹8944.3
Annual Electricity savings by replacing ordinary fans with energy efficient fans		₹825.62	₹482	₹206.40
Cost of Energy Efficient Star Rated Fan of 50 watts		₹1,660		
Simple Pay Back Period of replacement (in years)		2.01	3.44	8.04
Simple Pay Back Period of replacement (in days) (Above Row *365)		734	1256	2935

Source: Computed by the Researcher

Average life span for fan is 10 years; the cost can be paid back with 2.01 years, 3.44 years and 8.04 years. The annual energy savings by replacing ordinary fans with energy efficient fans is ₹825.62, ₹ 482 and ₹ 206.40 for 110W, 85W and 65W respectively.

Table 5.4

Simple Pay Back Period of Super Efficient Ceiling Fans

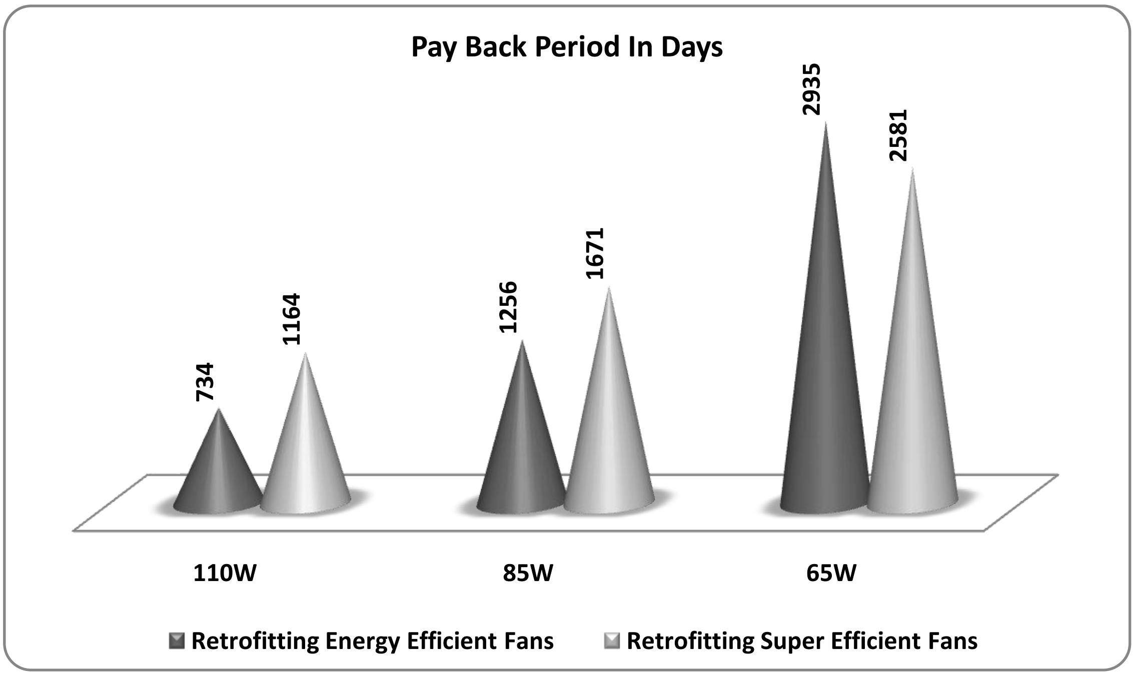
Project Proposal B - Retrofitting Super Efficient Ceiling Fans				
Capacity of the fan	28W (Super Efficient)	110W (Ordinary)	85W (Ordinary)	65W (Ordinary)
Electricity consumption in Units for a year (10 hours per day)	102.2 Units	401.5 Units	310.25 Units	237.25 Units
Electricity charges, ₹ 3.77 per unit for one year (Supplied at a rate of ₹ 3.77/kWh for domestic consumers) (Above Row * 3.77)	₹ 385	₹ 1513.65	₹1170	₹894.43
Electricity charges For 10 years(Above Row *10)	₹ 3,850.00	₹ 15,136.50	₹ 11,700	₹ 8,944.30
Annual Electricity savings by replacing ordinary fans with Super efficient fans		₹ 1,129.00	₹ 785	₹509.00
Cost of Super Efficient Fan of 28 watts		₹ 3,600		
Simple Pay Back Period of replacement (in years)		3.19	4.58	7.07
Simple Pay Back Period of replacement (in days) (Above Row *365)		1164	1671	2581

Source: Computed by the Researcher

Average life span for fan is 10 years. The cost of replacing super effiicient fans can be paid back within 3.19 years, 4.58 years and 7.07 years. The annual energy savings by replacing ordinary fans with Super Efficient fans is ₹1129, ₹ 785 and ₹509 for 110W, 85W and 65W respectively.

Figure 5.2

Pay Back Period of Retrofitting Energy Efficient and Super Efficient Fans



Source: Computed by the Researcher

The above figure shows the Pay Back Period of replacing ordinary fans of 110Watts, 85 Watts and 65 Watts with Energy Efficient fans of 50Watts and Super Efficient Fans of 28 Watts. The replacement of 110 Watt fans with 50 Watts Energy Efficient Fans has the lowest Pay Back Period even though energy savings is high with Super Efficient fans. This is because of the fact that Energy Efficient fans are less costly as compared to Super Efficient fans.

Pay Back period does not consider time value of money. For this discounted cash flow techniques are used. Discounting is the opposite of compounding. Discounting helps to find out the present value of future cash flows.

5.3.1.4 Net Present Value and Internal Rate of Return

Net Present Value is equal to the difference between the present value of cash inflows and cash outflows. NPV = Present value of net cash benefits – Present value of net cash outlay. Internal Rate of Return (IRR) is used to estimate the profitability of the projects. Internal rate of return is the discount rate at which the present value of all cash flows (both positive and negative) from a particular project equal to zero. Discount Rate is taken as 10% for the calculation of present value.

Table 5.5

Net Present Value and Internal Rate of Return of Electricity Savings by Retrofitting Energy Efficient Fans - Project Proposal A

Year	Replacing old fans of 110 watts		Replacing old fans of 85 watts		Replacing old fans of 65 watts	
	Net Savings	Present Value	Net Savings	Present Value	Net Savings	Present Value
0	-1660	-1660.0	-1660	-1660.0	-1660	-1660.0
1	825.62	750.5	482	438.1	206.4	187.6
2	825.62	682.3	482	398.3	206.4	170.6
3	825.62	620.3	482	362.1	206.4	155.1
4	825.62	563.9	482	329.2	206.4	141.0
5	825.62	512.6	482	299.3	206.4	128.2
6	825.62	466.1	482	272.1	206.4	116.5
7	825.62	423.7	482	247.4	206.4	105.9
8	825.62	385.2	482	224.9	206.4	96.3
9	825.62	350.1	482	204.4	206.4	87.5
10	825.62	318.3	482	185.8	206.4	79.6
NPV		3412.9		1301.6		-391.8
IRR		35%		15%		-5%

Source: Computed by the Researcher

Criteria for selecting the project on the basis of NPV is to accept the project when the NPV is positive and reject it when the NPV is negative.The above table shows the Net Present Value of electricity savings for ten years. NPV is calculated as 3412.9, 1301.6 and -391.8 for replacement of 110 watts, 85 watts and 65 watts fans of which the first two replacements are positive and can be accepted, but the third one is negative. Present Value of Cash inflows is 5073, 2962 and 1268. The IRR is 35%, 15% and -5% respectively. It is the compound annual rate of return. The higher the IRR, the more attractive the project is. The IRR is positive in the case of the first and second replacements.

Table 5.6

Net Present Value and Internal Rate of Return of Electricity Savings by Retrofitting Super Efficient Fans - Project Proposal B

	Replacing old fans of 110 watts		**Replacing old fans of 85 watts**		**Replacing old fans of 65 watts**	
Year	Net Savings	Present Value	Net Savings	Present Value	Net Savings	Present Value
0	-3600	-3600.0	-3600	-3600.0	-3600	-3600.0
1	1129	1026.3	785	713.6	509	462.7
2	1129	933.0	785	648.7	509	420.6
3	1129	848.2	785	589.8	509	382.4
4	1129	771.1	785	536.2	509	347.6
5	1129	701.0	785	487.4	509	316.0
6	1129	637.3	785	443.1	509	287.3
7	1129	579.4	785	402.9	509	261.2
8	1129	526.7	785	366.2	509	237.4
9	1129	478.8	785	332.9	509	215.9
10	1129	435.2	785	302.6	509	196.2
	NPV	3337.0		1223.4		-472.5
	IRR	17%		7%		-3%

Source: Computed by the Researcher

The Criteria for selecting the project is to accept the project when the NPV is positive and reject it when the NPV is negative. The above table shows the Net

Present Value of electricity savings for ten years by replacing old fans with super efficient fans. NPV is calculated as 3337, 1223.4 and -472.5 for 110 watts, 85watts and 65 watts replacements of which first two replacements are positive and can be accepted but the third one is negative.The present value of cash inflows are 6937, 4823 and 3127. The IRR is 17%, 7% and -3% respectively. The IRR is positive in the case of the first and second retrofitting.

5.3.1.5 Benefit Cost Ratio (BCR)/ Profitability Index

BCR helps to find out the ratio between costs and benefits of a project

BCR = Present Value of Cash inflows / Initial Investment

The financial attractiveness of the project increase with the BCR. A project with BCR less than '1' is not acceptable. Even though the projects have higher NPV, the selection is to be made on the basis of BCR. BCR/ PI helps in the ranking of the projects.

In the case of Retrofitting Energy Efficient Fans- Project Proposal A

BCR for First replacement = 5073/1660, 3.06:1

BCR for Second replacement = 2962/1660, 1.78:1

BCR for Third replacement = 1268/1660, 0.76:1

In the case of Retrofitting Super Efficient Fans - Project Proposal B

BCR for First replacement = 6937/3600, =1.93:1

BCR for Second replacement = 4823.4/3600, =1.34:1

BCR for Third replacement = 3127.5/3600, = 0.87:1

The advantage of using the BCR metrics is that, it is used to predict the benefits. NPV gives ranking on the basis of ratio. Although PI method is based on NPV, it is a better evaluation technique than NPV in a situation of capital rationing.The first and the second replacements are acceptable as they have a BCR greater than one.

5.3.1.6 Sensitivity Analysis or What-if Analysis

Sensitivity analysis is made to analyse the impact of different factors on the cash flow of the project. Sensitivity Analysis for 10 years if Discount (10%, 20%, 30% & 40%) is allowed on the Cost of the Energy Efficient Fans (Project Proposal A) is given below:

Table 5.7

Sensitivity Analysis for 10 Years if Discount is Allowed on the Cost of the Energy Efficient Fans

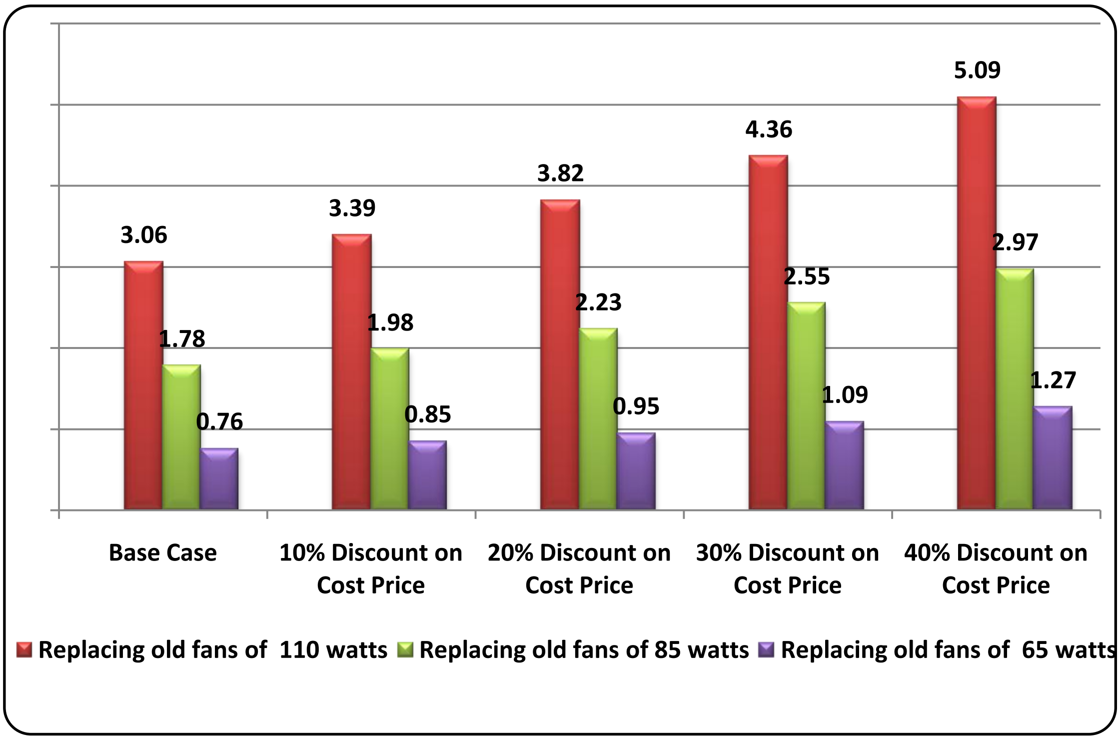
Sensitivity Analysis for 10 years if Discount (10%, 20%, 30% & 40%) is Allowed on the Cost of the Energy Efficient Fans (Project Proposal A)				
NPV, IRR and BCR for each type of Replacement with Energy Efficient Fans		Replacing old fans of 110 watts	Replacing old fans of 85 watts	Replacing old fans of 65 watts
Base Case, No Discount on Cost Price	NPV	3412.9	1301.6	-391.8
	IRR	35%	15%	-5%
	BCR	3.06:1	1.78:1	0.76:1
If 10% discount is allowed on cost price	NPV	3579	1467.6	-225.7
	IRR	40%	18%	-3%
	BCR	3.39:1	1.98:1	.85:1
If 20% discount is allowed on cost price	NPV	3745	1633.6	-59.7
	IRR	47%	22%	-1%
	BCR	3.82:1	2.23:1	.95:1
If 30% discount is allowed on cost price	NPV	3911	1799.6	106.3
	IRR	55%	27%	2%
	BCR	4.36:1	2.55:1	1.09:1
If 40% discount is allowed on cost price	NPV	4077	1965.6	272.3
	IRR	66%	34%	5%
	BCR	5.09:1	2.97:1	1.27:1

Source: Computed by the Researcher

The above table shows the impact of the different discount rates on the NPV, IRR and BCR of electricity savings of three types of fans replaced by energy efficient ones. If the discount rates are increased, the BCR, NPV and IRR also increase. Increased discount on fans also decrease the Pay Back Period.

Figure 5.3

Benefit Cost Ratio If Discount (10%, 20%, 30% and 40%) is Allowed on the Cost of the Energy Efficient fans



Source: Computed by the Researcher

The above figure 5.3, represents the change in BCR as a result of change in the cost price in all the three types of replacements. BCR is the highest for replacing old fans of 110 watts with energy efficient fans. At 40% discount the BCR is 5.09, 2.97 and 1.27 respectively for replacements of 110watts, 85watts and 65watts fans.

5.3.1.7 Analysis and Interpretation - Retrofitting Energy Efficient Fans

It can be concluded that, for the replacement of 110 watts and 85 watts fans BCR is more than one even without providing discount on cost price. But 110 watts fans are not common. They are the oldest type of fans used in Kerala households. The 85 watt fans are widely used. 65 watts fans are also common type, but the replacement of such fans are not cost beneficial upto 24% discount on cost price. BCR of replacing 65 watt fans will provide value more than '1' only if discount more than 24% is allowed on the cost price. The Sensitivity Analysis for 10 years if Discount (10%, 20%, 30% & 40%) is allowed on the Cost of the Super Efficient fans (Project Proposal B) is presented in the following table:

Table 5.8
Sensitivity Analysis for 10 years if Discount is Allowed on the Cost of the Super Efficient fans

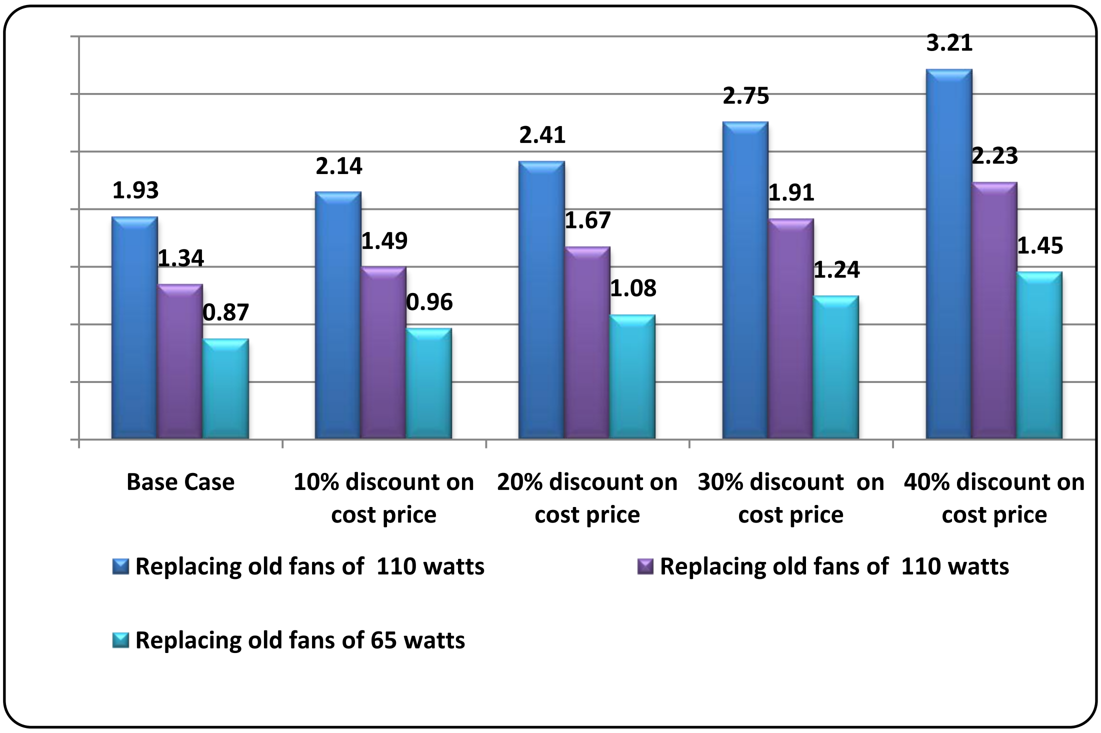
NPV, IRR and BCR for each type of Replacement		**Replacing old fans of 110 watts**	**Replacing old fans of 85 watts**	**Replacing old fans of 65 watts**
Base Case, No Discount on Cost Price	NPV	3337	1223.4	-472.5
	IRR	17%	7%	-3%
	BCR	1.93:1	1.34:1	0.87:1
If 10% discount is allowed on cost price	NPV	3697	1583.4	-112.5
	IRR	21%	10%	-1%
	BCR	2.14:1	1.49:1	.96:1
If 20% discount is allowed on cost price	NPV	4057	1943.4	247.5
	IRR	25%	13%	2%
	BCR	2.41:1	1.67:1	1.08:1
If 30% discount is allowed on cost price	NPV	4417	2303.4	607.5
	IRR	31%	17%	5%
	BCR	2.75:1	1.91:1	1.24:1
If 40% discount is allowed on cost price	NPV	4777	2663.4	967.5
	IRR	38%	22%	9%
	BCR	3.21:1	2.23:1	1.45:1

Source : Computed by the Researcher

The above table 5.8, shows the effect of the different discount rates (10%, 20%, 30% and 40% on the NPV, IRR and BCR of electricity savings of three types of fans replaced by Super Efficient ones. If the discount rates are increased, the BCR, NPV and IRR are increased. Increased discount on fans also decrease the Pay Back Period.

Figure 5.4

Benefit Cost Ratio if Discount (10%, 20%, 30% and 40%) is allowed on the Cost of the Super Efficient fans



Source : Computed by the Researcher

The above figure represents a sensitivity analysis of BCR of retrofitting super efficient fans in the place of inefficient fans the highest BCR is for the replacement of fans of 110 watts at 40% discount on cost price.The BCR is 3.21,which means that, for every 'one rupee' invested, the benefit is Rs 3.21.

5.3.1.8 Analysis and Interpretation - Retrofitting Super Efficient Fans

The above analysis considers the replacements of 110 watts, 85 watts and 65 watts fans with Super Efficient Fans. For the first two types of replacements (110 watts and 85 watts), the replacement has a BCR more than '1' even at 'zero'discount. But in the case of 65watts (common type) fans the replacement is beneficial only if more than 14% is provided as discount on the cost price.

5.3.2 Retrofitting Lighting Appliances

Penetration of lighting appliances is high among the domestic consumers. So retrofitting the inefficient lamps with the energy efficient lamps constitute a significant step in Demand Side Management. CFLs, LEDs, Solar Lamps etc., are distributed by KSEB Ltd. at low prices to the domestic consumers.

5.3.2.1 Energy Efficient Lighting

Light Emitting Diode (LED) lamps are the most energy efficient lamps used now a days. They do not contain mercury components and can be recycled. CFL bulbs or Compact Fluorescent light bulbs are energy efficient than incandescent lamps but contain Argon and mercury. LED lamps have a working life of 50000 hours and CFLs have about 8000 hours.The cost of CFLs are comparatively less as compared to LEDs.

Table 5.9

Comparison of Electricity Consumption and Brightness

Incandescent Watts	CFL Watts	LED Watts	Lumens (Brightness)
40	8-12	4-5	450
60	13-18	6-9	890
75-100	18-22	10-13	1210
100	23-30	16-20	1750
150	30-55	25-28	2780

Source: Compiled from the Report of the Bureau of Energy Efficiency

The above table represents the comparison of watts of incandescent lamps, LEDs and CFLs of equal lumen output. The commonly used incandescent lamps of 60 watts are equal to 13-18 watts CFL and 6- 9 watts LEDs because the lamps in this range can provide brightness of 890 Lumens.

Table 5.10

Comparison of Watts and Lumen Output of Tube Lights

Type	Watts	Lumens
T 12 with Magnetic Ballast	53	2450
T 12 with Electronic Choke	44	2450
T8	36	2350
T5	28	2900

Source: Compiled from the Report of the Energy Management Centre

Tube Lights consists of T12, T8 and T5 types. T12 is the thickest, T8 is the popular one and T5 is the slimmest and most energy efficient of the three types.T5 slim tubelights are available in 54, 28, 14 and 8 watts.

Table 5.11

Comparison of Working Life of Lighting Appliances

Type	Life
Incandescent Bulb	750-1000 hours
CFL	6000-10000 hours
Tube-lights	7000-24000 hours
LEDs	25000-50000 hours

Source: Compiled from the Website of Bijili Bachao Initiative

The estimated working life of incandescent lamps is 750-1000 hours i.e, around 6 months. CFLs have a working life of 6000-10000 hours (2-4 years) and LEDs have the longest life span 25000-50000 hours (7-10 years). Tubelights have a life span of 7000-24000 hours (3-5 years).

Table 5.12

Comparison of Lighting Appliances

Type of Appliance	Incandescent Lamps	CFL	LED	Ordinary Tubelight	Slim Tube light	LED Tube light	Zero watt Lamp	LED Lamp
Power consumption (watts)	60	15	9	36	28	16	15	0.5
Hours of Use Per day	4	4	4	4	4	4	10	10
Consumption in Units for a year (watts*Hours of use*365/1000)	87.6	21.9	13.14	52.56	40.88	23.36	54.75	1.825
Electricity charges, ₹3.77 per unit for one year	330.2	82.6	49.5	198.1	154.1	88.1	206.4	6.9
Electricity charges For 10 years (₹)	3,302	826	495	1,981	1,541	881	2,064	69

Source: Primary Data

The above table makes a comparison of different lighting appliances, power consumption in Watts, average hours of use of each appliance and the electricity charges.

5.3.2.2 Retrofitting Energy Efficient Lamps –Pay Back Period, Net Present Value, Internal Rate of Return and Benefit Cost Ratio

In this part of the study, Five project proposals for replacing the lighting appliances in the households in Kerala are considered :-

Project Proposal I - Replacing incandescent lamps with CFLs

Project Proposal II - Replacing CFL lamps with LEDs

Project Proposal III - Replacing ordinary tubelights with 28 watt slim tubelights

Project Proposal IV - Replacing tubelights with LED tubelights

Project Proposal V - Replacing Zerowatt bulbs with LED lamps of 0.5watts

Incandescent lamps were the popular form of lights used by the households. But they are very inefficient. Zero watt lamps operate with 15 watts. The old energy meters in our houses were not able to record the minute changes of consumption of these 15 watt lamps. So they were known as Zero watt lamps.

LED lamps are more energy efficient than CFLs. LEDs does not contain mercury components and are long lasting than CFLs.

The electricity savings and the Pay Back Period of replacing inefficient lamps with energy efficient types are discussed in the Table 5.13.

Table 5.13

Electricity Savings and Pay Back Period of Replacing Inefficient Lamps with Energy Efficient Type

Type of Replacement	Project Proposal I	Project Proposal II	Project Proposal III	Project Proposal IV	Project Proposal V
	Replacing incandescent lamps of 60 watts with CFLs of 15Watts	Replacing CFL lamps of 15 Watts with LEDs of 9Watts	Replacing 36 watt ordinary tubelights with 28 watt slim tubelights	Replacing tubelights with LED tubelights of 16 watts	Replacing Zerowatt bulbs of 15 watts with LED lamps of 0.5watts
Annual Electricity Savings in Rupees on replacement	248	33	44	110	199
Cost of Replacing Appliances(₹)	115	160	400	950	70
Pay Back Period (years)	.46	4.85	9.09	8.64	0.35
Pay Back Period (In days)	169	1770	3318	3152	128

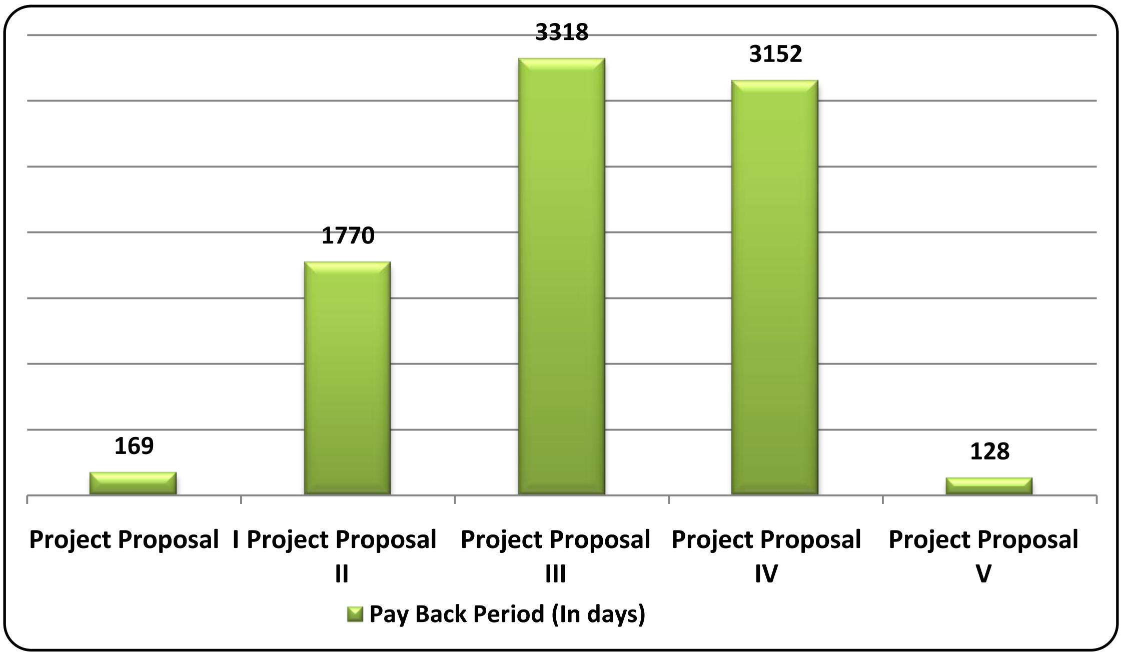
Source: Computed by the Researcher

The above table shows the electricity savings that can be attained through energy efficiency by replacing ordinary lamps with CFLs, LEDs, and slim tubelights. Highest savings in electricity charges is attained by replacing Incandescent Bulbs of 60 watts and Zero bulbs.

The Pay Back Period of all the five project proposals for Retrofitting Energy Efficient Lamps are represented in the following figure:

Figure 5.5

Pay Back Period of Projects for Retrofitting Energy Efficient Lamps



Source: Computed by the Researcher

The above figure represents the Pay Back Period of each type of replacement.

Project Proposal I - Incandescent Bulbs of 60 watts replaced by CFLs of 15 watts has the PB period of 169 days.

Project Proposal II - Replacing CFL lamps of 15 Watts with LEDs of 9 Watts has a PB period of 1770 days (4.85 years).

Project Proposal III - Replacing 36 watt ordinary tubelights with 28 watt slim tubelights has the Pay Back Period of 3318 days (9.09 years) and cannot be accepted because they have a lifespan of 3-5 years only.

Project Proposal IV - Replacing tubelights with LED tubelights of 16 watts has a PB period of 3152 days (8.64 years) and the life span of LED tubelights are 7-10 years

Project Proposal V – Replacing Zero watt bulbs by LEDs of 0.5 watt has the lowest PB period of 128 days.

All the proposals except Proposal III can be accepted.

After calculating the energy savings and PBP, the Net PresentValue, Internal Rate of Return and Benefit Cost Ratio for five project proposals are analysed as given below:

Table 5.14

Net Present Value, Internal Rate of Return and Benefit Cost Ratio for Five Project Proposals

Type of Replacement	**Project Proposal I**	**Project Proposal II**	**Project Proposal III**	**Project Proposal IV**	**Project Proposal V**
	Replacing incandescent lamps of 60 watts with CFLs of 15Watts	**Replacing CFL lamps of 15 Watts with LEDs of 9Watts**	**Replacing 36 watt ordinary tubelights with 28 watt slim tubelights**	**Replacing tubelights with LED tubelights of 16 watts**	**Replacing Zerowatt bulbs of 15 watts with LED lamps of 0.5watts**
Initial Investment	-115	-160	-400	-950	-70
Savings at the end of 1st Year	248	33	44	110	199
Savings at the end of 2ndYear	248	33	44	110	199
Savings at the end of 3rd Year	248	33	44	110	199
Savings at the end of 4th Year	248	33	44	110	199
Present Value of Initial Investment	-115	-160	-400	-950	-70
PV @ 10% of Savings at the end of 1st Year	225.46	30.00	40.00	100.00	180.91

PV @ 10% of Savings at the end of 2nd Year	204.95	27.27	36.36	90.90	164.45
PV @ 10% of Savings at the end of 3rd Year	186.32	24.79	33.06	82.64	149.51
PV @ 10% of Savings at the end of 4th Year	169.38	22.54	30.05	75.13	135.92
NPV at the end of 1st year	110.5	-130.0	-360.0	-850.0	110.9
NPV at the end of 2nd year	315.4	-102.7	-323.6	-759.1	275.4
NPV at the end of 3rd year	501.7	-77.9	-290.6	-676.5	424.9
NPV at the end of 4th year	671.1	-55.4	-260.5	-601.3	560.8
IRR at the end of 1st year	96%	Negative Value	Negative Value	Negative Value	158%
IRR at the end of 2nd year	164%	Negative Value	Negative Value	Negative Value	230%
IRR at the end of 3rd year	180%	Negative Value	Negative Value	Negative Value	245%
IRR at the end of 4th year	185%	Negative Value	Negative Value	Negative Value	248%
BCR at the end of 1st Year	1.96	0.19	0.10	0.11	2.58
BCR at the end of 2nd Year	3.74	0.36	0.19	0.20	4.93
BCR at the end of 3rd Year	5.36	0.51	0.27	0.29	7.07
BCR at the end of 4th Year	6.84	0.65	0.35	0.37	9.01

Source: Computed by the Researcher

The above table presents the NPV, IRR and BCR for five project proposals at 10% discount rate and reveals that NPV and IRR is positive only for 1^{st} and v^{th} projects and the II^{nd} , III^{rd} and IV^{th} projects are having negative NPV and IRR which cannot be accepted. BCR is greater than one only for Projects 1 and V. So at this cost price only Project I and V, i.e., Replacing Incandescent Bulbs of 60 Watts by CFLs and Replacing Zero watt bulbs by LEDs of 0.5 watts can be accepted.

5.3.2.3 Sensitivity Analysis Conducted to find Out NPV and BCR at Different Prices if Cost is Reduced

In all the cases 10% is taken as the discount factor for the calculation of Present Value and the results for four years are calculated. The Pay Back Period, NPV, IRR and BCR are calculated if the cost of the appliances are reduced by 10%, 20%, 30%, 40% and 50%. It is assumed that the cost of providing discount is met by the KSEB Ltd. and this cost is recouped from the benefits of energy savings.

Table 5.15

Sensitivity Analysis to Calculate the Net Present Value, Internal Rate of Return and Benefit Cost Ratio, if the Costs of the Lighting Appliances are Reduced

If 10% Discount is given on the Cost Price					
Type of Replacement	Project Proposal I	Project Proposal II	Project Proposal III	Project Proposal IV	Project Proposal V
Initial Investment	-103.5	-144	-360	-855	-63
PV @ 10% of Savings at the end of 1st Year	225.46	30	40	100	180.9
PV @ 10% of Savings at the end of 2nd Year	204.95	27.27	36.36	90.9	164.4
PV @ 10% of Savings at the end of 3rd Year	186.32	24.79	33.06	82.64	149.5
PV @ 10% of Savings at the end of 4th Year	169.38	22.54	30.05	75.13	135.9
NPV	682.61	-39.4	-220.53	-506.33	567.7
IRR	207%	Negative Value	Negative Value	Negative Value	277%
BCR	7.6	0.73	0.39	0.41	10
If 20% Discount is given on the Cost Price					
Initial Investment	-92	-128	-320	-760	-56
NPV	694.11	-23.4	-180.53	-411.33	574.79
IRR	235%	-8%	-28%	-26%	313%
BCR	8.5	0.82	0.43	0.46	11.26
If 30% Discount is given on the Cost Price					
Initial Investment	-80.5	-112	-280	-665	-49

NPV	705.61	-7.4	-140.53	-316.33	581.79
IRR	270%	-3%	-24%	-22%	360%
BCR	9.7	.93	0.5	0.52	12.87
If 40% Discount is given on the Cost Price					
Initial Investment	-69	-96	-240	-570	-42
NPV	717.11	8.6	-100.53	-221.33	588.79
IRR	317%	4%	-19%	-18%	421%
BCR	11.39	1.1	0.58	0.61	15.02
If 50% Discount is given on the Cost Price					
Initial Investment	-57.5	-80	-200	-475	-35
NPV	728.61	24.6	-60.53	-126.33	595.79
IRR	383%	12%	-14%	-12%	508%
BCR	13.67	1.31	.69	.73	18

Source: Computed by the Researcher

The above table makes a Sensitivity Analysis to Calculate the Net Present Value, Internal Rate of Return and Benefit Cost Ratio, if the Costs of the Lighting Appliances are reduced by 10%, 20%, 30%, 40% and 50%.

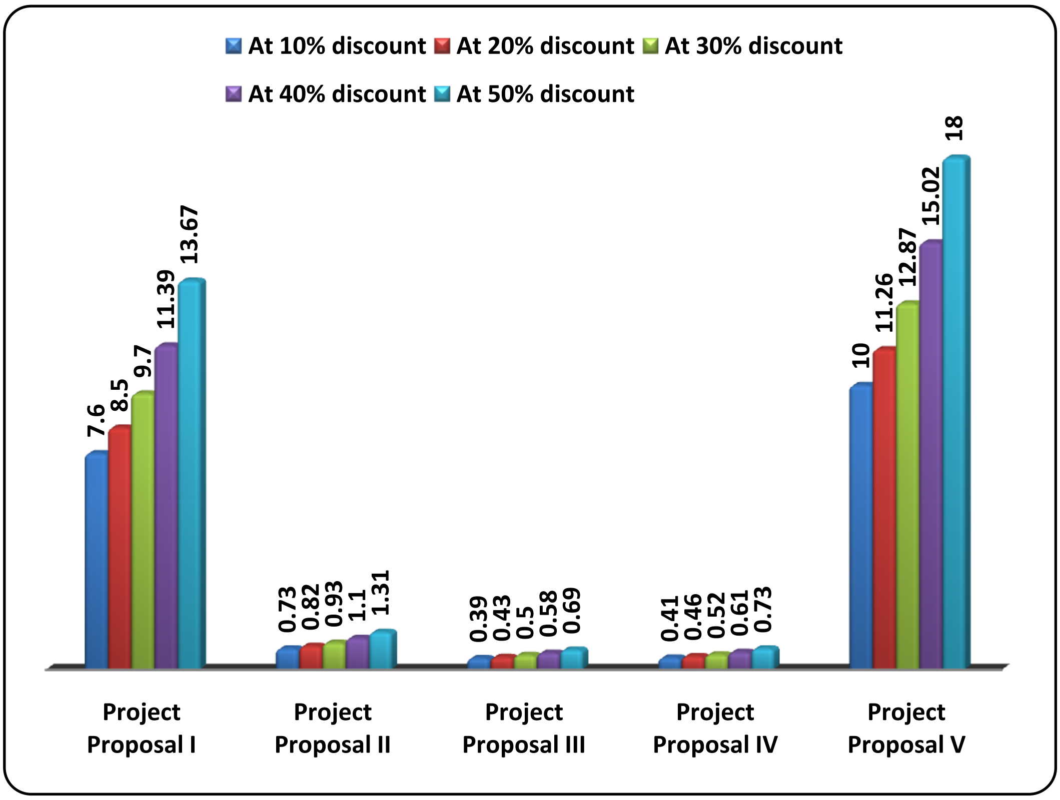
5.3.2.4 Analysis and Interpretation – Retrofitting Energy Efficient Lamps

The Pay Back Period, NPV and BCR is calculated for the Four years at a discount rate of 10% and price reduction of 10%, 20%, 30%, 40% and 50% for the Projects. Project IV is beneficial only if discount is allowed at 40% on the cost price of the lamp.

Projects III and IV are having negative NPV and IRR even at 50% discount. So they cannot be accepted in the short run, but only after the PB Period of 9.09 years and 8.64 years respectively.The replacement with LED tubelights provide positive NPV after 6 years, if 50% discount is allowed on the cost price and give positive NPV after 9 years if only 40% discount is allowed on the cost price. So instead of replacement with slim tubelights, LED tubelights can be used because LED tubelights have a life span of 8-10 years.

Figure 5.6

Benefit Cost Ratio if the Cost of the Energy Efficient Lamps is Reduced by 10%, 20%, 30%, 40% and 50%



Source: Computed by the Researcher

In the case of Project 1 and Project V, BCR is greater than '1' in all the cases. In the case of Project II, BCR is greater than '1' at 40% and 50% discount rate only. In thecase of Project III and Project IV, BCR is less than '1' in all the cases. Projects I and V are cost beneficial even without a discount.

5.3.3 Electricity Consumption Before and After Retrofitting Energy Efficient Appliances

This part of the chapter analyses the electricity consumption of the sample households before and after retrofitting the selected energy efficient appliances. This helps to estimate the electricity saving potential of the households, if the selected home appliances are replaced with energy efficient type.

Table 5.16

Electricity Consumption and Expenditure Pattern Before Retrofitting Energy Efficient Appliances

Name of the appliance	Total No. of appliances for 783 HH	Average no. of appliances per HH(Column 2/783)	In Watts	Duration of Use in Hours	Electricity Consumption per day in units for one appliance(Column 4*Column 5)/1000	Electricity Consumption in units for one year for one appliance.(Column 6*365)	Electricity Consumption in Kilowatt hours per year per HH(Column 3* Column 7))	Electricity Consumption in Kilowatt-hours per year for 783 HH(column 2*Column 7)	Electricity Charge in Rupees per year per HH(Column 8* Rs. 3.77)	Total Electricity Charge in Rupees per year for 783 HH(Column 9 * Rs. 3.77)
1	2	3	4	5	6	7	8	9	10	11
a.Incandescent Bulbs	43	0.0549	60	4	0.24	87.6	4.811	3766.8	18.136	14200.836
b.Slim Tube Light	2764	3.53	28	4	0.112	40.88	144.307	112992.32	544.037	425981.05
c.CFL	3351	4.2797	15	4	0.06	21.9	93.725	73386.9	353.344	276668.61
d.Zero bulbs	360	0.4598	15	10	0.15	54.75	25.172	19710	94.9	74306.7
e.Ordinary Tube lights	294	0.3755	40	4	0.16	58.4	21.928	17169.6	82.668	64729.392
f. Ceiling Fans	2382	3.0421	65	10	0.65	237.25	721.749	565129.5	2720.994	2130538.2
Total							**1011.692**	**792155.12**	**3814.079**	**2986424.8**

Source: Primary Data

The above table presents the electricity usage and expenditure pattern for the sample (783 households) in Kerala for the lights and fans. The total electricity consumption in kilowatt-hours per year for 783 households is 792155 and the total electricity charge per year for 783 households is ₹ 2986425. Total electricity consumption in kilowatt-hours per year per households is 1012 and the total electricity charge per year per households is ₹ 3814. Electricity consumption and expenditure pattern after retrofitting energy efficient appliances is presented in the following table.

Table 5.17

Electricity Consumption and Expenditure pattern After Retrofitting Energy Efficient Appliances

Name of the appliance	Total No. of appliances for 783 HH	Average no. of appliances per HH(Column 2/783)	In Watts	Duration of Use in Hours	Electricity Consumption per day in units for one appliance(Column 4*Column 5)/1000	Electricity Consumption in units for one year for one appliance.(Column 6*365)	Electricity Consumption in Kilowatt-hours per year per HH(Column 3* Column 7))	Electricity Consumption in Kilowatt-hours per year for 783 HH(column 2*Column 7)	Electricity Charge in Rupees per year per HH(Column 8 * 3.77)	Total Electricity Charge in Rupees per year for 783 HH(Column 9 * 3.77)
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
a.Incandescent Bulbs replaced by CFLs	**43**	**0.0549**	**15**	**4**	**0.06**	**21.9**	**1.203**	**941.7**	**4.534**	**3550.209**
b.Slim Tube Light replaced by LED tubelights	**2764**	**3.53**	**16**	**4**	**0.064**	**23.36**	**82.461**	**64567.04**	**310.878**	**243417.74**
c.CFL replaced by LEDs	**3351**	**4.2797**	**9**	**4**	**0.036**	**13.14**	**56.235**	**44032.14**	**212.007**	**166001.17**
e.Zero bulbs replaced by LEDs	**360**	**0.4598**	**0.5**	**10**	**0.005**	**1.825**	**0.839**	**657**	**3.163**	**2476.89**
f.Ordinary Tube lights replaced by Slim tubelights	**294**	**0.3755**	**28**	**4**	**0.112**	**40.88**	**15.35**	**12018.72**	**57.868**	**45310.574**
g. Ceiling Fans replaced by Super Efficient fans	**2382**	**3.0421**	**28**	**10**	**0.28**	**102.2**	**310.907**	**243440.4**	**1172.12**	**917770.31**
Total							**466.995**	**365657**	**1760.57**	**1378526.9**

Source: Primary Data

The above table presents the impact of retrofitting energy efficient appliances on the electricity usage and expenditure pattern of the sample households (783 households) in Kerala for the lights and fans. The total electricity consumption in kilowatt-hours per year for 783 households is reduced to 365657 and the total electricity charge per year for 783 households is reduced to ₹ 1378527. The total electricity consumption in kilowatt hours per year per households is 467 after retrofitting and the total electricity charges per year per households is reduced to ₹1761.

Table 5.18

Estimated Savings of Retrofitting Energy Efficient Lights and Fans to the House holds

Retrofitting Status	**Electricity Consumption in Kilowatt hours per year per HH**	**Electricity Consumption in Kilowatt hours per year for 783 HH**	**Electricity Charge in Rupees per year per HH**	**Total Electricity Charge in Rupees per year for 783 HH**
1	2	3	4	5
Before Retrofitting	1011.692	792155.12	3814.079	2986424.8
After Retrofitting	466.995	365657	1760.57	1378526.9
Savings	544.697	426498.1	2053.509	1607898

Source: Primary Data

Savings refers to the reduction in the electricity consumption expressed in Units and Rupees. This is obtained by deducting the values obtained After Retrofitting, from the values Before Retrofitting for each household and the total sample.

5.3.3.1 Benefits of Energy Efficient Retrofitting to the Households

a) Annual Electricity Savings in units per households is 545 units.

b) Annual Electricity Savings in units for the total sample households is 426498 units.

c) Annual Electricity Savings in Rupees per households is ₹ 2053

d) Annual Electricity Savings in Rupees for the total sample (783 households) is ₹ 1607898.

5.3.3.2 Benefits of Energy Efficient Retrofitting to KSEB Ltd.

In order to arrive at the benefits derived from retrofitting, the Pay Back Period, NPV and BCR of energy efficiency projects were analysed. Next step is to analyse the benefits to KSEB Ltd. DSM is the modification of consumer behaviour through financial incentives. If KSEB Ltd. is providing discount for the above said projects as part of DSM, the cost benefits are as follows.

Cost refers to the Discount given on energy efficient equipment to domestic consumers. Benefits to KSEB Ltd. refers to the avoided cost of capacity augmentation or Electricity purchase plus energy savings by the subsidised group.

Table 5.19

Average Realisation from Each Category of Consumers (₹/kWh)

Domestic	Commercial	Industrial LT	HT & EHT	Public Lighting	Agriculture	Licensee	Export	Traction
3.77	8.95	6.77	6.86	4.26	2.35	6.00	7.80	5.678

Source: Compiled from the Power System Statistics, 2016-17

The above table shows the average realisation from each category of consumers. ₹3.77 is realised from one unit of electricty supplied to the domestic consumers and only ₹2.35 is received from each unit supplied to the Agricultural consumers. This is because domestic and agricultural consumers are the subsidised groups. In the case of public lighting, the average realisation is very low ₹4.26/kWh. The highest amount is realised from commercial category Rs.8.95/kWh. Export contributes to ₹7.80/kWh and licencees provide ₹6/kWh. The Industrial LT, HT and EHT consumers provide ₹6.77 and ₹6.86 per unit respectively.

The cost per unit of electricity, derived from the report of Power System Statistics is given below.

Table 5.20

Cost Per Unit of Electricity (In Rupees)

At Generation end		At Transmission end		At Distribution side	
(a)	*(b)*	*(a)*	*(b)*	*(a)*	*(b)*
3.05	3.03	3.72	3.67	6.31	5.87

Source: Compiled from the Power System Statistics, 2016-17

The cost of electricity is given including and excluding interest charges repectively in column (a) and column (b). The above table shows the cost of generating, transmitting and distributing one unit of electricity is given. Though the average cost is ₹ 6.31 per unit at the distribution side, the domestic and agricultural consumers are availing electricity at a very cheap price.

5.3.3.3 Analysis and Interpretation- Benefits of Retrofitting Energy Efficient Appliances

KSEB Ltd. incurs ₹ 6.31 per unit for distribution of electricity. This is given at ₹ 3.77 per unit to domestic consumers. The difference of ₹ 2.54 per unit is given as subsidy. This difference can be utilised for providing discounts for energy efficient appliances. The subsidy provided to domestic consumers can be stopped because the domestic consumers are already benefitted from energy savings by retrofitting energy efficiency appliances. The saved energy can be utilised to provide electricity to high priced industrial (6.77 per kWh) and commercial consumers (8.95 per kWh) which further leads to the industrial and economic development of the state.

5.3.3.4 Super-efficient Equipment and Appliance Deployment (SEAD) Initiative

The Super-efficient Equipment and Appliance Deployment (SEAD) Initiative is a partnership among governments to promote the use of energy-efficient appliances worldwide. SEAD is an initiative under the Clean Energy Ministerial (CEM), global forum of clean energy. As part of this initiative, BEE has launched a new program known as Super Efficient Equipment Program (SEEP) in India to support the manufacturing of Super Efficient Appliances. It will be soon introduced in Kerala also.

5.4 Association between the Location of Residence and the Use of Lighting Appliances

Before analysing the electricity saving potential of the households, the usage pattern of the lighting appliances and ceiling fans is examined.

H_0.2: There is no significant association between the location of residence and the use of lighting appliances.

In order to check whether there is an association between the location of residence and the use of incandescent bulbs, zero bulbs, ordinary tube lights, CFLs, LEDs and slim tube lights, chi-square test of independence is used.

5.4.1 Association between the Location of Residence and the Use of Incandescent Bulbs

H_0: There is no significant association between the location of residence and the use of incandescent bulbs

In order to analyse the association between the location of residence and the use of incandescent bulbs, chi square test was applied. The result is as follows:

Table 5.21

Chi Square Test of Association between the Location of Residence and the Use of Incandescent Bulbs

Location of Residence	Using		Not Using		Total
	No.	Percentage	No.	Percentage	
Rural	24	5.83	388	94.17	412
Urban	13	3.50	358	96.50	371
Total	37	4.73	746	95.27	783
Pearson Chi – Square			D.F	p value	Inference
2.34			1	0.126	Not Significant

Source: Primary Data

From the above table, it is clear that Pearson Chi – Square (2.34) with p value 0.126 is more than 0.05. Hence, the null hypothesis is accepted. Therefore there is no significant association between the location of residence and the use of incandescent bulbs among the domestic consumers of KSEB Ltd. That means, the use of incandescent bulbs is not depending on whether the residence is situated in the rural area or urban area.

5.4.2 Association between the Location of Residence and the Use of Slim Tubelights

$H_{0.}$: There is no significant association between the location of residence and the use of slim tube lights

In order to analyse the association between the location of residence and the use of Slim Tubelights, chi square test was applied. The result is given in the following table:

Table 5.22

Chi Square Test of Association between the Location of Residence and the Use of slim tube lights

Location of Residence	Using		Not Using		Total
	No.	Percentage	No.	Percentage	
Rural	316	76.70	96	23.30	412
Urban	331	89.22	40	10.78	371
Total	647	82.63	136	17.37	783
Pearson Chi – Square			**D.F**	**p value**	**Inference** Significant at 1% level , H_0 rejected
21.32			1	0.000**	

Source: Primary Data

From the above table, it is clear that Pearson Chi – Square (21.32) with p value 0.000 is less than 0.01 at 1% level of significance. Hence, the null hypothesis is rejected. Therefore, there is significant association between the location of residence and the use of Slim Tube lights among the domestic consumers of KSEB Ltd. It is also revealed from the analysis that, the urban domestic consumers use more Slim Tube Lights than the rural domestic consumers of KSEB Ltd.

5.4.3 Association between the Location of Residence and the Use of Compact Fluorescent Lamps (CFLs)

H_0: There is no significant association between the Location of Residence and the use of Compact Fluorescent Lamps (CFLs)

In order to analyse the association between the location of residence and the use of Compact Fluorescent Lamps (CFLs), chi square test was applied. The result is given in the following table:

Table 5.23

Chi Square Test of Association between the Location of Residence and the Use of Compact Fluorescent Lamps (CFLs)

Location of Residence	Using		Not Using		Total
	No.	Percentage	No.	Percentage	
Rural	401	97.33	11	2.67	412
Urban	353	95.15	18	4.85	371
Total	754	96.30	29	3.70	783
Pearson Chi – Square			**D.F**	**p value**	**Inference**
2.61			1	0.106	Not Significant

Source: Primary Data

From the above table, it is clear that Pearson Chi – Square (2.61) with p value 0.106 is more than 0.05. Hence, the null hypothesis is accepted. It is revealed that there is no significant association between the location of residence and the use of CFLs among the domestic consumers of KSEB Ltd. That means, the use of CFLs is not depending on whether the residence is situated in the rural area or urban area.

5.4.4 Association between the Location of Residence and the Use of Light Emitting Diode (LED) Lamps

H_0: There is no significant association between the location of residence and the use of Light Emitting Diode (LED) Lamps

In order to analyse the association between the location of residence and the use of Light Emitting Diode (LED) Lamps, chi square test was applied. The result is given in the following table:

Table 5.24

Chi Square Test of Association between the Location of Residence and the Use of Light Emitting Diode (LED) Lamps

Location of Residence	Using		Not Using		Total
	No.	Percentage	No.	Percentage	
Rural	281	68.20	131	31.80	412
Urban	303	81.67	68	18.33	371
Total	584	74.58	199	25.42	783
Pearson Chi – Square			**D.F**	**p value**	**Inference**
18.68			1	0.000**	Significant at 1% level , H_0 rejected

Source: Primary Data

From the above table, it is clear that Pearson Chi – Square (18.68) with p value 0.000** is less than 0.01, and hence the null hypothesis is rejected at 1% level of significance. Therefore there is significant association between the location of residence and the use of LEDs among the domestic consumers of KSEB Ltd. It is also revealed from the analysis that, the urban domestic consumers use more LEDs than the rural domestic consumers of KSEB Ltd.

5.4.5 Association between the Location of Residence and the Use of Zero Bulbs

H_0: There is no significant association between the location of residence and the use of Zero bulbs

For analysing the association between the location of residence and the use of Zero bulbs, chi square test was applied. The result is given in the following table:

Table 5.25

Chi Square Test of Association between the Location of Residence and the Use of Zero bulbs

Location of Residence	Using		Not Using		Total
	No.	Percentage	No.	Percentage	
Rural	119	28.88	293	71.12	412
Urban	121	32.61	250	67.39	371
Total	240	30.65	543	69.35	783
Pearson Chi – Square			**D.F**	**p value**	**Inference**
1.28			1	0.258	Not Significant

Source: Primary Data

From the above table, it is clear that, Pearson Chi – Square (1.28) with p value 0.258 is more than 0.05. Thus the null hypothesis is accepted. Therefore there is no significant association between location of residence and the use of Zero bulbs among the domestic consumers of KSEB Ltd. That means, the use of Zero bulbs is not depending on whether the residence is situated in the rural area or urban area.

5.4.6 Association between the Location of Residence and the Use of Ordinary Tube Lights

H_0: There is no significant association between the location of residence and the use of Ordinary Tube lights

For analysing the association between the location of residence and the use of Ordinary Tube lights, chi square test was applied. The result is given in the following table:

Table 5.26

Chi Square Test of Association between the Location of Residence and the Use of Ordinary Tube Lights

Location of Residence	Using		Not Using		Total
	No.	Percentage	No.	Percentage	
Rural	137	33.25	275	66.75	412
Urban	109	29.38	262	70.62	371
Total	246	31.42	537	68.58	783
Pearson Chi – Square			**D.F**	**p value**	**Inference**
1.36			1	0.243	Not Significant

Source: Primary Data

From the above table, it is clear that Pearson Chi – Square (1.36) with p value 0.243 is more than 0.05. Thus the null hypothesis is accepted. Therefore there is no significant association between the location of residence and the use of ordinary tube lights among the domestic consumers of KSEB Ltd. That means, the use of ordinary tube lights is not depending on whether the residence is situated in the rural area or urban area.

5.5 Association between the Location of Residence and the Use of Ceiling Fans

H_0.3: There is no significant association between the location of residence and the use of Ceiling Fans

For analysing the association between the location of residence and the use of Ceiling Fans, chi square test was applied. The result is given in the following table:

Table 5.27

Chi Square Test of Association between the Location of Residence and the Use of Ceiling Fans

Location of Residence	Using		Not Using		Total
	No.	Percentage	No.	Percentage	
Rural	401	97.33	11	2.67	412
Urban	362	97.57	9	2.43	371
Total	763	97.45	20	2.55	783
Pearson Chi – Square			**D.F**	**p value**	**Inference**
0.047			1	0.828	Not Significant

Source: Primary Data

From the above table, it is seen that Pearson Chi – Square (0.047) with p value 0.828 is more than 0.05. Hence, the null hypothesis is accepted. Therefore, there is no significant association between the location of residence and the use of ceiling fans among the domestic consumers of KSEB Ltd. That means, the use of ceiling fans is not depending on whether the residence is situated in the rural area or urban area.

5.6 Association between the Location of Residence and the Use of the Appliances- Analysis and Interpretation

a) Pearson Chi – Square (2.34) with p value 0.126 is more than 0.05 for association between the location of residence and the use of incandescent bulbs among the domestic consumers of KSEB Ltd. Hence, there is no significant association.

b) Pearson Chi – Square (21.32) with p value 0.000 is less than 0.01 at 1% level of significance for association between the location of residence and the use of Slim Tube lights among the domestic consumers of KSEB Ltd. Hence, there is significant association.

c) Pearson Chi – Square (2.61) with p value 0.106 is more than 0.05 for association between the location of residence and the use of CFLs among the domestic consumers of KSEB Ltd. Hence, there is no significant association.

d) Pearson Chi – Square (18.68) with p value 0.000** is less than 0.01, and hence the null hypothesis is rejected at 1% level of significance. Therefore there is significant association between the location of residence and the use of LEDs among the domestic consumers of KSEB Ltd.

e) Pearson Chi – Square (1.28) with p value 0.258 is more than 0.05. Thus the null hypothesis is accepted. Therefore there is no significant association between location of residence and the use of Zero bulbs among the domestic consumers of KSEB Ltd.

f) Pearson Chi – Square (1.36) with p value 0.243 is more than 0.05 for association between the location of residence and the use of ordinary tube lights among the domestic consumers of KSEB Ltd. Hence, there is no significant association.

g) Pearson Chi – Square (0.047) with p value 0.828 is more than 0.05. Hence, the null hypothesis is accepted. Therefore, there is no significant association between the location of residence and the use of ceiling fans among the domestic consumers of KSEB Ltd.

On the basis of Pearson Chi Square analysis, it is revealed that there is no significant association between the location of residence and the use of the following appliances among the domestic consumers of KSEB Ltd.

- Incandescent Bulbs
- Zero Bulbs
- Ordinary Tube Lights
- Ceiling Fans and
- CFLs

On the other hand, there is a significant association between the location of residence and the use of the following appliances among the domestic consumers of KSEB Ltd.

- Slim Tube Lights and
- LEDs

Thus energy efficient lamps are widely used by the consumers irrespective of the location of residence, except for LEDs and Slim tubelights. It is also revealed from the analysis that, the urban domestic consumers use more Slim Tube Lights and LEDs than the rural domestic consumers of KSEB Ltd.

5.7 Electricity Saving Potential of the Households

Electricity Saving Potential refers to the 'possible savings'. The electricity savings that can be attained by retrofitting energy efficient lights and fans were calculated earlier in this chapter. This part analyse the significance of electricity saving potential of retrofitting selected EE appliances of the households.

H_0.4 : The electricity saving potential in the households of Kerala is not significant

In order to analyse the significance of electricity saving potential of retrofitting selected EE appliances of the households, one sample'‘t' test is conducted. The result is given in the following table:

Table 5.28

Electricity Saving Potential on Retrofitting Energy Efficient Appliances - One sample 't' test

Label	**Observations** N	**Mean**	**Standard deviation**	**df**	**t Stat**	**p-value**
The Electricity Saving potential of the Households	783	3.07	1.08	782	79.92	0.000**

Source: Primary Data ** Significant at 1% level

The above table reveals the result of 't-Test: one sample' conducted to analyse whether retrofitting EE appliances will significantly contribute to the electricity savings of the households. Energy saving potential for each household is estimated for retrofitting incandescent bulbs by CFLs, Slim tube lights by LED tube lights, CFLs by LEDs, Zero bulbs by LEDs, Ordinary tube lights by Slim tube lights and Ceiling fans by Super efficient fans. The p value is 0.000 which is less than 0.01, hence the H_0 is rejected at 1% level of significance. Therefore it is evident that there is significant electricity saving potential on retrofitting EE appliances.

5.8 Conclusion

Before implementing a DSM project, the costs and benefits should be analysed to see whether the project is financially viable for the consumers. After retrofitting, the total electricity consumption in kilowatt hours per year per household is reduced to 467 and the total electricity charge is reduced to ₹1761. The subsidy provided to domestic consumers may be stopped if they are already benefitted from energy savings by the retrofitting schemes. The saved energy can be utilised to provide electricity to high priced industrial and commercial consumers which further leads to the industrial and economic development of the state. It can be concluded that there is significant electricity saving potential on retrofitting EE appliances in the domestic sector of Kerala. The monetary benefit of Demand Side Management was examined in detail in this chapter. In the following chapter the consumer perception and behaviour towards DSM will be analysed.

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Chapter 6

Perception of the Domestic consumers of Kerala State Electricity Board Limited towards Demand Side Management

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Chapter 6

Perception of the Domestic Consumers of Kerala State Electricity Board Limited towards Demand Side Management

6.1 Introduction

Demand Side Management is the modification of consumer perception and behaviour towards electricity consumption. So the analysis of perception of domestic consumers is an important aspect of DSM. This chapter deals with the analysis of data regarding the demographic profile, consumption pattern and the scope of Demand Side Management in Kerala. Further, it also deals with the consumer perception towards Demand Side Management and the effect of DSM measures on the future electricity consumption.

This chapter comprises of

a) Socio-Demographic Profile
b) Consumption Pattern of Electricity
c) Scope for Demand Side Management
d) Consumer Perception towards Demand Side Management
e) Effect of DSM measures on the Future Electricity Consumption

6.2 Socio-Demographic Profile of the Respondents

This part of the chapter analyses the socio-demographic profile namely, gender, age, educational qualification, number of family members, monthly family income, location of residence, type of building, type of roofing, number of rooms in the house and floor area in square feet.

Table 6.1

Demographic Profile of the Respondents

Socio-demographic Profile	Frequency	Percentage
Gender		
Male	496	63.35
Female	287	36.65
Total	**783**	**100**
Age Group		
20-30 Years	114	14.56
30-40 Years	276	35.25
40-50 Years	266	33.97
Above 50 Years	127	16.22
Total	**783**	**100**
Educational Qualification / Equivalent Qualification		
SSLC and below	106	13.54
Plus two	198	25.29
Degree	272	34.74
PG	207	26.43
Total	**783**	**100**
Location of Residence		
Rural	412	52.62
Urban	371	47.38
Total	**783**	**100**
Number of members in the family		
2 and below	159	20.31
3	253	32.31
4	270	34.48
Above 4	101	12.9
Total	**783**	**100**

Monthly Family Income		
Less than 15000	63	8.05
15000-25000	184	23.5
25000-35000	217	27.71
35000-45000	194	24.78
More than 45000	125	15.96
Total	**783**	**100**

Source: Primary Data

The above table 6.1 reveals that out of 783 total respondents, 496 respondents (63.35 percentage) were male and the remaining 287 respondents (36.65) were female domestic consumers of KSEB Ltd. Hence majority of the selected domestic consumers of KSEB Ltd. were male. Out of 783 total respondents, 114 respondents (14.56 percentage) belongs to the age category of 20 – 30 years, 276 respondents belongs to the age category of 30-40 years, i.e. 35.25 percentage of the selected domestic consumers of KSEB Ltd. belong to the age category of 30-40 years. Out of 783 total respondents, 106 respondents (13.54 percentage) have qualification either SSLC or below and 272 respondents have Degree qualification. That is, 34.74 percent of the selected domestic consumers of KSEB have Degree or equivalent qualification. Out of the total 783 respondents, 412 respondents (52.62 percentage) are from the rural area and 371 respondents (47.38 percentage) are from the urban area. Hence majority of the selected domestic consumers of KSEB are from the rural area.

Out of 783 total respondents, 270 respondents have four members in their family and 101 respondents (12.9 percentage) have above 4 members in their family. Hence 34.48 percentage of the selected domestic consumers of KSEB have four members in their family.

Out of 783 total respondents, 63 respondents (8.05 percentage) have less than a monthly income of 15000 and 217 respondents (27.71 percentage) have monthly income between 25000-35000. 24.78% of the selected households have monthly income between 35000-45000. Hence we can say that, more than half of the households have income varying from 25000-45000 i.e., 52.49%.

Table 6.2

Details of Housing of the Respondents

Housing Details	Frequency	Percentage
Type of Building		
Single storied	537	68.58
Multi storied	246	31.42
Total	**783**	**100**
Type of Roofing		
Tile	92	11.75
Concrete	691	88.25
Total	**783**	**100**
Number of Rooms		
Less than 3	132	16.86
3-5	401	51.21
5-8	208	26.56
Above 8	42	5.37
Total	**783**	**100**
Area in Square Feet		
Below 800	141	18
800 - 1300	328	41.89
1300 - 1800	219	27.98
1800 - 2300	81	10.34
Above 2300	14	1.79
Total	**783**	**100**

Source: Primary Data

The above table reveals that, out of the selected 783 respondents, 246 respondents (31.42 percentage) have multi-storied building and the remaining 537 respondents (68.58 percentage) have single storied building. Hence more than two-third of the selected domestic consumers of KSEB Ltd. have single storied building. Out of the 783 selected respondents, 92 respondents (11.75 percentage) have tile roofs for their house and the remaining 691 respondents (88.25 percentage) have concrete roofs for their house. Hence majority of the selected domestic consumers of KSEB Ltd. have concrete roofing for their house.

Out of the 783 respondents, 401 respondents (51.21 percentage) have 3-5 rooms in their house and 42 respondents (5.37 percentage) have above 8 rooms. Thus half of the respondents have 3-5 rooms in their house. Out of the 783 respondents, 328 respondents have houses of 800-1300 sq. ft, and 14 respondents (1.79 percentage) have above 2300 sq. ft. So, 41.89 percentage of the respondents have houses with 800 – 1300 sq. ft.

6.3 Consumption Pattern of Electricity

This part of the chapter analyses the level of electricity consumption, penetration of electrical home appliances, expenditure pattern, connected load and type of electricity connection.

Table 6.3

Level of Electricity Consumption

Level of electricity consumption	**Frequency**	**Percentage**
High	264	33.72
Medium	315	40.22
Low	204	26.06
Total	**783**	**100**

Source: Primary Data

The above table deals with the level of electricity consumption by the domestic consumers of KSEB. The result identified that out of the 783 domestic consumers of KSEB, 315 consumers (40.22 percentage) consume electricity moderately. From this, it is found that, most of the domestic consumers of KSEB Ltd. consume the electricity at a moderate level.

Table 6.4

Electricity Consumption Pattern of Households in Kerala

Name of the appliance	Total No. of appliances for 783 HH	Average no. of appliances per HH (Column 2/783)	In Watts	Duration of Use	Duration of Use in Hours	Electricity Consumption per day in units for one appliance (Column 4*Column 6)/1000	Electricity Consumption in units for one year (Column 7*365)
1	2	3	4	5	6	7	8
a.Incandescent Bulbs	43	0.0549	60	4	4	0.24	87.600
b.Slim Tube Light	2764	3.5300	28	4	4	0.112	40.880
c.CFL	3351	4.2797	15	4	4	0.06	21.900
d.LED lamps	2286	2.9195	9	4	4	0.036	13.140
e.Zero bulbs	360	0.4598	15	10	10	0.15	54.750
f.Ordinary Tube lights	294	0.3755	40	4	4	0.16	58.400
g.Fans	3332	4.2554	65	10	10	0.65	237.250
h.Refridgerators	701	0.8953	125	24	24	3	1095.000
i.Electric iron	677	0.8646	750	15 minutes	0.25	0.1875	68.438
j.TV	680	0.8685	100	5	5	0.5	182.500
k.Air Conditioners	251	0.3206	1500	2	2	3	1095.000
l.Air coolers	74	0.0945	200	2	2	0.4	146.000
m.Computer	403	0.5147	150	1	1	0.15	54.750
n.Exhaust Fans	693	0.8851	150	1	1	0.15	54.750

o.1.Washing machine Semi automatic	317	0.4049	325	2 hrs per week	0.285	0.092856	33.892
o.2.Washing machine Fully Automatic	274	0.3499	1500	2 hrs per week	0.285	0.428565	156.426
p.Water Heater	251	0.3206	3000	10 minutes	0.167	0.50001	182.504
q.Induction cooker	215	0.2746	1000	15 minutes	0.25	0.25	91.250
r.Microwave oven	164	0.2095	1500	10 minutes	0.167	0.250005	91.252
s.Mixer	744	0.9502	450	15 minutes	0.25	0.1125	41.063
t.Grinder	337	0.4304	500	1 hour per week	0.143	0.07143	26.072
u.Juicer	219	0.2797	900	10 minutes per week	0.024	0.0216	7.884
v.Motor Pump	806	1.0294	750	30 minutes	0.5	0.375	136.875
w.Radio	333	0.4253	15	1 hour	1	0.015	5.475
x.Dish washer	106	0.1354	1500	20 minutes	0.333	0.4995	182.318
y.Electric Sewing Machine	102	0.1303	85	30 minutes	0.5	0.0425	15.513
z.invertor	223	0.2848	300watts load	Back up 6 hours			

Source: Primary Data

The above table shows the electricity consumption pattern of 783 households for a year.The average number of appliances per households is calculated by dividing the total number of appliances by 783. Home appliances commonly used in the households in Kerala are taken for the study. The average consumption hours of each appliance and rating in watts of most common appliance are taken for the calculation. The unit of electricity is calculated by using the following formula

1 unit= One Kilowatt hour = watts*hours/1000

Electricity Consumption in Kilowatt hours per year for each type of Appliance for total sample households, electricity Consumption in Kilowatt hours per year per household (average Number) and electricity Consumption in units for one year are calculated separately.This helps to identify the consumption in units as average, total and per appliance.

Table 6.5

Expenditure Pattern for Electricity for Households in Kerala

Name of the appliance	Electricity Consumption in Kilowatt hours per year per HH	Electricity Consumption in Kilowatt hours per year for 783 HH (Column 2* 783)	Electricity Charge in Rupees per year per HH (Column 2*3.77)	Total Electricity Charge in Rupees per year for 783 HH (Column 3*3.77)
1	**2**	**3**	**4**	**5**
a.Incandescent Bulbs	4.81	3766.8	18.13	14200.8
b.Slim Tube Light	144.31	112992	544.05	425981
c.CFL	93.73	73386.9	353.36	276669
d.LED lamps	38.36	30038	144.62	113243
e.Zero bulbs	25.18	19710	95	74307
f.Ordinary Tube lights	21.93	17169.6	82.68	64729.4
g.Fans	1009.6	790517	3806.19	2980249

h.Refridgerators	980.33	767595	3695.84	2893833
i.Electric iron	59.17	46332.2	223.07	174672
j.TV	158.49	124100	597.51	467857
k.Air Conditioners	351.02	274845	1323.35	1036166
l.Air coolers	13.8	10804	52.03	40731.1
m.Computer	28.18	22064.3	106.24	83182.2
n.Exhaust Fans	48.46	37941.8	182.69	143040
o.1.Washing machine Semi automatic	13.72	10743.9	51.72	40504.4
o.2.Washing machine Fully Automatic	54.74	42860.8	206.37	161585
p.Water Heater	58.5	45808.4	220.55	172698
q.Induction cooker	25.06	19618.8	94.48	73962.7
r.Microwave oven	19.11	14965.3	72.04	56419.2
s.Mixer	39.02	30550.5	147.11	115175
t.Grinder	11.22	8786.25	42.3	33124.2
u.Juicer	2.21	1726.6	8.33	6509.28
v.Motor Pump	140.9	110321	531.19	415911
w.Radio	2.33	1823.18	8.78	6873.39
x.Dish washer	24.68	19325.7	93.04	72857.7
y.Electric Sewing Machine	2.02	1582.28	7.62	5965.2

Source: Primary Data

The above table represents the electricity charge for the sample households. The calculation is made on the basis of the average revenue realised from domestic consumers of KSEB, i.e, ₹3.77 per kWh.

Calculations :

a) Electricity Consumption in Kilowatt hours per year per households= Average no. of appliances per households * Electricity Consumption in units for one year

b) Electricity Consumption in Kilowatt hours per year for 783 households = Electricity Consumption in Kilowatt hours per year per households *783

c) Electricity Charge in Rupees per year per household = Electricity Consumption in Kilowatt hours per year per household *3.77

d) Total Electricity Charge in Rupees per year for 783 households = Electricity Consumption in Kilowatt hours per year for 783 households *3.77

Some appliances like fans, refridgerators, lighting appliances and motor pumps constitute the highest consumption in rupees. The total electricity consumption of fans is ₹2980249.09, refridgerators is ₹2893833.15, motor pump is ₹415911.11, Air conditioners is ₹1036165.65, TV is ₹467857.00. But the expenditure per household is more for lighting, fans, fridge and motorpumps. This is due to the high penetration of these appliances.

Table 6.6

Type of Electricity Connection

Type of Electricity Connection	**Frequency**	**Percentage**
Single Phase connection	587	74.97
Three Phase connection	196	25.03
Total	**783**	**100**

Source: Primary Data

Table 5.14 deals with the type of electricity connection of the selected consumers of KSEB Ltd. It reveals that out of the 783 respondents, 587 respondents (74.97 percentage) have single phase connection in their house. Hence majority of the respondents have single phase connection in their house.

Table 6.7

Connected Load of the Households

Connected Load (In Watts)	Frequency	Percentage
Less than 500	82	10.47
500-1000	108	13.79
1000-2000	143	18.26
2000-3000	122	15.58
3000-4000	107	13.67
4000-5000	69	8.81
5000-6000	99	12.64
Above 6000	53	6.77
Total	**783**	**100**

Source: Primary Data

The above table deals with the range of connected load of the domestic consumers of KSEB Ltd. The result shows that, out of the 783 domestic consumers of KSEB, 143 consumers (18.26 percentage) have connected load of 1000-2000 watts and 53 consumers (6.77 percentage) have connected load of above 6000 watts.

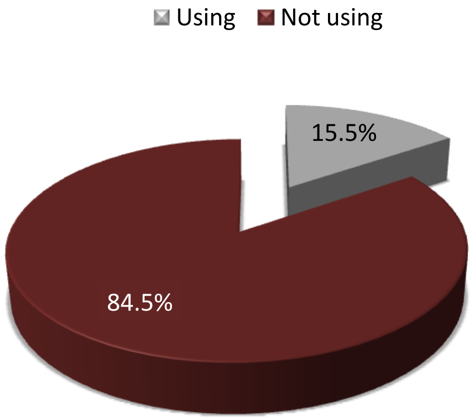
From the table it is found that about 50% of the domestic consumers of KSEB Ltd. have connected load ranging from 1000- 4000 watts.

6.4 Scope for Demand Side Management

This part of the chapter deals with the scope for Demand Side Management in the household sector of Kerala. It involves the scope for alternative sources of energy, time span of electrical appliances and the time of use of appliances.

Figure: 6.1

Use of Alternative Sources of Electricity in the Households



Source: Primary Data

The above figure represent that 121 (15.50%) of the households are using alternative sources of energy. Solar or biomass or both are the commonly used alternatives by the domestic consumers. 662 (84.5%) houses are not using any alternative sources.There is wide scope for DSM through the use of alternative sources in Kerala.

Table 6.8

Time Span of Electrical Home Appliances

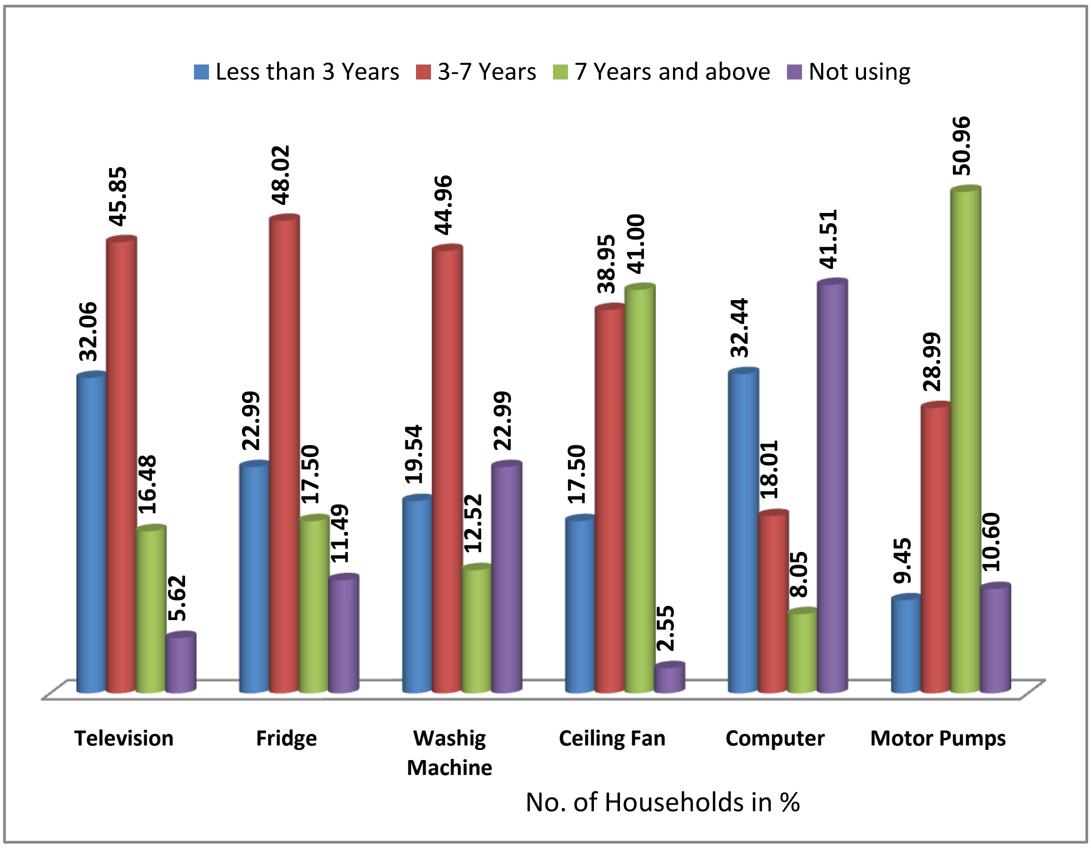
Time Span	Television	Fridge	Washig Machine	Ceiling Fan	Computer	Motor Pumps
Less than 3 Years	251	180	153	137	254	74
3-7 Years	359	376	352	305	141	227
7 Years and above	129	137	98	321	63	399
Not using	44	90	180	20	325	83
Total	**783**	**783**	**783**	**783**	**783**	**783**

Source: Primary Data

The above table 6.8 represents the time span of selected electrical home appliances. The households in Kerala are using different types of home appliances, but only the appliances having high penetration like TV, Fridge, washing machine, fan, computer and motor pumps are selected for the study.

Figure 6.2

Time Span of Selected Electrical Home Appliances



Source: Primary Data

The above chart shows the time span of selected electrical home appliances in percentage. Older electrical appliances consume more electricity. Motor pump is the appliance with the longest time span used by 399 (50.96%) of people. Only 74 i.e., 9.45% of people are using new motor pumps. Following the motor pump, Fans having a lifespan of 7 years and above are used by 321 (41 %) of people. Fan has the highest penetration, only 20 (2.55 %) people are not using fans. Computer is the appliance having timespan of less than three years used by 254 (32.44%) of consumers and 325 (41.51%) of households are not using computer at all. The next is fridge, with a life span of 3-7 years which is used by 376 (48.02%) households.

About half of the consumers have appliances which are 3-7 years old, including TV (45.85%), fridge (48.02%) and Washing Machine (44.96%). These appliances will be consuming the maximum amount of electricity.

So in case of implementing a DSM project for replacing electrical home appliances, motor pumps and fans can be given prior consideration because they are the oldest and most inefficient appliance as compared to other appliances. So there is high potential for Energy Efficiency in Kerala. In other words, there is great scope for DSM in Kerala through replacement of inefficient lamps.

Table 6.9

Time of High Use of Electrical Home Appliances

Time of Use	Television		Washing Machine		Computer		Motor Pumps		Lights		Fans	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
6AM –10 AM	103	13.2	245	31.3	7	0.9	168	21.5	137	17.50	101	12.90
10AM –6PM	188	24.0	253	32.3	86	11.0	197	25.2	0	0.00	128	16.35
6PM –10 PM	256	32.7	87	11.1	244	31.2	174	22.2	540	68.97	328	41.89
10 PM- 6 AM	192	24.5	18	2.3	121	15.5	161	20.6	106	13.54	226	28.86
Not Using	44	5.6	180	23	325	41.5	83	10.6	0	0	0	0.00
Total	783	100.0	783	100.0	783	100.0	783	100.0	783	100.0	783	100.0

Source: Primary Data

The above table represents the time of high use of selected electrical home appliances. Fridge has an even use irrespective of the time. Lights and fans have high use at evening and at night. The table shows that TV and computers have high use during the peak hours, 6 PM to 10 PM. There is great scope for load shifting in Kerala, by shifting the time of electricity use. The time slot considered by KSEB Ltd. for Time Of Use (TOU) pricing are Normal hours 6 – 18 hours, Peak hours 18 - 22 hours and Off-peak hours as 22 - 6 hours.

The association between the factors like the size of the household, location of residence and roofing, type of building, income level etc., and the level of electricity consumption are analysed below. Alternative sources of energy is alo discussed, to examine the scope for Demand Side Management.

6.4.1 Association between the Size of the Household and the Level of Electricity Consumption

$H_{0.}5$: There is no significant association between the size of the household and the level of electricity consumption

In order to analyse the association between the size of the household and the level of electricity consumption, chi square test for association is conducted and the results are presented in the following table:

Table 6.10

Chi Square Test for Association between the Size of the Household and the Level of Electricity Consumption

Number of Members in the Family	**High**		**Medium**		**Low**		**Total**
	No.	Percentage	No.	Percentage	No.	Percentage	
2 and below	37	23.27	65	40.88	57	35.85	159
3	83	32.81	93	36.76	77	30.43	253
4	92	34.07	126	46.67	52	19.26	270
Above 4	52	51.49	31	30.69	18	17.82	101
Total	264	33.72	315	40.23	204	26.05	783
Pearson Chi – Square			**D.F**	**p value**	**Inference**		
35.645			6	0.000**	Significant at 1% level , H_0 rejected		

Source: Primary Data

From the above table, it is clear that Pearson Chi – Square (35.645) with p value 0.000 is less than that of 0.01 at 1% level of significance. Thus the null hypothesis is rejected. Hence, there is a significant association between the size of the household and the level of electricity consumption among the domestic consumers of KSEB Ltd. The households with more than 4 members in the family is having a high level of electricity consumption i.e 51.49% and the households with less than two members have a low level of electricity consumption (35.85%).

6.4.2 Association between the Location of Residence and the Level of Electricity Consumption

H_0.6: There is no significant association between the location of residence and the level of electricity consumption

In order to analyse the association between the location of residence and the level of electricity consumption, chi square test for association is conducted and the results are presented in the following table:

Table 6.11

Chi Square Test for Association between the Location of Residence and the Level of Electricity Consumption

Location of Residence	**High**		**Medium**		**Low**		**Total**
	No.	Percentage	No.	Percentage	No.	Percentage	
Rural	109	26.46	187	45.39	116	28.16	412
Urban	155	41.78	128	34.50	88	23.72	371
Total	264	33.72	315	40.23	204	26.05	783
Pearson Chi – Square			**D.F**	**p value**	**Inference**		
20.82			2	0.000**	Significant at 1% level , H_0 rejected		

Source: Primary Data

From the above table, it is clear that Pearson Chi – Square (20.82) with p value 0.00003 is less than 0.01 at 1% level of significance. Thus the null hypothesis is rejected. Therefore there is a significant association between the location of the residence and the level of electricity consumption among the domestic consumers of KSEB Ltd. From the above table, it is revealed that the urban consumers have a high level of electricity consumption and electricity consumption is low in the case of rural consumers.

6.4.3 Association between the Location of the Residence and the Use of Alternative Sources of Energy

$H_{0.}7$: There is no significant association between the location of the residence and the use of alternative sources of energy

In order to analyse the association between the location of residence and the use of alternative sources of energy, chi square test for association is conducted and the results are presented in the following table:

Table 6.12

Chi Square Test for Association between the Location of the Residence and the Use of Alternative Sources of Energy

Location of Residence	**Using Alternative Source**		**Not Using Alternative Source**		**Total**
	No.	Percentage	No.	Percentage	
Urban	76	20.49	295	79.51	371
Rural	45	10.92	367	89.08	412
Total	121	15.45	662	84.55	783
Pearson Chi – Square			**D.F**	**p value**	**Inference**
13.66			1	0.000**	Significant at 1% level , H_0 rejected

Source: Primary Data

From the above table, it is clear that Pearson Chi – Square (13.66) with p value 0.000021 is less than 0.01 at 1% level of significance.Thus the null hypothesis is rejected. Hence, there is a significant association between the location of residence and the use of alternative sources of energy.

It is found that the usage of alternative sources of electricity is different among the rural and urban domestic consumers of KSEB Ltd. It is also revealed from the table that, the urban domestic consumers use more alternative sources of electricity than the rural domestic consumers of KSEB Ltd.

6.4.4 Association between the Type of Building and the Level of Electricity Consumption

H_0.8: There is no significant association between the type of building and the level of electricity consumption

In order to analyse the association between the type of building and the level of electricity consumption, chi square test for association is conducted and the results are presented in the following table:

Table 6.13

Chi Square Test for Association between the Type of Building and the Level of Electricity Consumption

Type of Building	**High**		**Medium**		**Low**		**Total**
	No.	Percentage	No.	Percentage	No.	Percentage	
Single storied	112	20.86	257	47.86	168	31.28	537
Multi storied	152	61.79	58	23.58	36	14.63	246
Total	264	33.72	315	40.23	204	26.05	783
Pearson Chi – Square			**D.F**	**p value**	**Inference**		
126.51			2	0.000**	Significant at 1% level , H_0 rejected		

Source: Primary Data

From the above table, it is clear that Pearson Chi – Square (126.51) with p value 0.000 is less than 0.01 at 1% level of significance. Thus the null hypothesis is rejected. Therefore there is a significant association between the type of building and the level of electricity consumption among the domestic consumers of KSEB Ltd. It is also found from the table that, the level of electricity consumption is high for the multi storied houses as compared to the single storied houses.

6.4.5 Association between the Type of Roofing of the Building and the Level of Electricity Consumption

H_{0}.9: There is no significant association between the type of roofing of the building and the level of electricity consumption

In order to analyse the association between the type of roofing of the building and the level of electricity consumption, chi square test for association is conducted and the results are presented in the following table:

Table 6.14

Chi Square Test for Association between Type of Roofing and the Level of Electricity Consumption

Type of Roofing	High		Medium		Low		Total
	No.	Percentage	No.	Percentage	No.	Percentage	
Tile	5	5.43	36	39.13	51	55.43	92
Concrete	259	37.48	279	40.38	153	22.14	691
Total	264	33.72	315	40.23	204	26.05	783

Pearson Chi – Square	D.F	p value	Inference
59.3	2	0.000**	Significant at 1% level , H_0 rejected

Source: Primary Data

From the above table, it is clear that Pearson Chi – Square (59.30) with p value 0.000 is less than 0.01 at 1% level of significance, thus the null hypothesis is rejected. Therefore there is a significant association between the type of roofing of the building and the level of electricity consumption among the domestic consumers of KSEB Ltd. It is also revealed that the level of electricity consumption is high in the case of houses with concrete roofing as compared to the tiled houses.

6.4.6 Relationship between Income level and the Expenditure Pattern (Electricity Bill)

H_{0}.10: There is no significant relationship between the income level and the expenditure for electricity of the domestic consumers of KSEB Ltd.

In order to analyse the relationship between the income level and the expenditure pattern of electricity of the domestic consumers of KSEB Ltd., correlation analysis is conducted and the results are presented in the following table:

Table 6.15

Relationship between Income Level and the Expenditure Pattern of Electricity

Variables	**Correlation (r)**	**Significance**
Income level and expenditure for electricity	0.673	0.000**
** ***Correlation is significant at 0.01 level (2-tailed)***		

Source: Primary Data

The above table shows the relationship between the income level and the expenditure for electricity consumption for the domestic consumers of KSEB Ltd. It indicates that the income level of the consumers has significant relationship with the expenditure for electricity of the domestic consumers of KSEB at 1% level of significance (p value .000 < 0.01). Hence the hypothesis is rejected. The result also reveals that the income level of the consumers has 67.3 percentage relationship with expenditure for electricity consumption for the domestic consumers of KSEB.

6.5 Consumer Perception towards Demand Side Management

Customer Perception refers to the process by which a customer selects, organizes, and interprets information or stimuli to create a meaningful image of the product which influence their decision making. Consumer perception towards DSM was analysed by examining the factors considered by the domestic consumers while purchasing the electrical home appliances, consumer awareness and opinion and the problems faced by the domestic consumers in practising demand side management. Independent ‘t’ test is applied to test the significant difference in the level of satisfaction in practising DSM between the rural and urban domestic consumers.

6.5.1 Factors Considered while Purchasing Electrical Home Appliances

Factors considered by the domestic consumers while purchasing electrical home appliances are analysed here. This helps to understand the perception of consumers regarding the quality and appearance of household appliances. Garrett’s Ranking Technique is used to find out the most significant factor considered by the domestic consumers while purchasing home appliances. First the percentage score is calculated as follows.

Table 6.16

Garrett’s Ranking - Percentage Position

Rank	**Garrett’s Formula** **=100 (Rij - 0.5) / Nj**	**Garrett Scale Value**
1	8.33	77
2	25.00	63
3	41.67	54
4	58.33	46
5	75.00	37
6	91.67	23

Source: Primary Data

The percentage values obtained for the six ranks are converted into Garrett scale values using Scale Conversion Table given by Henry Garrett. The total scores are calculated by adding the score values of each rank for every factor. The mean score is then calculated by dividing the total score by the number of respondents, to find out the order of preference given by the respondents for the factors.

Table 6.17

Garrett Score of the Factors Considered While Purchasing Electrical Home Appliances

Factors	**Total Score**	**Mean Score**	**Rank**
Colour	28249	36.08	VI
Design	35635	45.51	V
Brand Name	48911	62.47	I
Star Rating	41813	53.40	II
Convenience in Use	39128	49.97	IV
Price	41151	52.56	III

Source: Primary Data

The above table deals with the factors considered by the domestic consumers, while purchasing the electrical home appliances. The results identified that, the highest factor considered is the Brand Name with the Garrett score of 48911 and the second factor is Star Rating with the Garrett score of 41813. The least factor considered by the domestic consumers, while purchasing is the Colour of the appliances.

6.5.2 Consumer Awareness regarding Demand Side Management

H_0.11: Awareness of the domestic consumers regarding Demand Side Management is not significant

One sample ‘t’ test is conducted to analyse the significance of consumer awareness regarding Demand Side Management and the result is presented in the following table:

Table 6.18

Consumer Awareness Regarding Demand Side Management – One Sample ‘t’ test

Awareness	Mean	t Value	p value	Inference
I am aware of the various Energy Conservation measures	4.25	39.86	0.000**	p < .01 Highly Significant
I am aware of various Energy Efficiency measures	4.22	36.75	0.000**	p < .01 Highly Significant
I have knowledge about various Load Management measures	3.67	16.46	0.000**	p < .01 Highly Significant
I know that DSM helps to improve the quality (Voltage) and reliability (Uninterrupted power supply) of electricity	3.32	7.21	0.000**	p < .01 Highly Significant
I know that DSM helps to reduce electricity bill	3.42	10.70	0.000**	p < .01 Highly Significant

Source: Primary Data ** Significant at 1% level

The above table deals with the results of one sample ‘t’ test conducted to analyse the significance of consumer awareness regarding Demand Side Management. p value is less than that of 0.01 and the null hypothesis is rejected. Awareness of the domestic consumers regarding Demand Side Management is significant at 1% level of significance. The table also reveals the mean values on consumer awareness regarding demand side management. The mean score on “I am aware of the various Energy

Conservation measures" , 4.25 is the highest. The mean score on "I am aware of various Energy Efficiency measures", 4.22 is the second.

6.5.3 Consumer Opinion regarding Demand Side Management

Opinion of the domestic consumers is an important aspect of consumer perception.

$H_{0.}$ 12: Opinion of the domestic consumers regarding Demand Side Management is not significant

One sample 't' test is conducted to analyse the significance of consumer opinion regarding Demand Side Management and the result is presented in the following table:

Table 6.19

Consumer Opinion regarding Demand Side Management – One Sample 't' test

Opinion	Mean	t Value	p value	Inference
KSEB Ltd. and other utilities should expand various strategies to promote DSM	3.96	28.94	0.000**	p < .01 Highly Significant
DSM is the solution for power crisis of the state.	3.08	2.23	0.026*	p <.05 Significant
Government, KSEB Ltd. and other agencies should provide financial assistance and subsidies to customers for the promotion of DSM	3.24	6.16	0.000**	p < .01 Highly Significant
Behavioural modification of consumers through education is essential	3.18	4.61	0.000**	p < .01 Highly Significant
DSM measures ensure sustainability	3.11	2.80	0.005**	p < .01 Highly Significant
Level of Satisfaction				
Level of Satisfaction regarding Demand Side Management	3.83	21.32	0.000**	p < .01 Highly Significant

Source: Primary Data ** Significant at 1% level
*Significant at 5% level

The table above, deals with the results of one sample 't' test conducted to analyse the significance of consumer opinion regarding Demand Side Management. The p value is less than 0.01 except for the opinion "DSM is the solution for power crisis of the state" for which p value is less than 0.05 . So null hypothesis is rejected. Opinion of the domestic consumers regarding Demand Side Management is significant.

The table also reveals the mean values on consumer opinion regarding demand side management. The mean score on the expectation that, "KSEB Ltd. and other utilities should expand various strategies to promote DSM" is 3.96 which is the highest.

The mean score on the opinion that "DSM is the solution for power crisis of the state" with the value 3.08 is the lowest. Thus it can be observed that all the opinions are having a mean score above the average.

6.5.4 The Problems Confronted by the Domestic Consumers in Practising Demand Side Management

An analysis of the problems faced by the consumers in practising DSM is very essential. Solutions have to be provided for such problems for effective implementation of DSM. Problems commonly experienced by consumers of KSEB Ltd. are identified through discussions and literature review. Identified variables are the following:

1. **Lack of awareness regarding the monetary benefits of DSM measures**

Eventhough the consumers are aware of the measures for Demand Side Management, they are not fully aware of the monetary benefits arising from different DSM measures.

2. **Lack of motivation**

Lack of motivation is another problem faced by the domestic consumers. A real time feed back of energy consumption and awareness regarding the financial benefits of DSM is necessary for this.

3. **Energy Efficient appliances are not eco-friendly**

Many of the energy efficient appliances are not eco-friendly. For example, the mercury components of CFL are very hazardous to the environment. There are no ways for the disposal of old bulbs, tubelights and other appliances in case of replacements.

4. **Inconvenience in following DSM measures**

DSM measures like switching of electrical appliances when not in use, using alternative sources of energy etc. is very inconvenient.

5. **Cost factor**

Many of the BEE star rated and branded appliances are very costly. So the consumers hesitate to purchase such appliances.

6. **Time factor**

Time is a very important factor in today’s busy world. So the households will have difficulty in shifting the use of energy from the peak hours to the off- peak hours.

7. **Health and safety problems**

In addition to ecological problems, the new type of energy efficient electrical home appliances are causing threat to health and safety. For eg. the new LED light has high blue content, which can cause severe glare; resulting in pupillary constriction in the eyes, which when used in high levels can even damage the retina according to the American Medical Association.

8. **Lack of compulsion/ statutory measures**

The DSM measures are not mandatory in the case of domestic consumers as compared to industrial and commercial consumers.

9. **Lack of support from the family members**

All the family members, particulary children, do not have equal willingness in practising DSM.

10. **Availability of low quality electrical gadgets and foreign white goods at cheaper rates.**

As electrical appliances are available at cheaper rates from the market and through online shopping, consumers hesitate to purchase the branded appliances at higher price.

The appliances available at cheaper rates are often of low quality and does not last long. The purpose of cost effectiveness cannot be met through such a replacement.

The hypothesis tested regarding the problem faced by the consumers is given below:

H_0.13: Problems confronted by the domestic consumers in practising Demand Side Management is not significant

One sample ‘t’ test is conducted to analyse the significance of problems confronted by the domestic consumers in practising Demand Side Management.

The following table is formulated with the mean value, t value and p value regarding the problems mentioned above and inferences is drawn.

Table 6.20

Problems Confronted by the Domestic Consumers in Practising Demand Side Management – One Sample ‘t’ test

Problems	Mean	t value	p value	Inference
Lack of awareness regarding monetary benefits of DSM measures	3.2	3.96	.000**	p < .01 Highly Significant
Lack of motivation	3.11	2.45	.014*	p < .05 Significant
Energy Efficient appliances are not eco – friendly	3.85	22.05	.000**	p < .01 Highly Significant
Inconvenience in following DSM measures	3.83	22.95	.000**	p < .01 Highly Significant
Cost factor	4.17	27.91	.000**	p < .01 Highly Significant
Time factor	3.39	8.58	.000**	p < .01 Highly Significant
Health and Safety problems	3.46	10.85	.000**	p < .01 Highly Significant
Lack of compulsion/statutory measures	3.44	9.82	.000**	P < .01 Highly Significant
Lack of support from the family members	2.53	-10.08	.000**	p < .01 Highly Significant
Availability of low quality electrical gadgets and foreign white goods at cheaper rates	3.37	9.59	.000**	p < .01 Highly Significant

Source: Primary Data ** Significant at 1% level

*Significant at 5% level

The above table deals with the results of one sample‘t’ test conducted to analyse the significance of problems confronted by the domestic consumers in practising Demand Side Management. p value is less than 0.01 except for the problem, “Lack of Motivation” for which p value is less than 0.05 . So null hypothesis is rejected. Problems confronted by the domestic consumers is significant. The table also reveals the mean values on the problems faced by the domestic consumers in practising the demand side management. The result revealed that the major and the foremost factor that causes problems in practising Demand Side Management, by the domestic consumer is the cost factor (4.17), the second biggest problem is that the energy efficient bulbs and other appliances are not eco-friendly (3.85). While the third problem is inconvenience in following DSM measures (3.83) and the problem with the least prominance is lack of support from the family members (2.53).

6.5.5 Difference in the Level of Satisfaction Regarding the Practice of Demand Side Management between the Rural and Urban Consumers

H_{0}.14: There is no significant difference between the rural and urban consumers in the level of perception regarding satisfaction in practising Demand Side Management.

Independent sample 't' test is conducted to analyse the significance of difference between the rural and urban consumers in the level of perception regarding satisfaction in practising Demand Side Management and the result is presented in the following table:

Table 6.21

Perception Regarding Satisfaction in Practising Demand Side Management between Rural and Urban Consumers - Independent Sample 't' test

Variable	Label	N	Mean	Sd	t	p	Sig.
Level of satisfaction	Rural	412	3.43	1.06	1.69	.09	Not Significant
	Urban	371	3.30	1.12			

Source: Primary Data

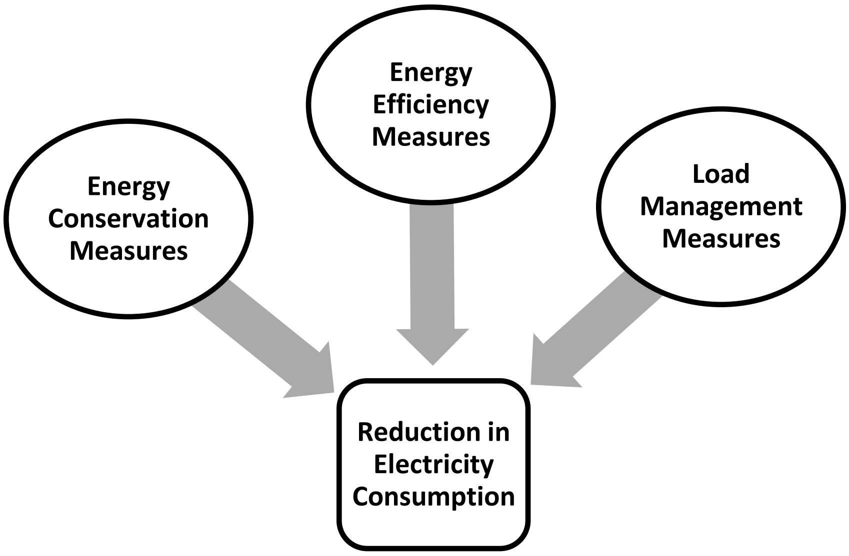
The above table reveals the result of Independent sample 't' test applied to test the significant difference in the level of satisfaction in practising DSM between the rural and urban domestic consumers of KSEB Ltd. The calculated value for the level of satisfaction (t value = 1.69) show that there is no significant difference between the rural and urban domestic consumers of KSEB Ltd., since its p value (.09) is more than 0.05 . Hence, the null hypothesis is accepted.

6.6 Demand Side Management from the Perspective of Domestic Consumers

The usage of electricity is an indicator of standard of living of the people. Consumers practise DSM for financial benefits and for attaining social values. Energy Conservation, Energy Efficiency and Load Management lead to the reduction in the consumption of electricity.

Figure 6.3

Proposed Structural Equation Model



6.7 Behavioural Changes Implied through Demand Side Management in Kerala

Behavioural Intention or willingness to practise the measures of DSM leads to considerable changes in the future electricity consumption. Behavioral Intention (BI) is defined as a person's perceived likelihood or "subjective probability that he or she will engage in a given behaviour", (Committee on Communication for Behaviour Change in the 21st Century, 2002)

Demand Side Management constitutes changes in the perception, energy usage behaviour and decision making of the consumer. Eventhough energy behaviour is diverse in nature, the following modifications in energy behaviour is expected in the area of energy conservation, energy efficiency and load management.

Energy Efficiency

Energy efficiency means the optimum utilisation of electricity through the use of CFLs/LEDs instead of incandescent bulbs, slim tubelights instead of ordinary ones, use of star rated/quality appliances, one watt LED bulbs instead of zerowatt bulbs, electronic regulator for fans, computers and TV with LED/LCD monitors etc.

Energy Conservation

Energy conservation is the curtailment of the use of electricity. Switching off lights, fans and other appliances when not in use, use of natural sunlight instead of using electric lights, use of fans, ACs and water pumps of correct size and capacity, defrosting the freezers in refridgerators periodically, setting sleep mode in computers when not in use, ironing the clothes once in a week instead of ironing one or two items daily, etc., can be considered as the wise use of electricity. The technical name for such wise usage is 'energy conservation'.

Load Management

This includes shifting the use of energy from peak hours 6.00 pm-10.00 pm to off-peak hours, avoiding the use of electricity under low voltage conditions, switching off fridge for a few hours during peak time, avoiding the use of two or more heavy electricity appliances at a time, preventing excess use during festive seasons and occasions etc.

Load management is not only curtailing the consumption during peak hours (Peak clipping), but also increasing the consumption during the off-peak period (valley filling).

6.8 Structural Equation Model (SEM)

Structural Equation Modelling (SEM) is a statistical technique that proves the relationship between the independent variables and dependent variables. SEM aims to analyze the causal relationship between the latent constructs including estimation of variance and covariance, assessing confirmatory factor analysis, linear regression, testing hypotheses and modifying the theoretical models for the best fit. SEM is mainly used to test the hypotheses arising from the theoretical model specifying how the latent variables are related to each other and which latent constructs directly or indirectly influence the values of other latent constructs. In order to perform the SEM analysis, the two-stage approach recommended by Anderson and Gerbing (1988) was adopted. In the first stage (measurement model), the analysis is conducted by specifying the causal relationships between the observed variables and the underlying theoretical constructs. For this purpose, confirmatory factor analysis using AMOS 20 was performed. The paths or causal relationship between the underlying constructs were specified in the structural model (second stage). Once all the constructs in the measurement model (stage one) were validated and satisfactory fit achieved, a structural model is tested as a main stage of the analysis using AMOS 20.

Table 6.22

Reliability Analysis on the Demand Side Management Measures

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.858
Bartlett's Test of Sphericity	Approx. Chi-Square	70334.898
	Df	136
	Sig.	.000

Source: Primary Data

The above table reveals the results of two tests namely, Kaiser-Meyer-Olkin measure of sampling adequacy and Bartlett's Test of Sphericity, to test whether the relationship among the variables is significant or not. Kaiser-Meyer-Olkin measure of sampling adequacy shows the value of test statistic as 0.858 (KMO > 0.5), which means the factor analysis for selected variables is found to be appropriate. Bartlett's Test of Sphericity shows the significant value as 0.000, which means the selected variables are statistically significant and exhibits a high relationship among the demand side management measures of KSEB Ltd.

Data regarding the behavioural intention of the domestic consumers to follow energy conservation measures, energy efficiency measures and load management measures was collected using the interview schedule based on Likerts Five Point Scale rating.

Table 6.23

Clustering of Demand Side Management Measures of Kerala State Electricity Board Limited

Factor	**Parameters**	**Rotated Factor Loadings**
Factor 1: Energy Conservation Measures (ECM) 26.57 % of Variance	Switch off lights, fans and other appliances when not in use	0.579
	Iron the clothes once in a week instead of ironing 1 or 2 items daily	0.654
	Use alternative sources of energy	0.489
	Use of natural sunlight whenever possible	0.468
	Use of proper ventilation instead of fans and cooling systems	0.661
	Defrost the freezers in refridgerators periodically	0.637
Factor 2: Load Management Measures (LCM) 19.62 % of Variance	Shift the use of energy from peak hours 6.00 pm -10.00 pm to off-peak hours	0.654
	Switch off fridge for few hours during peak time	0.473
	Do not use two or more heavy electricit appliances at a time	0.594
	Avoid using current under low voltage conditions	0.526
	Do not make excess use during festive seasons and occasions	0.509

Factor 3: Energy Efficiency Measures (EEM) 15.71 % of Variance	Use of LED bulbs instead of CFLs	0.699
	Purchase of BEE Star rated appliances	0.766
	Use of 0.5 watt LED bulbs instead of Zero Watt bulbs	0.709
	Use of Energy Efficient tubelights	0.671
	Use of Energy Efficient Fans	0.718
	Replacing old and inefficient heavy electrical home appliances	0.515
Total Variance Explained : 61.95 % Variance		

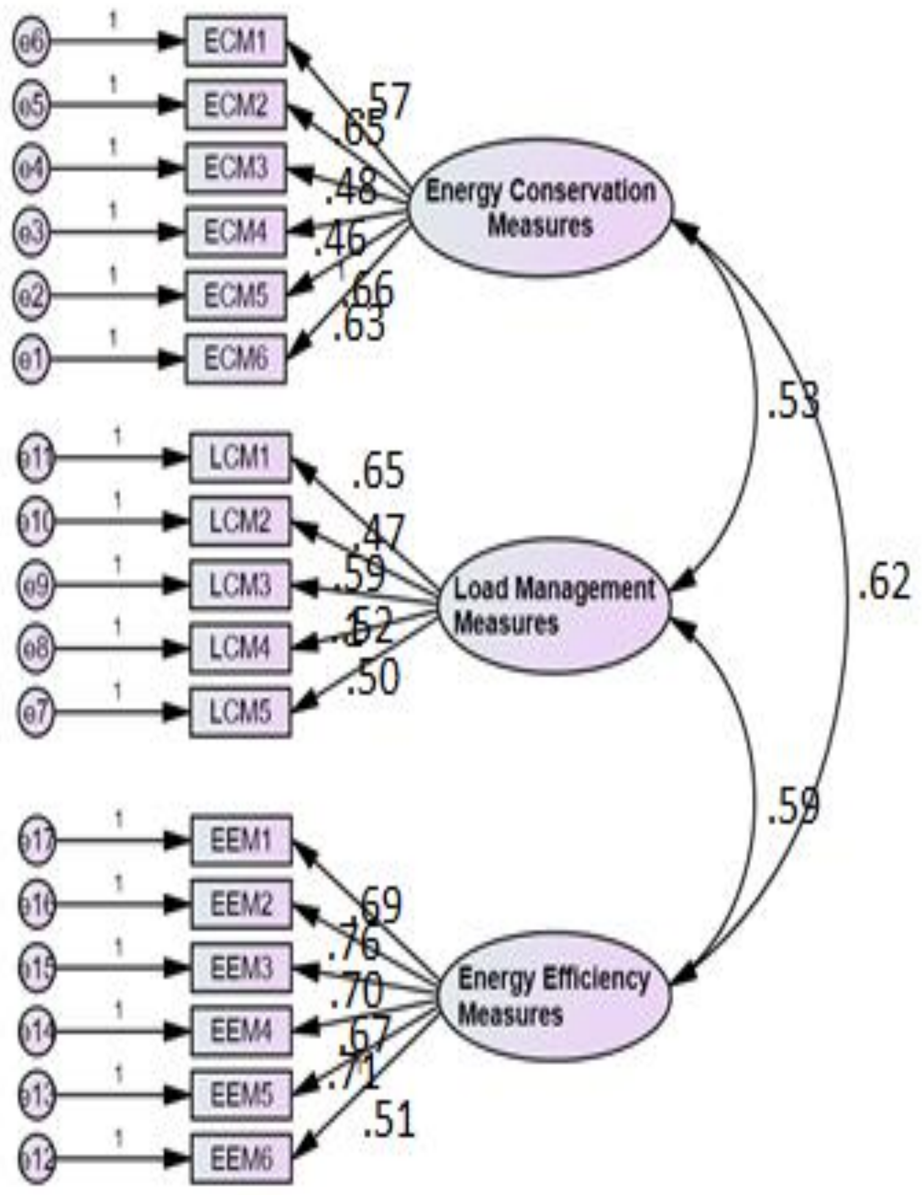
Source: Primary Data

The above table and figure indicate the factor model of demand side management measures. Keeping in view the Confirmatory Factor Analysis models conducted in the studies of Paré & Tremblay (2007) and Nasurdin, Ahmad, & Lin, (2009), it is decided that the factor loading of an item statement must be ≥ .40, to be retained in its respective scale. Thus it is noted that out of the 17 statements of demand side management measures, 3 factors have been extracted with the factor loading greater than or equal to .40 and these factors explain the total variance of demand side management measures to the extent of 61.95 percentage.

The 6 statements of demand side management measures were clustered together as factor 1 (Energy Conservation Measures) with 26.57 percentage variance. The other 5 statements of demand side management measures were grouped as factor 2 (Load Management Measures) with variance of 19.62 percentage. Another 6 statements of demand side management measures were formed together as factor 3 (Energy Efficiency Measures) with variance of 15.71 percentage.

Figure 6.4

Confirmatory Factor Model on Demand Side Management Measures



Source: Primary Data

It is identified that the loading patterns of the factors suggest a strong association among the parameters and all these variables are found to be contributing to the demand side management measures of KSEB Ltd. In the following table the results of goodness of fit indices are analysed.

Table 6.24

Results of Goodness of Fit Test for the Factor Model of Demand Side Management Measures of Kerala State Electricity Board Limited

Indices	CMIN/ Df	P	GFI	AGFI	NFI	TLI	CFI	RMSEA	RMR
Model Value	**1.528**	**.154**	**.989**	**.975**	**.970**	**.972**	**.983**	**.045**	**.049**
Recommended Value	**< 3.0**	**> .05**	**>0.90**	**>0.90**	**>0.90**	**>0.90**	**>0.95**	**< 0.05**	**<0.05**

Source: Compiled by the Researcher

CFA model yielded a good model fit with acceptable indices of GFI (Goodness of Fit Index = .989), AGFI (Adjusted Goodness of fit Index= .975) which considers the degrees of freedom, NFI (Normed Fit Index = .970), TLI (Tucker-Lewis Index= .972) and CFI (Comparative Fit Index = .983).

The RMSEA (Root Mean Square Error of Approximation= .045) , RMR (Standardized Root Mean square Residual)= .049, chi-square = 49.314, CMIN/df which means the minimum discrepancy divided by the degrees of freedom, i.e,1.528 and Probability level (p value) = .154, which is used for testing whether the model fit perfectly. (Anderson and Gerbing, 1988 Hair et al., 1995, Kline, 2005). It is concluded that the factors loaded for demand side management measures of KSEB Ltd. is within the prescribed limits recommended and thus the construct ensures unidimensionality.

6.9 Effect of Demand Side Management Measures on the Future Electricity Consumption

After analysing the loading patterns of the factors and the association among the parameters contributing to the Demand Side Management measures, next step is to test the hypotheses regarding the effect of the Load Management measures, Energy Efficiency measures and the Enegry Conservation measures on the future electricity consumption.

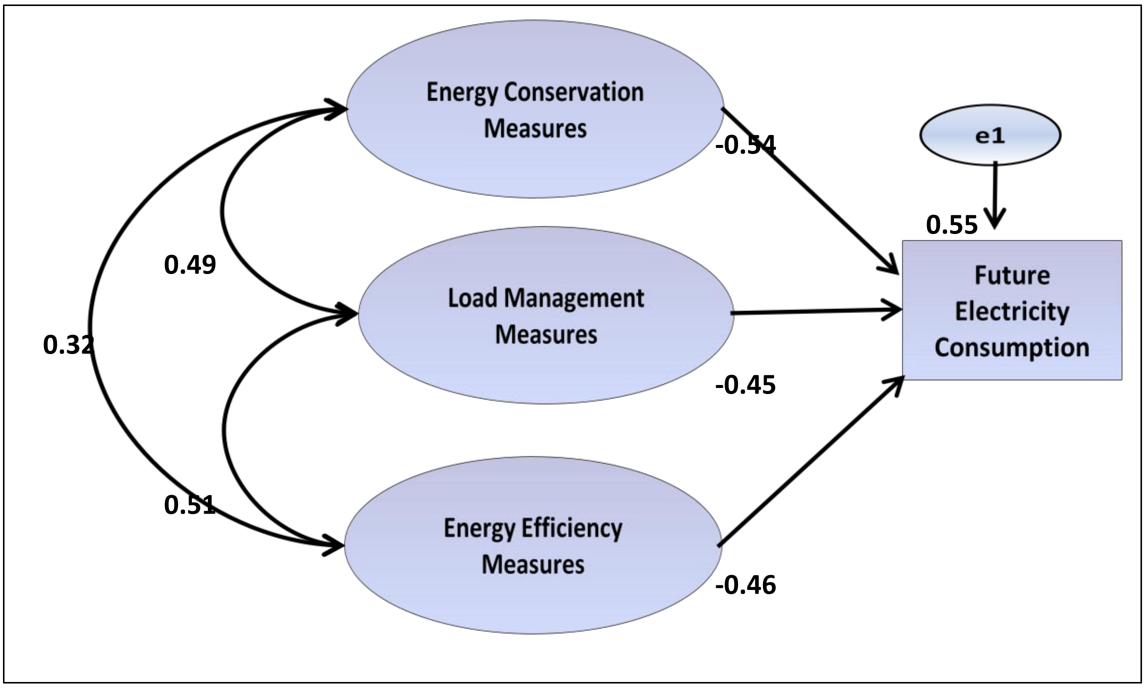
H_0.15: Load Management Measures have no significant effect on the future electricity consumption

H_0.16: Energy Efficient Measures have no significant effect on the future electricity consumption

H_0.17: Energy Conservation Measures have no significant effect on the future electricity consumption

Figure 6.5

Structural Equation Model with Standardized Regression Estimates



Source: Primary Data

The above figure shows the effect of the independent variables namely, Load Management measures, Energy Efficiency measures and the Enegry Conservation measures on the dependent variable future electricity consumption. Standardised estimates of the regression coefficients are given in the figure. The effect of the Load

Management measures, Energy Efficiency measures and the Enegry Conservation measures on the future electricity consumption is tested using regression coefficients as given below:

Table 6.25

Results of Goodness of Fit

χ^2/df	P	GFI	AGFI	NFI	TLI	CFI	RMSEA	RMR
2.341	0.346	.921	.915	.931	.964	.997	.042	.046
< 3.0	> 0.05	> 0.90	> 0.90	> 0.90	> 0.90	> 0.95	< 0.05	< 0.05

Source: Compiled by the Researcher

Table depicts the values of different goodness of fit indices. The values in respect of χ^2/df are 2.341, P value is 0.346, GFI is 0.921, AGFI is 0.915, NFI is .931, TLI is 0.964, CFI is .997, RMSEA is 0.042 and RMR is 0.046. These values revealing the results in respect of validity of the proposed model fall well, within the generally accepted limits.

This confirms that, the available data set, moderately fits into the proposed structural model.

Table 6.26

Regression Weights

DIM	INF	DIM	UE	SE	S.E.	C.R.	P	Inference
Future electricity consumption	←	Energy conservation measures	**-0.516**	**-0.54**	**0.104**	**-4.967**	***	Null Hypothesis rejected
Future electricity consumption	←	Load management measures	**-0.655**	**-0.45**	**0.083**	**-7.873**	***	Null Hypothesis rejected
Future electricity consumption	←	Energy efficiency measures	**-0.466**	**-0.46**	**0.087**	**-5.366**	***	Null Hypothesis rejected

*** Significant at 0.01 percentage Level
UE – Unstandardised Estimate
SE – Standardised Estimate
S.E – Standard Error
C.R – Critical Ratio
P – Probability Value
DIM – Dimensions
INF – Influence

Source: Primary Data

The Standardized Estimate (SE) is considered to find out the influence of the independent variable on the dependent variable. It is revealed that all the three variables of demand side management measures have negative influence on (will reduce) the future electricity consumption. Null hypothesis is rejected.The influence is identified as follows:

1. If energy conservation measures is increased by one unit, then it can be seen that the future electricity consumption is reduced by 0.516
2. If load management measures is increased by one unit, then it can be seen that the future electricity consumption is reduced by 0.655
3. If energy efficiency measures is increased by one unit, then it can be seen that the future electricity consumption is reduced by 0.466

Table 6.27

Squared Multiple Correlations (SMC)

Dimensions	**Estimate**
Future electricity consumption	0.55

Source: Primary Data

All the measures of demand side management such as energy conservation measures, load management measures and energy efficiency measures have 55 percentage influence on the future electricity consumption. Hence the SEM model proves the effect of demand side management measures on the future electricity consumption.

6.10 Conclusion

This chapter dealt with the socio-demographic profile, consumption pattern of electricity and scope for demand side management in the domestic sector of Kerala. Electricity consumption in kilowatt hours per year for each type of appliance for total sample of households, electricity consumption in kilowatt hours per year per household (average Number) and electricity consumption in units for one year are examined. This helped to understand the existing consumption level and the potential for DSM. It also analysed the opinion, awareness, level of satisfaction of the consumers and the problems faced by the domestic consumers in practising DSM. The effect of DSM measures on the future electricity consumption was also analysed, it is revealed that all the three variables of demand side management measure have negative influence on the future electricity consumption which means that if the Demand Side Management measures are increased, the electricity consumption in the future will be reduced.

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Chapter 7
Findings, Conclusion and Recommendations

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Chapter 7

Findings, Conclusion and Recommendations

7.1 Introduction

Energy Efficiency, Energy Conservation and Load Management have assumed enhanced significance in today's world. Energy conservation alone cannot meet the objective of Demand Side Management because energy conservation means the restricted use of electricity and in the long run this will restrict the overall growth and development. Improving the energy efficiency and load management along with energy conservation helps to promote sustainable development of the nation. The depleting fossil fuels, environmental pollution, health hazards of the generating stations, etc. forced the government to introduce new regulatory measures to make energy management mandatory through the Energy Conservation Act. The Bureau of Energy Efficiency has launched several energy management programmes. Over the past one decade, per capita consumption of electricity shows a steep increase.

Demand-Side Management (DSM) is the implementation of projects which helps the utilities to influence the customer-side of the electricity meter. This in turn reduces the energy costs of the Electricity Board and delays the generation capacity additions. DSM measures are unavoidable for providing reliable and affordable power for all. The electricity savings achieved through DSM can be supplied to the commercial and industrial sectors, who pay high price for electricity and contribute to the industrial and economic development of the nation.

7.2 The Research Problem

In Kerala, the main source of electricity is the hydroelectric plants. The state do not possess fossil fuel reserves for generation of electricity. Due to the public protests and strict environment protection laws, new power projects cannot be implemented. Because of these reasons, there is a wide gap between the demand and supply of elecrticity. Around half of the electricity usage is made by the subsidised household category of consumers. There is a large variation in the electricity demand during different time range and seasons. The demand during 6 pm to 10 pm is very high as compared to other time ranges and demand during summer season is more than that of the winter season. To meet this excess demand during peak period, capacity augmentation is required. But this augmented capacity remains idle during the off-peak period. Other wise electricity is to be purchased at higher cost to meet the excess demand.

Owing to this, proper energy management is essential to ensure sustainable consumption of electricty. It also helps to increase the efficiency of the Electricity Sector. DSM reduces the harmful impact of the power plants on the ecosystem. DSM can be attained by reducing the consumption of electricity during peak period and increasing the demand during the off-peak period. This is possible through the modification of the behaviour i.e, electricty usage pattern of the consumers. Electricity Boards use the 'de'marketing strategies for reducing the demand. The study is of great importance because very few studies have been conducted in the area of demarketing strategies for Demand Side Management.

From the literature review, it is concluded that no systematic study has been conducted regarding the demand side variables of energy management in Kerala and hence the researcher has taken it as the research problem.

The present work investigates into the following aspects of the research problem:

- The demarketing strategies implemented by Kerala State Electricity Board Limited in the domestic sector of Kerala for the promotion of Demand Side management

- The influence of demarketing strategies on the domestic consumer behaviour leading to Demand Side Management

- Financial viability of the energy efficient lights and fans used by the domestic consumers

- The trends in the electricity consumption in Kerala

- The level of perception of the domestic consumers regarding Demand Side Management

- Impact of Demand Side Management on the future electricity consumption

7.3 Objectives of the Study

The main objective of the study is to analyse the Demand Side Management in the Electricity Sector of Kerala. In order to attain the main objective, the following specific objectives are stated:

1. To examine the demarketing strategies implemented by Kerala State Electricity Board Limited for the promotion of Demand Side Management among the domestic consumers
2. To analyse the effect of demarketing strategies on the domestic consumer behaviour towards electricity
3. To conduct a 'Cost Benefit Analysis' of Demand Side Management with special reference to energy efficient lights and fans in the domestic sector of Kerala
4. To assess the trends of electricity consumption of the domestic consumers of Kerala State Electricity Board Limited
5. To study the level of perception of the domestic consumers of Kerala State Electricity Board Limited regarding the promotion of Demand Side Management.
6. To analyse the effect of Demand Side Management measures on the future electricity consumption

7.4 Research Hypotheses

In accordance with the objectives, the following hypotheses were formulated.

Objective: To analyse the effect of demarketing strategies on the domestic consumer behaviour towards electricity

H_0.1: Demarketing strategies of KSEB Ltd. have no significant effect on the domestic consumer behaviour towards electricity.

Objective : To conduct a 'Cost Benefit Analysis' of Demand Side Management with special reference to energy efficient lights and fans in the domestic sector of Kerala

H_0.2: There is no significant association between the location of residence and the use of lighting appliances.

H_0.3: There is no significant association between the location of residence and the use of ceiling fans.

H_0.4 : The electricity saving potential in the households of Kerala is not significant.

Objective : To assess the trends of electricity consumption of the domestic consumers of Kerala State Electricity Board Limited

H_0.5: There is no significant association between the size of the household and the level of electricity consumption

H_0.6: There is no significant association between the location of residence and the level of electricity consumption.

H_0.7: There is no significant association between the location of the residence and the use of alternative sources of energy.

H_0.8: There is no significant association between the type of building and the level of electricity consumption.

H_0.9: There is no significant association between the type of roofing of the building and the level of electricity consumption.

H_0.10: There is no significant relationship between the income level and the expenditure for electricity of the domestic consumers of KSEB Ltd.

Objective : To study the level of perception of the domestic consumers of Kerala State Electricity Board Limited regarding the promotion of Demand Side Management

H_0.11: Awareness of the domestic consumers regarding Demand Side Management is not significant.

$H_{0.}$ 12: Opinion of the domestic consumers regarding Demand Side Management is not significant.

H_0.13: Problems confronted by the domestic consumers in practising Demand Side Management is not significant.

$H_{0.}$14: There is no significant difference between the rural and urban consumers in the level of perception regarding satisfaction in practising Demand Side Management.

Objective : To analyse the effect of Demand Side Management measures on the future electricity consumption

H_0.15: Load Management Measures have no significant effect on the future electricity consumption.

H_0.16: Energy Efficient Measures have no significant effect on the future electricity consumption.

H_0.17: Energy Conservation Measures have no significant effect on the future electricity consumption.

7.5 Research Methodology

The study titled “A Study on the Demand Side Management (DSM) Adopted by Kerala State Electricity Board Limited” is both descriptive and analytical. Both the secondary and primary data are used for the study. The secondary data from 2006-2007 to 2016-17 is used in the study. Secondary data sources consist of reports and publications of Kerala State Planning Board, Central Statistical Organisation, Kerala State Electricity Board Ltd., Energy Management Centre, Agency for Non-conventional Energy and Rural Technology, Ministry of Power and the Central Electricity Authority. In addition to this, related articles in journals, reports, magazines and websites are also used. Primary data collection methods are used to analyse the electricity usage pattern, demographic profile, scope for DSM, perception, electricity saving potential, exposure towards demarketing strategies, effect of the demarketing strategies and consumer behaviour of the domestic consumers.

Cluster sampling method is used among 25 electrical circles (clusters) in Kerala, 4 electrical circles are taken for the study.The population of the study is 93,84,957 domestic consumers and the sample size is 666 domestic consumers. Out of 800 numbers, 783 interview schedules were received completed.

This study is organized into seven chapters which clearly explain the design and methodology of the study formulated with the supportive literature reviews and strong theoretical background. The study mainly focuses to prove the objectives with the help of appropriate statistical tools such as Percentage analysis, Descriptive Statistics, Independent 't' test, one sample 't' test, Chi-Square, Correlation Analysis, and Multiple Regression and finally validated the hypothetic conceptual model with the help of Structural Equation Modeling.

7.6 Limitations of the Study

1. KSEB Ltd. carries out the Demand Side Management activities in Kerala with the support of various agencies. In the present study only the role of EMC and ANERT are considered.
2. The social and environmental impacts of DSM are not analysed in detail in the study.
3. The present work makes a Cost Benefit Analysis of energy efficient lights and fans only. Financial benefits of other DSM measures are not considered in the present study.

7.7 Findings of the study

The findings of the secondary data analysis, qualitative data analysis, cost benefit analysis and analysis of consumer perception and consumer behaviour conducted in the previous chapters are given below.

7.7.1 Highlights of the Electricity Sector of Kerala

7.7.1.1 Electricity Requirement and Availability in Kerala

The electricity requirement and availability in Kerala shows an increasing trend. The average annual growth rate of electricity requirement is 4.96 % and electricity availability is 5.20%.

7.7.1.2 Installed Capacity of Electricity Generation in Kerala

In Kerala, 48.34% of the electricity is generated from the thermal sources. 37.64% of the electricity is generated from hydro sources, 7.24% is from nuclear sources and 6.78% is from non-conventional sources.The major share of electricity generation is given by the State Sector (43.74%). The share of Central Sector is 36.6% and that of the Private Sector is only 19.66% of the total.

7.7.1.3 Renewable Energy in Kerala

The main source of renewable energy in Kerala is the small hydro plants. The major share of electricity from small hydro station is generated by KSEB Ltd. i.e., 358.9 MU.

7.7.1.4 Sales of Electricity in Kerala

Sales of electricity shows an increase from 2006-07 onwards, except for 2008-09 and for 2014-15. The average annual growth rate of total electricity sales is 5.07 % and that of the sales of electricity within Kerala is 5.91%. The year 2009-10 and 2011-12 show a major increase in the sale of electricity in Kerala.

7.7.1.5 Revenue from the Sale of Electricity

Upto 2012-13, there was only a slow increase in the revenue, from 2013-14 onwards, there is a steep increase in the revenue from the sales of electricty. The growth rate is above average for the years 2007-08, 2012-13 and 2013-14. The year 2013-14 shows the highest growth rate of 38.08%. The average annual growth rate of sales revenue is 11.48 %. The reason for the increase in the sales revenue for 2012-13 and 2013-14 is the tarriff hike and increased sales of electricity.

7.7.1.6 Annual Growth Rate of Per Capita Consumption of Electricity

The average annual growth rate of per capita consumption of electricity is 5.59%. The growth rate for the period 2009-10 and 2011-12 is more than the AAGR, 12% and 9.63% respectively.

7.7.1.7 Number and Connected Load of Different Category of Consumers

The different categories of consumers and their connected loads were analysed. Domestic consumers are the majority. They are 78.24% and have a connected load of 64.45% of the total. Commercial LT consumers are the second highest i.e., 11.34% of the total and have a connected load of 8.41%.

7.7.1.8 Sales and Revenue – Category-wise

51.18 % of the sales is made to the domestic consumers, but they are contributing only to 35.82 % of the revenue. 1.6 % of electricity sales is to agricultural consumers. They contribute 0.92 % to the revenue. 1.87 % of sales to public lighting category consumers provide only 1.42 % to the revenue. Sales to Licencees, Railway Traction and Export category of consumers though a small percentage (3.05 %, 1.14%, .25 %) contributes to 3.29 %, 1.18% and .11 % of the revenue.

7.7.1.9 Transmission and Distribution Loss

The percentage of T&D losses has decreased which means that the efficiency of the power system has improved. The T&D Loss percentage for 2016-17 is 13.93%.

For 2015-16 it was 14.37% and for 2014-15 it was 14.57% and for 2013-14 it was 14.95%.

7.7.1.10 Comparative Analysis of the Statement of Profit and Loss of KSEB Ltd.

Horizontal analysis of statements of profit and loss of KSEB Ltd. for the years 2015-16 and 2016-17 reveals that the revenue, i.e. both the tariff and non-tariff has been increased as compared to the previous year i.e. 2.79 % and 10.53 % respectively. The total expenses shows an increase of 14.38 %. The loss for the year 2016-17 has increased, 427.44%. This was due to the decrease in the revenue and increase in the expenses as compared to the previous year.

7.7.2 Demarketing Mix in the Electricity Sector of Kerala

The 4 P’s of demarketing mix used in the Electricity Sector of Kerala are given below:

7.7.2.1 Product

CFL / LED distibution, Retrofitting Energy efficient Equipment, BEE Star Rated Equipment and Alternative Sources of Energy are the strategies used. Bachat Lamp Yojana, Domestic Efficient Lighting Programme, LabhaPrabha, Energy Labelling, Super Efficient Equipment Programme, Solar energy, Bio-mass energy etc., are the tactics and innovative programmes implemented as part of the demarketing strategy.

7.7.2.2. Price

Tariff Hike, Telescopic billing, Time of Use Billing, Subsidies and Financial Incentives are the pricing strategies used.

7.7.2.3 Physical Distribution

Load management, Load shifting, Smart metering, Smart grids and Demand Response are the strategies used as part of physical distribution.

7.7.2.4 Promotion

Sponsored programmes/advertisements in various media, energy education programmes like energy conservation classes, seminars, talkshows, skit, video clippings, power quiz, smart energy programme for students, ‘Nalekkithiri Urjam’, Serve As a Volunteer of Energy (SAVE) programmes, essay writing competition, poster making, etc. are carried out through schools, colleges and other educational institutions and agencies. Public awareness campaigns like rally, camps, exhibition, energy management clinics for housewives, etc. for creating awareness. Distribution of materials like brochures, name slips, printed hats, leaflets, posters, shirts etc. as reminders. Statutory Measures like Anti Power Theft Squad, energy standards and energy audit are the different strategies used for promotion.

7.7.3 Exposure towards Demarketing Strategies

The mean score of the exposure of the domestic consumers towards demarketing strategies is analysed. The lowest mean score is for the exposure towards Statutory Measures which is only 2.93. Hence it can be concluded that domestic consumers of KSEB have high exposure towards CFL/LED distribution (mean score on the exposure towards CFL/LED distribution is 4.21), promotion of BEE Star Rated Equipment (4.08) and retrofitting energy efficient equipment(4.01) but have less exposure towards Statutory Measures.

7.7.4 Effect of Demarketing Strategies of KSEB Ltd. on the Domestic Consumer Behaviour towards Electricity

The model summary table shows the overall predictability of the regression model. Multiple Coefficient of Correlation is the Multiple R=.92. R^2 is the Squared Multiple Coefficient of Correlation or coefficient of determination of value 0.84 which states that all the 10 independent variables of demarketing strategies of KSEB contribute to 84 percent of variance on the dependent variable called electricity consumption. It is the proportion of variance in the dependent variable that is predictable from the predictors.

ANOVA results reveal that, there is a significant relationship between the variables tested in the hypothesis. Thus it has been identified that the factors of demarketing strategies of KSEB are closely associated and have an effect on the domestic consumer behaviour towards electricity.

The positive values of coefficients reveal that, the demarketing strategies have positive effect on the domestic consumer behaviour.

a) The effect on the dependent variable (domestic consumer behaviour) would increase by 0.616 for every unit increase in the independent variable (exposure towards Energy Education Programmes).

b) The effect on the dependent variable (domestic consumer behaviour) would increase by 0.655 for every unit increase in the independent variable (exposure towards Public Awareness Campaigns).

c) The effect on the dependent variable (domestic consumer behaviour) would increase by 0.766 for every unit increase in the independent variable (exposure towards Sponsored Programmes/Advertisements).

d) The effect on the dependent variable (domestic consumer behaviour) would increase by 0.833 for every unit increase in the independent variable (exposure towards Retrofitting Programmes).

e) The effect on the dependent variable (domestic consumer behaviour) would increase by 0.713 for every unit increase in the independent variable (exposure towards Tariff rates).

f) The effect on the dependent variable (domestic consumer behaviour) would increase by 0.863 for every unit increase in the independent variable (exposure towards Promotion of BEE Star Rated Equipment).

g) The effect on the dependent variable (domestic consumer behaviour) would increase by 0.784 for every unit increase in the independent variable (exposure towards Power Cuts / Load Shedding).

h) The effect on the dependent variable (domestic consumer behaviour) would increase by 0.792 for every unit increase in the independent variable (exposure towards Promotion of Alternative Sources).

i) The effect on the dependent variable (domestic consumer behaviour) would increase by 0.841 for every unit increase in the independent variable (exposure towards CFL/LED distribution programmes).

j) The effect on the dependent variable (domestic consumer behaviour) would increase by 0.277 for every unit increase in the independent variable (exposure towards Statutory Measures).

The effect in general proves that, the consumers have exposure to the demarketing strategies promoted by KSEB Ltd. and are motivated to make cautious usage of electricity. The CFL/LED distribution is the dominant demarketing strategy, as it has the highest standardized coefficient value.

7.7.5 Cost Benefit Analysis of Demand Side Management

7.7.5.1 Retrofitting Energy Efficient Fans

For the replacement of 110 watts fans and 85 watts fans, BCR is more than '1' even without providing discount on cost price. 65 watt fans are also the common type but the replacement of such fans are not cost beneficial upto 24% discount on cost price. BCR of replacing 65 watt fans will provide value more than '1' only if discount more than 24% is allowed on the cost price.

7.7.5.2 Retrofitting Super Efficient Fans

For the first two types of replacements, 110 watts and 85 watts, the replacement has a BCR more than '1' even at zero discount. But in the case of 65watts (common type) fans the replacement is beneficial only if discount more than 14% is provided on the cost price.

7.7.5.3 Retrofitting Energy Efficient Lamps

The Pay Back Period, Net Present Value and Benefit Cost Ratio is calculated for the four years at a discount rate of 10% and price reduction of 10%, 20%, 30%, 40% and 50% for the Projects. Project IV is beneficial only if discount is allowed at 40% on the cost price of the lamp. Projects III and IV are having negative NPV and

IRR even at 50% discount. So they cannot be accepted in the short run, but only after the PB period of 9.09 years and 8.64 years respectively. The replacement with LED tubelights provide positive NPV after 6 years if 50% discount is allowed on the cost price and give positive NPV after 9 years if only 40% discount is allowed on the cost price. So instead of replacing with slim tubelights, LED tubelights can be used because LED tubelights have a life span of 8-10 years.

7.7.5.4 Benefits of Energy Efficient Retrofitting to the Households

- Electricity Savings in units per year per household is 545 units.
- Electricity Savings in units per year for the total sample household is 426498 units.
- Electricity Savings in Rupees per year per household is ₹2053
- Electricity Savings in Rupees per year for the total sample (783 household) is ₹1607898.

7.7.5.5 Benefits of Energy Efficient Retrofitting to KSEB Ltd.

Cost means the discount given by KSEB Ltd. on energy efficient equipment to domestic consumers. Benefits to KSEB Ltd. refer to the avoided cost of capacity augmentation or electricity purchase plus energy savings by the subsidised group. KSEB Ltd. incurs ₹ 6.31 per unit for distribution of electricity. This is given at a subsidised rate of ₹ 3.77 per unit to domestic consumers. The difference of ₹ 2.54 per unit is the subsidy. This difference can be utilised for providing discounts for energy efficient equipment. The subsidy provided to domestic consumers can be stopped because the domestic consumers are already benefitted from energy savings by retrofitting energy efficiency appliances. The saved energy can be utilised to provide electricity to high priced industrial (₹6.77 per kWh) and commercial consumers (₹8.95 per kWh) which further leads to the industrial and economic development of the state.

7.7.5.6 Association between the Location of Residence and the Use of Appliances

Association between the Location of Residence and the Use of Appliances is tested using Pearson Chi – Square and the results are that there is no significant association between the location of residence and the use of the following appliances among the domestic consumers of KSEB Ltd.

- Incandescent Bulbs
- Zero Bulbs
- Ordinary Tube Lights
- Ceiling Fans and
- CFLs

On the other hand, there is a significant association between the location of residence and the use of the following appliances among the domestic consumers of KSEB Ltd.

- Slim Tube Lights and
- LEDs

Thus energy efficient lamps are widely used by the consumers irrespective of the location of residence, except for LEDs and Slim tubelights. It is also revealed from the analysis that, the urban domestic consumers use more Slim Tube Lights and LEDs than the rural domestic consumers of KSEB Ltd.

7.7.5.7 Electricity Saving Potential of the Households

't-Test: one sample' was conducted to analyse whether retrofitting EE appliances will significantly contribute to the electricity savings of the households. Energy saving potential for each household is estimated for retrofitting incandescent bulbs by CFLs, slim tube lights by LED tube lights, CFLs by LEDs, zero bulbs by LEDs, ordinary tube lights by slim tube lights and ceiling fans by super efficient fans.The result was that there is significant electricity saving potential on retrofitting EE appliances.

7.7.6 Perception of the Domestic consumers of Kerala State Electricity Board Limited towards Demand Side Management

7.7.6.1 Socio-Demographic Profile of the Respondents

a) Out of 783 total respondents, 496 respondents (63.35 percentage) were male Hence, majority of the selected domestic consumers of KSEB Ltd. were male.

b) 276 respondents (35.25 percentage) belong to the age category of 30-40 years.

c) Out of 783 total respondents, 272 respondents have Degree qualification. 34.74 percentage of the selected domestic consumers of KSEB Ltd. have Degree or equivalent qualification.

d) Out of total 783 respondents, 412 respondents (52.62 percentage) are from the rural area. Hence majority of the selected domestic consumers of KSEB Ltd. are from the rural area.

e) 270 respondents have four members in their family. 34.48 percentage of the selected domestic consumers of KSEB Ltd. have four members in their family.

f) 217 respondents (27.71 percentage) have monthly income between 25000-35000.

g) Majority of the selected domestic consumers of KSEB Ltd. have single storied building, 537 respondents (68.58 percentage).

h) 691 respondents (88.25 percentage) have concrete roofs for their houses. Hence majority of the selected domestic consumers of KSEB Ltd. have concrete roofing in their house.

i) Out of the 783 respondents, 401 respondents (51.21 percentage) have 3-5 rooms in their house. Half of the respondents have 3-5 rooms in their house.

j) Out of the 783 respondents, 328 respondents (41.89 percentage) belongs to houses of 800-1300 sq. ft

7.7.6.2 Consumption Pattern of Electricity

a. Analysis of the level of electricity consumption reveals that 315 consumers (40.22 percentage) consume electricity moderately.

b. The total electricity consumption of fans is ₹ 2980249.09 , refridgerators is ₹2893833.15, motor pump is ₹415911.11, Air conditioners is ₹1036165.65, TV is

₹467857.00. But the expenditure per house hold is more for lighting, fans, fridge and motorpumps. This is due to the high penetration of these equipment.

c. The analysis of the type of electricity connection of the selected consumers of KSEB Ltd. reveals that out of the 783 respondents, 587 respondents (74.97 percentage) have single phase connection in their houses. Hence majority of the respondents have single phase connection in their house.

d. Analysis of the range of connected load of the domestic consumers of KSEB Ltd. identified that out of the 783 domestic consumers of KSEB, 143 consumers (18.26 percentage) have connected load of 1000-2000 watts and 53 consumers (6.77 percentage) have connected load of above 6000 watts.

7.7.6.3 Scope for DSM

a) Solar or biomass or both are the commonly used alternatives by the domestic consumers. 662 (84.5%) houses are not using any alternative sources.There is wide scope for DSM through the use of alternative sources in Kerala. 121 (15.50%) of the households are using alternative sources of energy.

b) Motor pump is the appliance with the longest time span used by 399 (50.96%) of people.Only 74 (9.45%) of people are using new motor pumps. Following the motor pump, Fan having a lifespan of 7 years and above is used by 321 (41 %) of respondents. Computer is the appliance having time span of less than three years used by 254 (32.44%) of consumers.

c) About half of the consumers have appliances which are 3-7 years old. TV users - 45.85%, fridge - 48.02% and Washing Machine - 44.96%. These appliances will be consuming maximum amount of electricity.

So in the case of implementing a DSM project for replacing electrical home appliances, motor pumps and fans can be given prior consideration because they are the oldest and most inefficient appliance as compared to other appliances.

d) Fridge has an even use irrespective of the time. Lights and fans have high use at evening and at night. The above table shows that TV and computers have high use during the peak hours, 6 PM to 10 PM. There is great scope for load shifting (DSM) in Kerala.

e) Pearson Chi – Square test reveals that there is a significant association between the size of the house hold and the level of electricity consumption among the domestic consumers of KSEB Ltd. The households with more than 4 members in the family is having a high level of electricity consumption i.e 51.49% and the households with less than two members have a low level of electricity consumption (35.85%).

f) Pearson Chi – Square test reveals that there is a significant association between location of residence and the level of electricity consumption among the domestic consumers of KSEB Ltd. it is revealed that the urban consumers have a high level of electricity consumption and electricity consumption is low in the case of rural consumers.

g) Pearson Chi – Square test reveals that there is a significant association between location of residence and the use of alternative sources of energy. It is found that the usage of alternative sources of electricity is different among the rural and urban domestic consumers of KSEB Ltd. It is also revealed from the table that, the urban domestic consumers use more alternative sources of electricity than the rural domestic consumers of KSEB Ltd.

h) Pearson Chi – Square analysis reveals that there is a significant association between the type of building and the level of electricity consumption among the domestic consumers of KSEB Ltd. The level of electricity consumption is high for the multi storied houses as compared to the single storied houses.

i) Pearson Chi – Square analysis reveals that there is a significant association between the type of roofing of the building and the level of electricity consumption among the domestic consumers of KSEB Ltd. It is also revealed that the level of electricity consumption is high in the case of houses with concrete roofing as compared to the tiled houses.

j) Correlation analysis revealed that income level of consumers has 67.3 percentage relationship with expenditure for electricity consumption of the domestic consumers of KSEB Ltd.

7.7.6.4 Consumer Perception towards Demand Side Management

Consumer perception towards DSM was analysed to examine the factors considered by the domestic consumers while purchasing the electrical home appliances, awareness, opinion and problems and level of satisfaction. One sample 't' test revealed that the opinion, awareness and problems of domestic consumers are significant.

a) The factors considered by the domestic consumers while purchasing the electrical home appliances are analysed. The results identified that the highest factor considered is the brand name with the Garrett score of 48911 and the second factor is star rating with the Garrett score of 41813. The factor considered the least is the colour of the appliances.
b) The mean values on consumer awareness regarding demand side management reveals that "I am aware of the various Energy Conservation measures", 4.25 is the highest.
c) The mean values on consumer opinion regarding demand side management reveals that "I expect KSEB and other utilities to expand various strategies to promote DSM" with 3.96 is the highest.
d) The mean score on the problems faced by the domestic consumers in practising the demand side management revealed that major and foremost factor that causes problems in practicing the demand side management of KSEB by the domestic consumer is the Cost factor (4.17), the second problem is that Energy Efficient bulbs and other appliances are not eco – friendly (3.85) and the least problem is lack of support from the family members (2.53).
e) Independent 't' test applied to test the significant difference in the level of satisfaction in practising DSM between the rural and urban domestic consumers show that there is no significant difference between the rural and urban domestic consumers.

7.7.6.5 Effect of Demand Side Management Measures on the Future Electricity Consumption

SEM analysis revealed that all the three variables of demand side management measures have negative influence on future electricity consumption (Reduce future electricity consumption).

a. If energy conservation measures (the influence of the independent variable) is increased by one unit, then it can be seen that the future electricity consumption (dependent variable) is reduced by 0.516

b. If load management measures (the influence of the independent variable) is increased by one unit, then it can be seen that the future electricity consumption (dependent variable) is reduced by 0.655.

c. If energy efficiency measures (the influence of the independent variable) is increased by one unit, then it can be seen that the future electricity consumption (dependent variable) is reduced by 0.466

d. All the measures of demand side management such as energy conservation measures, load management measures and energy efficiency measures have 55 percentage influence on the future electricity consumption.

7.8 Conclusion

The study shows that, the Demand Side Management only can solve the problem of power crisis in Kerala. Since the power requirement is high compared to the power generated by KSEB Ltd. Memorandum of Understandings are being signed by KSEB Ltd. with various organisations and agencies engaged in generating electricity from alternative sources. Replacing Energy Efficient appliances in the place of inefficient appliances, promotion of star rated equipment, distribution of Compact fluorescent lamps (CFL) and LED lamps etc. are the significant measures adopted by KSEB Ltd. to achieve Demand side Management. Raising tariff rates, telescopic pricing, Time of Use pricing, load shedding and rationing of energy on equitable basis etc. are also carried out. Energy demand Management or DSM is the modification of consumption patterns of electricity. Consumer awareness programmes like save energy, DELP, Labhaprabha, Smart energy programmes, advertisements, power quiz, poster making and essay writing competitions are also conducted by KSEB Ltd. The above said measures of demand management help to make the consumers aware of the energy crisis. As responsible citizens, they will make rational use of electricity. As domestic consumers constitute 78 % of the total number of consumers, there will be drastic changes in Kerala’s Power Sector as all of them practice DSM. Around half of the total electricity sales is made to domestic consumers who generates only 36 % of the total revenue. Even though the total cost of electricity comes to ₹6.30 per unit only ₹3.77 per unit is raised from the domestic consumers as they are the subsidised group. It is hoped that extensive use of DSM measures will be promoted by KSEB Ltd.

7.9 Recommendations

a) Consumers are aware about the importance of energy management but not fully aware of the monetary benefits that can be attained through DSM. The energy education programmes should be concentrated on this aspect. Then only the consumers will become more responsible.

b) Inefficient and low quality electrical gadgets are available in the market at lower cost. The standards and labelling programme should be made mandatory and the sale of such gadgets should be prohibited.

c) Financial subsidies and schemes for DSM are not sufficient. The promotion of star rated Energy efficient products and CFLs and LEDs are very effective for DSM. Significant steps should be taken by the Electricity Board and the government for providing financial assistance for this.

d) Safe disposal of damaged/used CFL lamps is required to avoid mercury pollution.The disposal of old incandescent lamps and other inefficient appliances is also a matter of concern. A recycling plant is required in Kerala for the disposal of inefficient or used electrical appliances under appropriate administrative machinery. Otherwise the negative impacts of generation plants cannot be mitigated using DSM.

e) The member of the family who is meeting the electicity charges is aware of the need for reducing electricity consumption. But lack of co-operation of family members is a problem in practising DSM. Programmes like energy clinics for housewives are to be encouraged because the members who are handling heavy electrical home appliances should be aware of DSM. Energy education shall be included in the curriculum, so that children may grow as responsible citizens.

f) Majority of the consumers are aware of DSM measures but not practising them due to inconveniences, time factor etc. In Kerala, DSM is not mandatory in the case of domestic consumers. Observance of the statutory measures should be made more stringent.

g) DSM does not mean giving up comfort. It refers to using the energy more effectively. Energy Efficient Lamps and equipment of equal lumen output can be used to solve the problems of safety and security.

h) Load Management Strategies are to be adopted by the Electricity Board, to modify customer load pattern and to reduce their peak demands. Load management strategies may be demonstrated to the consumers, so that, they can make voluntary load curtailment during peak hours. Measures like Time-of-Use pricing can be implemented for all categories of consumers. Demand response, smart metering and smart grids help the consumers to have a real time feedback of their bills and electricity usage to facilitate real time control. Electricity is a service that cannot be stored so there should be effective utilisation during off-peak hours. The capacity that remain idle during off-peak hours can be used for new innovative purposes like electricity driven vehicles. Fuel crisis can be reduced through DSM. Advancement of technology is inevitable in Kerala. Further research is required for this.

i) The success of DSM measures lies in their ability to improve the cash savings of the utility. The subsidies given to agricultural and domestic consumers may be rationed. The funds thus saved can be utilised by KSEB Ltd. for productive purposes and for commercial and industrial purposes. The reduced electricity rates will encourage new energy intensive industries in Kerala and lead to a balanced use of electricity.

j) DSM regulations provided by the government does not specify target to be attained in terms of fund or units of energy savings to be attained through DSM. In order to carry out DSM succesfully, the actual electricity consumption should be available in units or in monetary terms. Then the standards of energy savings can be set and deviations can be calculated. For this surveys and data collection should be carried out to analyse DSM quantitatively. Load Survey is an important method used to measure the consumption pattern of the consumers by the Distributing Companies or State Electricity Boards. This may be uploaded on the website of KSEB Ltd. on a periodical basis. These details should be transparent so that theElectricity Board as well as researchers can make use of it for further research and analysis.

k) A study on the technical aspects of low plant load factor and the capacity utilisation of the generation plants may be carried out. In advanced nations, smart meters and smart grids are widely used. Such technological advancements should be introduced in Kerala for effective demand response activities.

l) Transmission and Distribution (T&D) losses in Kerala is showing a decreasing trend. Less T&D losses means more electricity is available.To reduce the T&D loss it is essential that the number of substations, transformers and length of cables and HT lines should be enhanced. Huge investments are required for this purpose.

m) In order to improvise DSM power tariff has to be restructured. At present consumers are classified into domestic, agricultural, commercial, industrial, general, railway etc. This may be redesigned in such a way that the benefits of subsidy accrue to the really deserving sections, among these categories.

n) In Kerala, thermal power stations shall not be encouraged. Hydro projects are renewable but large projects will destruct the ecological balance. Solution for this issue is the small hydro stations which provide more benefits as compared to the social costs involved in it. The tendency to depend on Independent Power Producers (IPPs) using Diesel and Naphtha as fuels may be discouraged. Power Sector investments may be controlled by the Central Government and State Governments. In order to ensure reliable and quality power in Kerala, the state has to create capacity augmentations. For this Micro, Mini and Small Hydro potential, which possess less negative effects, may be fully exploited. The enormous scope that exists for non-conventional energy sources like solar, tidal and wind may also be tapped to the maximum.

7.10 Policy Implications

a) Popularise LED village campaigns.

b) Encourage the participation of the State Designated Agencies in the area of energy management.

c) Contribution of professionals like Energy Auditors, Energy Managers etc. can be improved in the field of DSM in the household sector.

d) At present Energy Conservation Building Codes (ECBC) is applicable only for commercial and industrial buildings. Special programmes can be designed for implementing energy conservation building codes for construction of houses also.

e) Provide subsidies to invest in renewable energy sources for households.There is a need to develop strategies of alternate energy supply (e.g. biogas, smokeless chulhas, fuel efficient stoves etc.) for domestic consumers to avoid total dependence on LPG, induction cookers and microwave ovens.

f) Women should be involved in planning of household energy issues. Organise workshops/ training programmes for all family members especially children.

7.11 Scope for Further Research

a) The present study is an analysis of DSM in the Electricity Sector of Kerala with special reference to domestic consumers of KSEB Ltd. There is scope for further research in the case of other distribution licencees who purchase electricity from KSEB Ltd. and distribute in their respective areas. The DSM measures used by such distribution licencees among their consumers can be analysed.

b) The role of voluntory organisations, NGOs, Local Self Govt. Institutions and other organisations in carrying out energy management activities can be analysed.

c) Demand Side Management considers only the demand side variables but the supply side variables like the non-conventional sources of energy can be analysed in further studies for better energy management.

d) The researcher has made a Cost Benefit Analysis of energy efficient lighting in households. Further studies on Cost Benefit Analysis can be carried out in the following areas.

- Replacing home appliances with solar and bio energy appliances.
- Old agricultural pumps with energy efficient pumps.
- Energy efficient street lights.

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Annexure 1

Interview Schedule for the Domestic Consumers

Sl. No............

Part A

Demographic Profile

<table>
<tr><td rowspan="2">DP.1. Name of the Consumer</td><td colspan="2">DP.2 You belong to</td></tr>
<tr><td>a. Panchayat Area</td><td>b. Municipality/Corporation Area</td></tr>
<tr><td colspan="3">DP.3. Male/Female..................

Number of members in the family
DP.4.a. 2 and below.............
DP.4.b. 3...................
DP.4.c. 4...................
DP.4.d. Above 4 ....</td></tr>
<tr><td colspan="3">Educational qualifications /Equivalent

DP.5.a. SSLC and below......
DP.5.b. Plus two.........
DP.5.c. Degree.....
DP.5.d. PG.....</td></tr>
<tr><td colspan="3">Average Monthly income of the family

DP.6.a. Less than 15000
DP.6.b. 15000-25000
DP.6.c. 25000-35000
DP.6.d. 35000-45000
DP.6.e. Above 45000</td></tr>
<tr><td colspan="3">Age group

DP.7. a. 20-30 years
DP.7. b. 30-40 years
DP.7. c. 40-50 years
DP.7. d. Above 50 years</td></tr>
<tr><td colspan="2">DP.8.District</td><td>DP.9.Electrical Section</td></tr>
<tr><td colspan="2">DP.10. Number of rooms in your house</td><td>DP.11. Area in square feet</td></tr>
</table>

Part – B Consumption Pattern

CP1. Consumer number	CP2. 1.Single / 2.Multi storeyed building
CP3.Type of roofing: 1. Tiled /2.Concrete	
CP4. 1.Single phase / 2.Three phase	CP5. Connected Load
CP6. Your bimonthly electricity charge in rupees........	
CP7. Your bimonthly electricity consumption in units.................KWh	

CP 8.A. What are the different electrical appliances used in your house? Please specify the number: -

Name	Number of appliances	Watts	Hours of use
Name of appliances			
a.Incandescent Bulbs			
b.Slim Tube Light			
c.CFL			
d.LED lamps			
e.Zero bulbs			
f.Ordinary Tube lights			
g.Fans (Specify Ceiling/others)			
h.Refrigerators			
i.Electric iron			
j.TV			
k.Air Conditioners			
l.Air coolers			
m.Computer			
n.Exhaust Fans			
o.Washing machine S/F			
p.Water Heater			
q.Induction cooker			
r.Microwave oven			
s.Mixer/t.Grinder/u.Juicer			
v.Motor Pump			
w.Radio			
x.Dish washer			
y.Electric Sewing Machine			
z. Invertor			

CP 8.B. Can you judge the possible electricity savings that can be attained by retrofitting energy efficient lights and fans in your house

0 -15%	15% -30%	30% -45%	45% - 60%	Above 60%
1	**2**	**3**	**4**	**5**

CP.9. How old are your heavy electricity appliances?	Not Using	Less than 3 years	3 years-7years	7 years and above
a.Television				
b.Fridge				
c.Washing Machine				
d. Ceiling Fan				
e.Computer				
f.Motor pumps				
CP10. Are you using solar/ other alternative sources of energy in your house? If Yes, Please specify the source:- 1. Yes / 2. No				

CP.11 Time of high use of electrical home appliances

	Television	Washing Machine	Computer	Motor Pumps	Lights	Fans
6AM - 10 AM						
10AM - 6 PM						
6PM - 10 PM						
10 PM 6 AM						
Not Using						

Part –C

Demarketing Strategies of KSEB Ltd.

DS.1. Have the children in your family participated in or attended Energy Education Programmes like energy conservation classes, talkshows, skit, seminars, video clippings, power quiz, essay writing competition, poster making, 'smart energy' programme for students , 'nalekkithiri urjam', and other similar programmes in their educational institutions.

Number of programmes participated/attended ……………..

Above 4

3

2

1

None

DS.2. Public Awareness Campaigns like rally, camps, energy management clinics for housewives, SAVE energy programmes , distribution of materials as reminders like brochures, leaflets, posters, name slips, printed hats etc. Energy conservation and electrical safety exhibitions, Labhaprabha competition, touch screen energy information kiosks, energy conservation slogans as caller tunes in KSEB Offices.etc are conducted by KSEB Ltd. Number of programmes participated in …………….. Above 4 3 2 1 None

DS.3. Have you seen sponsored programmes/ advertisements regarding energy saving in the following media, tick if yes : a. Cinema Theatres, TV and other visual media ☐ b. Radio ☐ c. Newspaper, magazines or other publications ☐ d. Online ☐ e. Other media ☐

DS.4. Level of understanding regarding tariff revisions of KSEB Ltd :

Very High 5	High 4	Medium 3	Low 2	Very Low 1

DS.5. How many CFL/LEDs have you received from KSEB ?	Above 3	3 bulbs	2 bulbs	1 bulb	None

DS.6. Exposure towards the BEE Star Rated Equipments				
Very High 5	High 4	Medium 3	Low 2	Very Low 1

DS.7. Exposure towards retrofitting of Energy Efficient Equipments				
Very High 5	High 4	Medium 3	Low 2	Very Low 1

DS.8. Exposure towards the promotion of alternative sources of energy				
Very High 5	High 4	Medium 3	Low 2	Very Low 1

DS.9. Frequency of Power Cuts and load shedding in your area :	Very High 5	High 4	Medium 3	Low 2	Very Low 1

DS.10. Please tick your level of familiarity regarding the statutory measures to promote DSM :	Very High 5	High 4	Medium 3	Low 2	Very Low 1

DS.11. Please judge the effectiveness of the demarketing strategies of KSEB Ltd. mentioned above on modifying your behaviour towards electricity consumption:

Extremely effective 5	Very effective 4	Effective 3	Somewhat Effective 2	Not Effective 1

Part D

Consumer Perception towards DSM

DSM.1. Factors considered while purchasing electrical home appliances?	Please rank
1.Colour	
2.Design	
3.Brand name	
4.Star rating	
5.Convenience in using	
6.Price	

DSM. II Please provide tick marks	Strongly Agree 5	Agree 4	Neutral 3	Dis agree 2	Strongly disagree 1
Awareness					
I am aware of the various Energy Conservation measures					
I am aware of various Energy Efficiency measures					
I have knowledge about various Load Management measures					
I know that DSM helps to improve the quality (voltage) and reliability (uninterrupted power supply) of electricity					
I know that DSM helps to reduce electricity bill					

Opinion					
I expect KSEB and other utilities to expand various strategies to promote DSM					
DSM is the solution for power crisis of the state.					
I expect that Govt, KSEB and other agencies should provide financial assistance and subsidies to customers for the promotion of DSM					
I think that behavioural modification of consumers through education is essential					
DSM measures ensure sustainability					

DSM. III Please tick your level of Satisfaction regarding Demand Side Management	Very High 5	High 4	Medium 3	Low 2	Very Low 1

DSM . IV Problems	Extremely serious 5	Very serious 4	Serious 3	Somewhat Serious 2	Not Serious 1
1. Lack of awareness regarding monetary benefits of DSM measures					
2. Lack of motivation					
3. Energy Efficient appliances are not eco – friendly					
4. Inconvenience in following DSM measures					

5. Cost factor					
6. Time factor					
7. Health and Safety problems					
8. Lack of compulsion/statutory measures					
9. Lack of support from the family members					
10. Low quality electrical gadgets and foreign white goods are available at cheaper rates					

DSM. V Demand Side Management	Willingness to Practice				
DSM .1.Energy Efficiency Measures	Very High 5	High 4	Medium 3	Low 2	Very Low 1
Use of LED bulbs instead of CFLs					
Purchase of BEE star rated appliances					
Use of 0.5 watt LED bulbs instead of zerowatt bulbs					
Use of EE tubelights					
Use of energy efficient fans					
Replacing old and inefficient heavy electrical home appliances with appliances of correct size and capacity					
DSM .2. Energy Conservation Measures	Very High 5	High 4	Medium 3	Low 2	Very Low 1
Switch off lights, fans and other appliances when not in use					
Iron the clothes once in a week instead of ironing 1 or 2 daily					

Use alternative sources of energy					
Use of natural sunlight whenever possible					
Use of proper ventilation instead of fans and cooling systems					
Defrost the freezers in refridgerators periodically					
DSM .3. Load Management Measures	Very High 5	High 4	Medium 3	Low 2	Very Low 1
Shift the use of energy from peak hours 6.00pm-10.00pm to off peak hours					
Switch off fridge for few hours during peak time					
Do not use two or more heavy electricity appliances at a time					
Avoid using current under low voltage conditions					
Do not make excess use during festive seasons and occasions					

DSM. VI Percentage of reduction in the electricity consumption after practising DSM (Put Tick Mark)				
0 -15%	15% -30%	30% -45%	45% - 60%	Above 60%
1	**2**	**3**	**4**	**5**
Try to express savings in units.......................kWh				

Thank you

Annexure II
Interview Schedule for the
Kerala State Electricity Board Limited

Name of the Officer : .... Designation :...

Office:....................Name and Details of Programmes Conducted in the Office……….

Details of materials distributed as part of DSM in the Office :.....................................

What is DSM? What makes it different from Energy Conservation and Energy Efficiency? What are the Expected Outcomes of DSM?	
Can you explain the pricing policy followed by KSEB?	Tariff Rates, Differential Pricing, Financial Incentives/ Subsidies provided in billing
What are the sources that can be used as an alternative for electricity?	Alternative sources used in Kerala Promotion methods for alternative sources Promotion of energy efficient products
How the peak demand for electricity is managed?	Load management Difference between load shedding and power cuts
What are the programmes adopted for the Promotion of DSM? Are the same programmes implemented for the different categories of consumers?	DSM programmes conducted by KSEB Different categories of consumers
Are the DSM programmes cost beneficial? Which are the other organistions engaged in implementing the DSM programmes? What are the problems encountered while implementing DSM?	