सत्यमेव जयते
Government of India

A REPORT ON

IMPACT OF ENERGY EFFICIENCY MEASURES

FOR THE YEAR 2018-19

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Preface

Energy efficiency provides considerable potential to promote low carbon transformation in the Indian context. India had realized this importance of energy optimization long back, evident from the launch of the Energy Conservation Act in 2001. It had further directed its policies to focus specifically on energy efficiency by setting up the Bureau of Energy Efficiency (BEE) and then initiating the National Mission for Enhanced Energy Efficiency (NMEEE).

Rolling out several schemes to conserve energy is one aspect, but assessing their impact on ground helps to understand their actual effectiveness. Therefore, an impact assessment of all the schemes related to energy efficiency is required. In FY 2016-17, BEE had conducted a third-party assessment of annual energy savings of its own set of schemes for the last 10 years (2007-2017).

Along with BEE, there are other organizations at national level that are also supporting in energy efficiency by launching its own set of schemes. These schemes are spanning across major energy consuming sectors in India such as Industry, Commercial, Residential, Transport, Agriculture, Municipal etc., along with cross cutting mechanisms for realization of energy savings.

With respect to the related energy efficiency schemes, BEE **conducts an annual study comparing the actual energy consumption in a particular year with the estimated energy consumption, had the current energy efficiency measures not been undertaken i.e. counterfactual.**

BEE hired the services of an expert agency through competitive bidding to conduct this study for the FY 2018-19. The overall objective of this study is to assess the impact of all the energy efficiency schemes/programmes in India in terms of total energy saved and reduction in the amount of CO_2 emissions in 2018-19. This assignment has taken energy efficiency estimation based on impact of the schemes/ programmes implemented since FY 2015-16.

This study assesses the overall impact of all the energy efficiency schemes at national as well as state level for the FY 2018-19 and compares it with a situation where the same were not implemented. The study focuses on following schemes/programmes, viz. Perform, Achieve and Trade Scheme, Standards & Labeling Programme, UJALA Programme, ECBC – Commercial Buildings Programme, BEE Star rated buildings, Building Energy efficiency Programme, Corporate Average Fuel Economy (CAFE), FAME Scheme, BEE – SME Programme, GEF – UNIDO – BEE Project, GEF – World Bank Project, Agriculture Demand Side Management Programme, and Municipal Demand Side Management Programme.

The estimated findings of the report reflect that the adoption of energy efficiency schemes/ programmes have led to overall electricity savings to the tune of 113.16 BU in 2018-19, which is 9.39% of the net electricity consumption (1204 BU). The study divides the various sectors of the economy into those that only consume energy (i.e. Demand Side sectors) and those that primarily produce / transform / supply energy in addition to consuming energy (i.e. Supply Side sectors). Energy savings (electrical + thermal), achieved in the energy consuming sectors (i.e. Demand Side sectors) is to the tune of 16.54 Mtoe, which is 2.84% of the net total energy consumption (581.60 Mtoe) in 2018-19.

The total energy savings achieved is 23.73 Mtoe, which is 2.69% of the total primary energy supply (879.23 Mtoe) during 2018-19. This includes both Supply Side and Demand Side sectors of the economy. Overall, this study has estimated that various energy efficiency measures have translated into savings worth INR 89,122 crores (approximately) and contributed in reducing 151.74 Million Tonnes of CO_2 emission.

March 2020
New Delhi

Abhay Bakre
Director General, BEE

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Abbreviations

AC	Air Conditioner
BEE	Bureau of Energy Efficiency
BEEP	Building Energy Efficiency Programme
BU	Billion Units
CEA	Central Electricity Authority
CO_2	Carbon Dioxide
COP	Coefficient of Performance
CSTL	Cooling Season Total Load
CTV	Color Television
DCR	Direct Cooling Refrigerator
EE	Energy Efficiency
EESL	Energy Efficiency Services Limited
FFR	Frost Free Refrigerator
FY	Financial Year
GEF	Global Environment Facility
GWh	Giga Watt Hour
ISSER	Indian Seasonal Energy Efficiency Rating
kg	Kilogram
kW	Kilo Watt
kWh	Kilo Watt Hour
LED	Light Emitting Diode
LPG	Liquified Petroleum Gas
Mtoe	Million Tonne of Oil Equivalent
$MtCO_2$	Million tonne of carbon dioxide (emissions)
MU	Million Units
MW	Mega Watt
No	Number
Q	Quarter
RAC	Room Air Conditioner
RE	Renewable Energy
S&L	Standard and Labeling
S&L	Standards & Labeling
SDA	State Designated Agency
SEC	Specific Energy Consumption
TFL	Tubular Florescent Lamp
TWh	Tera watt hour
TOE	Tonne Of Oil Equivalent
UNIDO	United Nations Industrial Development Organization
UNNATEE	Unlock National Energy Efficiency Potential
UT	Union Territories
VLT	Visible Light Transmittance
W	Watt
WBP	Whole Building Performance
Yr	Year

Executive Summary

With a total energy consumption of 553.9 Million Tonnes of Oil Equivalent (Mtoe)[1] in 2017-18, India stood the third largest energy consumer in the world after United States of America and China. India also ranks highest in terms of growth rate of energy consumption in the world. India's energy consumption is expected to grow fastest among global economies and account for 11% of global energy demand by 2040[2].

As India, submitted its Nationally Determined Contributions (NDC) target to United Nations Framework Convention on Climate Change (UNFCCC), intending to reduce emission intensity of its GDP, the role of energy efficiency would be crucial in complying with those targets.

The Energy Intensity of India (at 2011-12 prices) decreased from 65.5 toe per crore rupees in 2011-12 to 55.8 toe/Cr Rupees in 2017-18, which is presented in Figure 1[3]. This decline is attributed to the services sector having a growing share of the economy, and deployment of energy efficiency programmes among other factors.

There have been multiple energy efficiency programs initiated in the country by Bureau

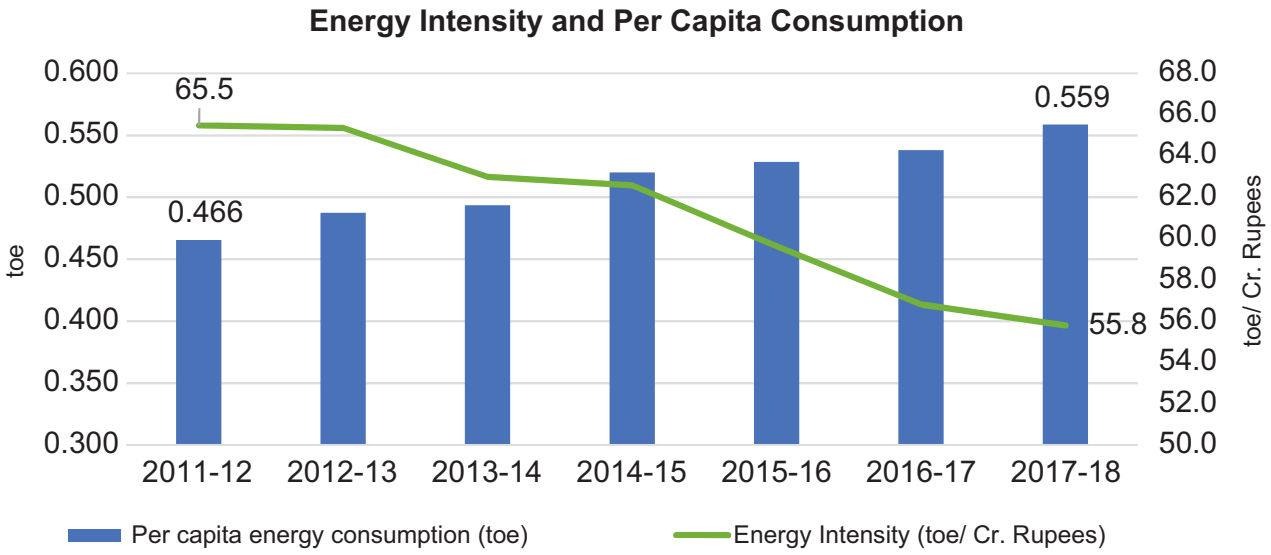


Figure 1: Energy intensity and Per capita Consumption trend

1 Energy Statistics, 2019

2 BP Energy Outlook – 2019

3 Energy Statistics, 2019. Here we considered 1 toe = 41,840.00 MJ

of Energy Efficiency (BEE), as well as complimenting programs by other agencies and institutions, a direct consequence of which can be observed in the declining trend of India's energy intensity of the economy.

Energy efficiency activities span across major energy consuming sectors in India, viz. Industry, Transport, Agriculture, Commercial, Residential, etc. along with cross cutting mechanisms for realization of energy savings. Several omnibus schemes at the national, state and sectoral levels are in operation, to achieve the goal of energy efficiency in India. Major energy consuming sectors and prominent schemes in these sectors are presented in Figure 2

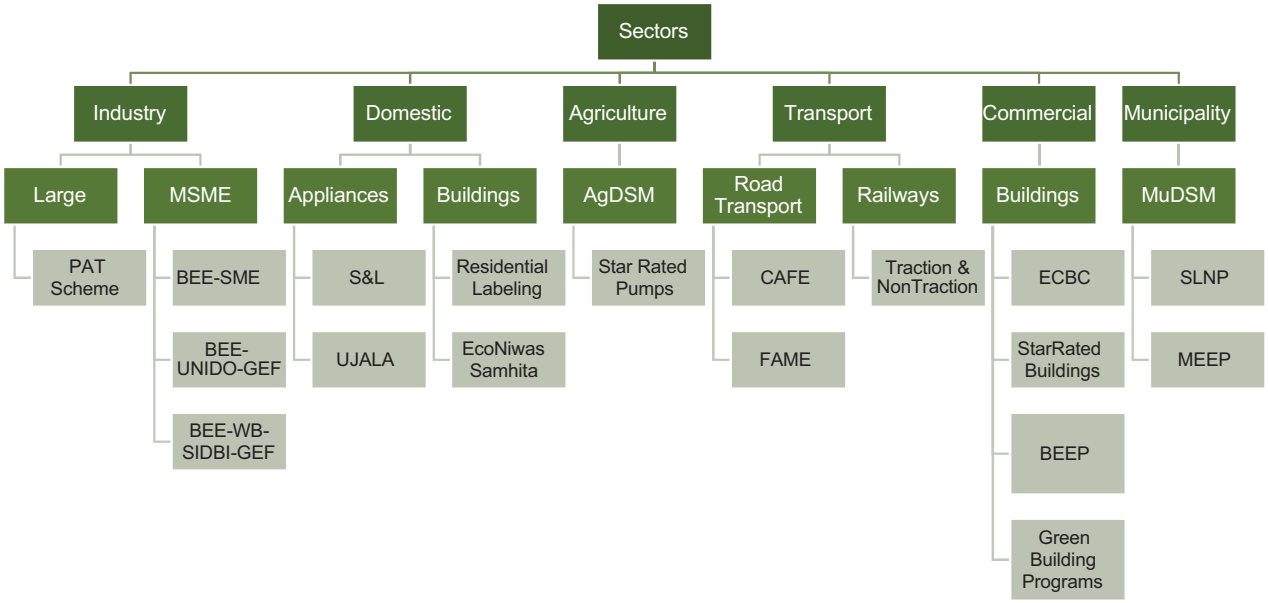


Figure 2: Energy Efficiency Schemes

Rationale and Objective

With respect to the related energy efficiency schemes, Bureau of Energy Efficiency conducts an annual study comparing the actual energy consumption in 2018-19 with the estimated energy consumption had the current energy efficiency measures not been undertaken i.e. counterfactual. BEE hires the services of an expert agency to conduct this study.

The overall objective of the study is to assess the impact of all the energy efficiency schemes/ programmes in India in terms of total energy saved and reduction in the amount of CO_2 emissions in 2018-19. In order to assess the impact, agency has carried out the following tasks:

- Review of all national level schemes pertaining to energy efficiency
- Data collection, verification and analysis

The agency had detailed consultations with all departments / agencies / bodies involved in implementing energy saving measures across the country.

Estimated Energy Savings for 2018-19

The adoption of energy efficiency schemes/ programmes has led to the overall energy savings of 23.728 Mtoe for the year 2018-19. Savings from various schemes and interventions are presented in Table 1.

The tentative findings of the report reflect that the adoption of energy efficiency schemes/ programs has led to the overall thermal energy savings in the order of 12 Mtoe, while overall electricity savings are to the tune of 136.374 BU.

PAT scheme contributed to 57.72% of the total energy savings, while S&L and UJALA accounted for 36.26% of the total energy saving from all major interventions carried out during the FY18-19. Share of various schemes in the total Energy savings is presented in Figure 3.

Table 1: Summary of energy savings (2018-19)[4]

Name of the scheme / programme		Energy Savings		Total Savings (Mtoe)	Emission Reduction ($MtCO_2$)	Monetary Savings (INR Crore)
		Thermal (Mtoe)	Electrical (BU)			
PAT Scheme	Demand side sector	5.901	7.064	6.509	25.529	14391
	Supply side sectors - TPP, DISCOMs & Refineries	5.192	23.215	7.189	36.371	20014
MSMEs	BEE-SME Programme	0.001		0.001	0.004	2
	BEE-UNIDO-GEF Programme	0.009		0.009	0.047	16
	BEE-WB-GEF Programme	0.012		0.012	0.073	22
Standards and labeling Programme			55.693	4.790	45.668	27846
UJALA Programme**			44.645	3.839	36.609	22323
ECBC – Commercial buildings programme			0.040	0.003	0.033	20
BEE Star rating buildings*			0.083	0.007	0.068	41
Building energy efficiency programme*			0.110	0.009	0.090	55
Other Green Building Programmes			0.070	0.006	0.057	35
MuDSM (Street Lighting Programme)			5.647	0.486	4.631	2824
AgDSM* (Star Rated Pumps)			0.18	0.015	0.148	90
Corporate Average Fuel Economy (CAFE)		0.848		0.848	2.650	1560
FAME-I Scheme		0.038		0.038	0.070	70
Total		**12.000**	**136.374**	**23.728**	**151.741**	**89,122**

4 *Saving of AgDSM, BEEP, Star rating building is primarily on account of the retrofitting of the energy efficient BEE star labeled appliances. As saving of the Appliances is accounted in S&L programme thus saving indicated under these heads are not included in total (to avoid double counting).**Saving other than UJALA LED deployment programme not considered

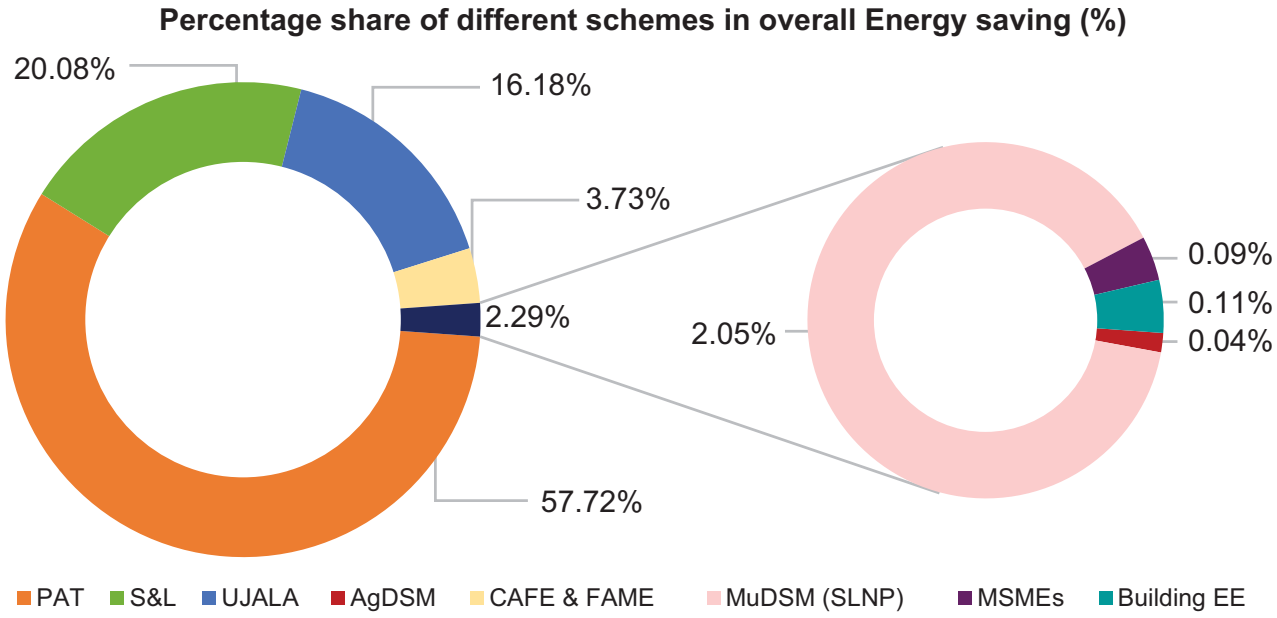


Figure 3: Total energy savings (Mtoe) by Scheme / Programme (2018-19)

Most of these schemes/programmes are essentially cross-sectoral in nature, therefore these schemes successfully managed to save energy across all the demand sectors.

Implementation of energy efficiency interventions has led to the reduction of 16.540 Mtoe in the demand side energy consumption, amounting to 2.84% of the energy demand (581.6 Mtoe[5]) during the 2018-19. Similarly, energy savings at the supply side has been achieved in the order of 23.728 Mtoe (inclusive of demand side energy savings). These energy savings amount to 2.69% of the total primary energy supply (879.23 Mtoe[5]) during 2018-19.

Thermal and Electrical Energy savings contribution from various economic sectors is presented in Table 2.

Table 2: Sector wise energy saving summary

Sector	Thermal Saving (Mtoe)	Electrical Saving (BU)	Total energy savings (Mtoe)	Emission reduction (Tonne of CO_2/year)
Industry[6]	10.980	7.998	11.67	43.33
Domestic[7]		92.003	7.91	75.44
Commercial Buildings (including buildings under PAT)		1.407	0.12	1.15
Transport (including Railways)	1.020	0.706	1.08	3.72
Others (including Municipal and DISCOM)		27.208	2.34	22.31
Agriculture (including Star Rated pumps)		7.051	0.61	5.78
Total	**12.000**	**136.374**	**23.728**	**151.74**

5 This is considered with assumption of 5% increase YoY on energy values of 2018 taken from MoSPI report.

6 Industry Sector includes the savings from PAT (Excluding – DISCOM, Buildings, Railways) and MSMEs

7 Domestic Sector includes the savings from S&L (except pump sets and DTs) and savings from UJALA programme

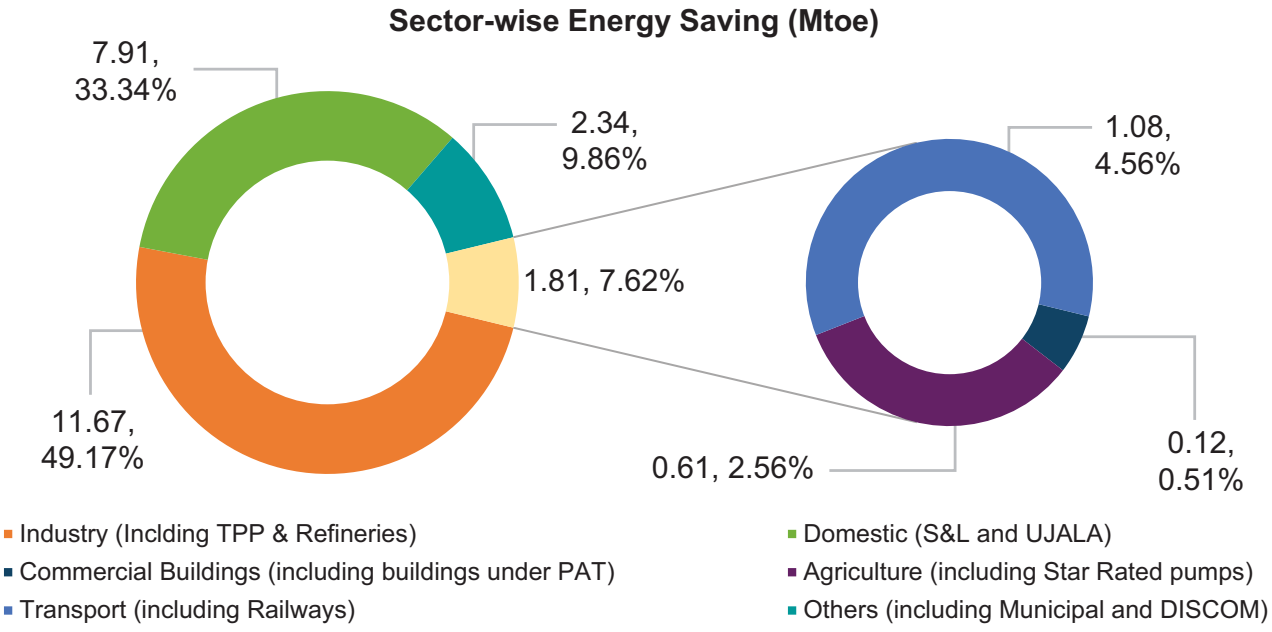


Figure 4: Total Energy Savings by Economic Sectors (2018-19)

Industry sector has the highest contribution (49.17%) in the total energy savings while domestic sector has contributed to 33.34% of the total savings achieved during FY 18-19.

Overall, these energy savings translated into monetary savings of worth INR 89,122 crores and contributed in reducing 151.741 Million Tonnes of CO_2 emission. Emission reductions from the various schemes is presented in Figure 5

Various interventions in industry sector contribute to 28.56% of the emission reductions by energy efficiency interventions carried out during FY 18-19, and various schemes under domestic sector had contributed to 49.72% of the total emission reductions.

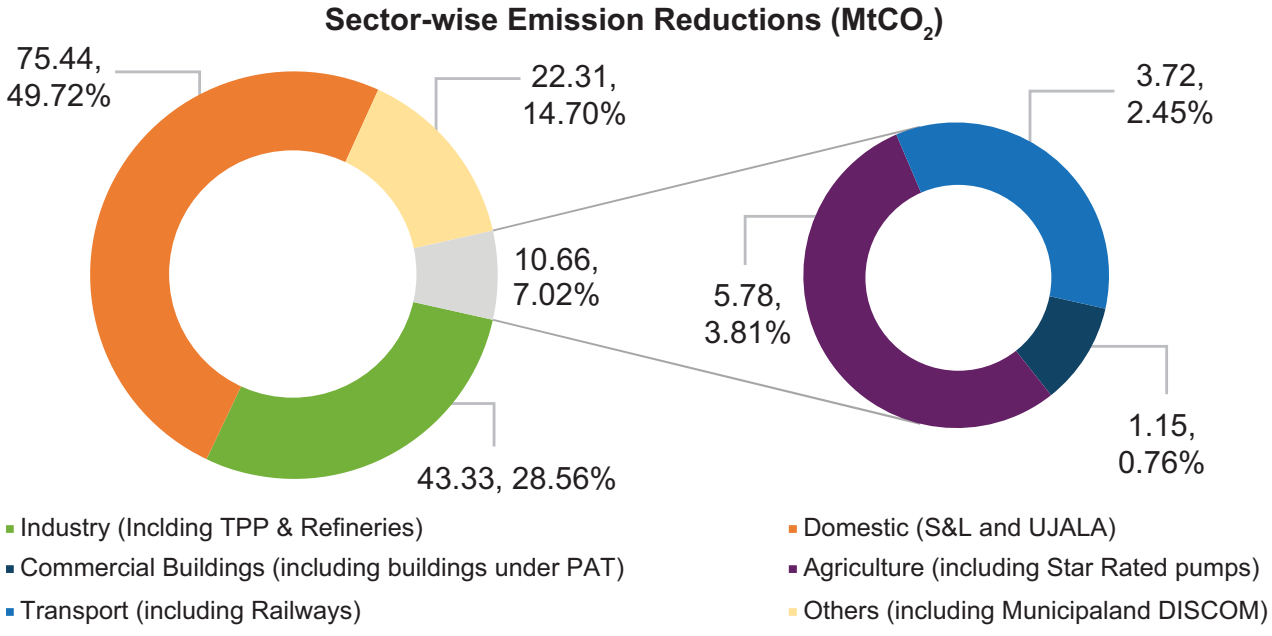


Figure 5: CO_2 Emission Reductions by Economic Sectors (2018-19)

Impact of various Energy Efficiency Interventions in India

Based on the energy savings data provided in the previous section, it is quite evident that all these schemes/programmes, were largely successful in generating substantial amount of savings spanning across major energy consuming sectors viz. Industry, Commercial, Residential, Transport, Agriculture, etc. and creating a culture of energy efficiency in India.

Over the years, Bureau of Energy Efficiency and various other institutions have initiated multiple energy efficiency programs for promotion of energy efficiency in India. The consolidated values of energy savings achieved for all these schemes during 2011-12 to 2018-19 across various sectors viz. Industry, building (domestic and commercial), municipal, agriculture, transport, and miscellaneous is calculated and impact of various schemes is presented in Figure 6. The role of energy efficiency remains crucial in complying by India's emission intensity reduction targets. Therefore, in order to capture the impact of all these interventions we have compared the energy savings achieved during the years with total energy consumption of the country for the respective years:

Across all these years, these energy efficiency interventions have not only resulted into significant energy savings but have also been successful in building institutional capacity and creating strong awareness for energy efficiency in India.

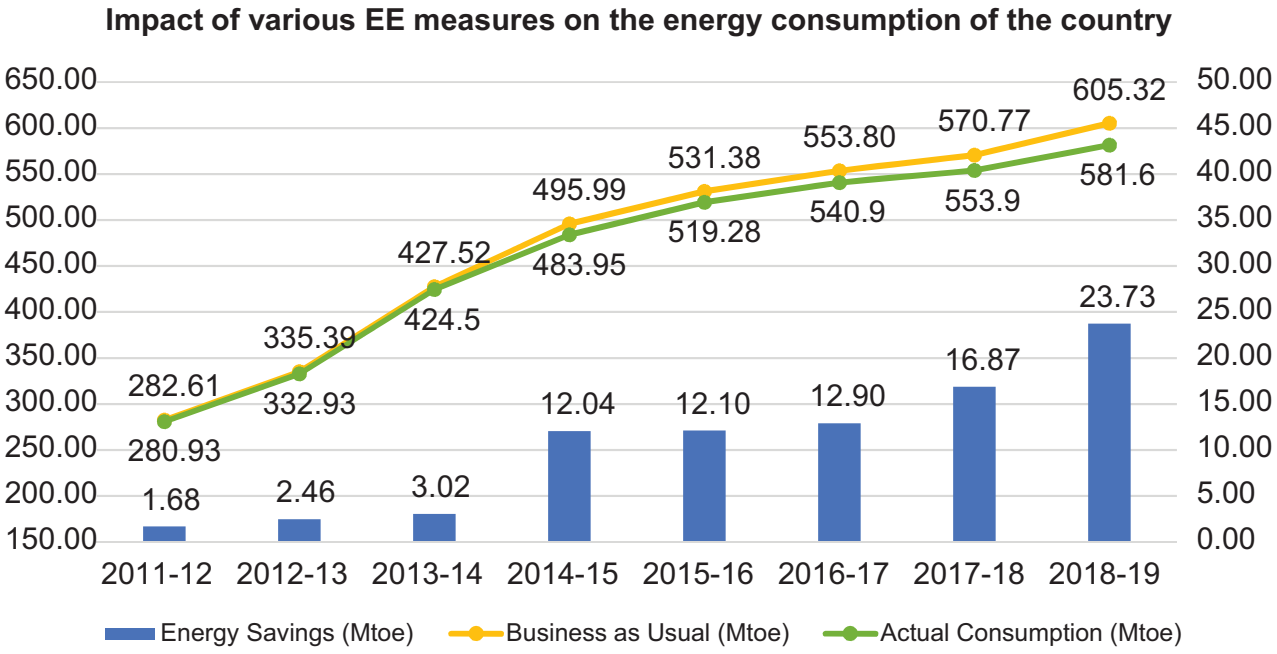


Figure 6: Impact of various EE measures (Mtoe)

Way forward

The energy demand in India is increasing rapidly by virtue of its growing economy, rapid urbanization and rising income levels. As energy has always been recognized as one of the most important inputs to determine the economic growth of a country, it is prudent to initiate new and innovative policies to curb the unnecessary energy consumption across all the sectors.

With this understanding, the Bureau of Energy efficiency has developed a National Strategy Plan Titled Unlocking National Energy Efficiency Potential (UNNATEE). As per the report, India's

Table 3: Comparison with UNNATEE

Sector	Energy Savings Potential[8] w.r.t baseline year, 2016-17 (Mtoe) till 2031	Pro-rata[9] Energy Savings Targets (Mtoe) for two years (2017-19)	Total Savings (Mtoe) for Last two Years (2017-19)	Achievement as compared to the target energy savings (Mtoe)
	(A)	(B)=(A)*14.3%	(C)	(D)=(C)-(B)
Agriculture	5.7	0.82	0.69	(0.13)
Commercial	4.9	0.70	0.22	(0.48)
Domestic	12.1	1.73	4.11	2.38
Municipal	0.1	0.01	0.49	0.48
Industrial	47.5	6.79	12.5	5.71
Transport	15.8	2.26	1.09	(1.17)
Total	**86.9**	**12.43**	**19.1**	6.66

energy saving potential is estimated to be 86.9 Mtoe in case of a “moderate” implementation of EE programs and 129 Mtoe in case of an “ambitious” implementation of EE programs by year 2031 which stands at 15% reduction in energy demand as compared to BAU approach to energy savings.

Bureau of Energy Efficiency and various other organizations initiated several omnibus policies at the national, state and sectoral levels to achieve the goal of energy efficiency in India. The consolidated values of energy savings achieved for all these schemes during last 2 years is compared with energy savings target for various demand sectors and presented in Table 3.

The current policy and program implementation landscape of the country shapes the energy consumption of the demand sectors. Current schemes/programs were largely successful in achieving significant energy savings across various sectors viz. Industry, building (domestic and commercial), municipal, agriculture, and transport. However, it is possible that the future landscape would be driven by disruptive technologies and economic mega-trends such as smart cities, e-mobility etc. which are changing the dynamics of energy sector.

Activities to operationalize the National Strategic Plan on Energy Efficiency would not only focus on available technology to make such improvements but would also include relatively new technologies such as E-mobility, fuel cell vehicles (FCVs), integration of renewables & storage, net zero buildings, district cooling, smart meters, internet of things, active appliance feedback, blockchain technologies etc. for decarbonizing various sectors of the economy.

8 Moderate scenario

9 Energy Savings targets are for 14 years from 2017 to 2031. Pro-rata savings are considered for two years (2/14)%= 14.3%

Introduction

CHAPTER 1

The power sector in India has experienced considerable growth in the last two decades encompassing demand sectors from industrial to agriculture as well as residential. High urbanization levels, growth in the average per capita income levels, improved electricity access and electrification and increased economic activities impacting these demand sectors have been some of the contributing factors for growth in the power demand. The electricity consumption in the country over the years is presented in Figure 7:

In a world that is increasingly becoming resource constrained, the emerging challenge for a country like India has been to strike a

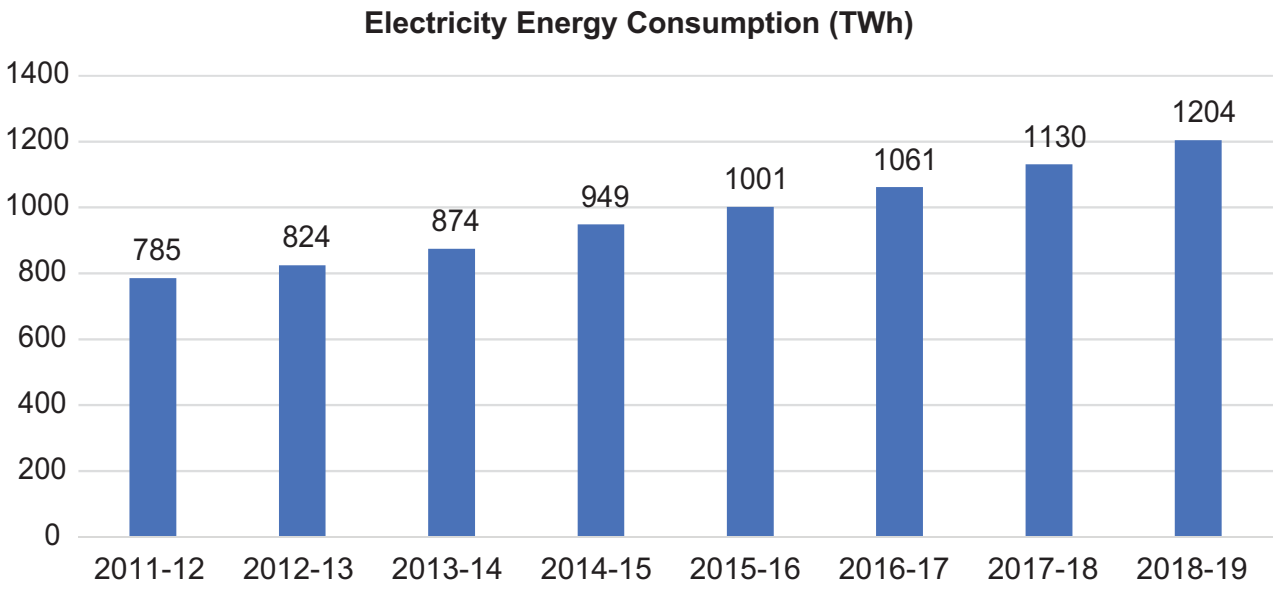


Figure 7: Electricity consumption in India[10]

10 http://www.mospi.gov.in/sites/default/files/publication_reports/Energy%20Statistics%202019-finall.pdf

balance between trying to catapult the country to the next level of economic growth and at the same time negate the challenges arising out of resource inefficiency in the country.

A two-pronged strategy that has been adopted by governments across the world, including India, includes a gradual shift towards Renewable Energy (RE) integration into the grid and a systems approach on engendering Energy Efficiency (EE) practices in the various end use sectors of the economy.

This approach focuses on radically disrupting the energy supply scenario and energy mix in the country and at the same time reducing the demand for energy usage, while ensuring that the economy stays on track to meet the country's economic goals.

Energy efficiency provides considerable potential to promote low carbon transformation. India had realized this importance of energy optimization long back, evident from the launch of the Energy Conservation Act in 2001 and its amendment in 2010. It had further directed its policies to focus specifically on energy efficiency by setting up the Bureau of Energy efficiency (BEE) and then initiating the National Mission for Enhanced Energy Efficiency (NMEEE).

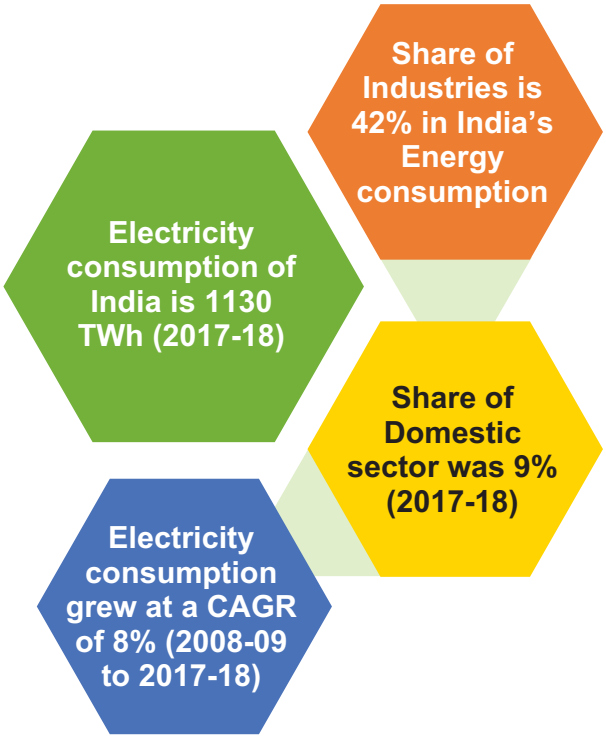


Figure 8: Electricity Consumption in India

Bureau of Energy Efficiency coordinates policies and programs on efficient use of energy and its conservation with the involvement of various stakeholders as well as formulates, manages and implements energy conservation programs as envisaged in the Energy Conservation Act.

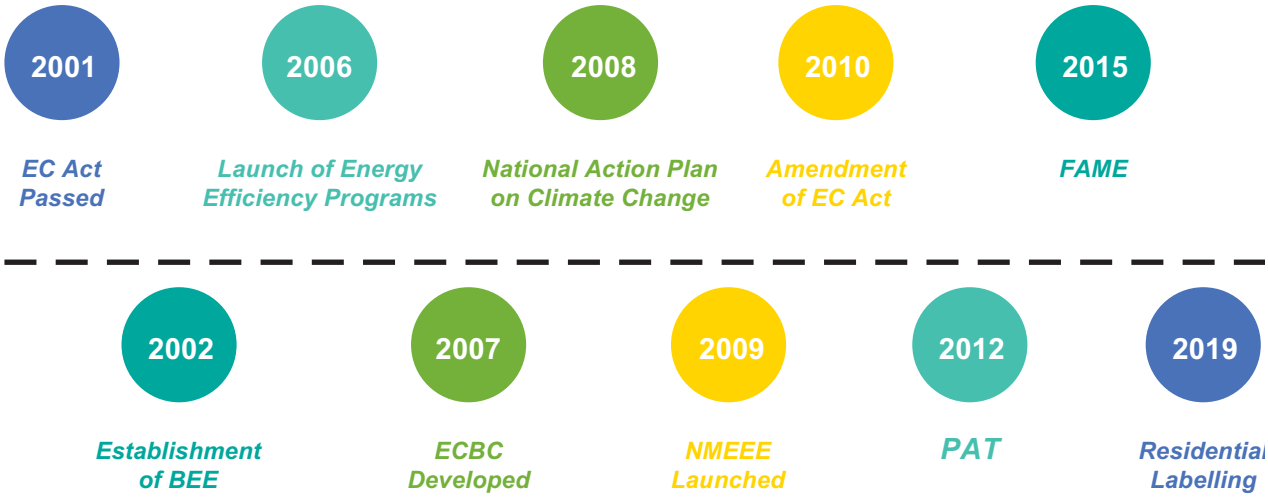


Figure 9: Chronograph of EE policies and programs in India

1.1 Objective of the Study

Along with BEE, there are other organizations at the national, and state level, who are also supporting in achieving the goal of energy efficiency in India. These activities are spanning across major energy consuming sectors in India, viz. Industry, Transport, Agriculture, Commercial, Residential, etc., along with cross cutting mechanisms for realization of energy savings. All such schemes to promote energy conservation and energy efficiency are presented in Table 4, along with their status in FY 2018-19.

Table 4: Status of major EE schemes and programmes

Sector/ Sub-sector	Schemes/ Programs	Status as on FY 2018-19
Industry- Large Industry	Perform, Achieve and Trade (PAT) Scheme	• PAT cycle-I (2012-15) comprised of 478 DCs from 8 energy intensive sectors. • PAT cycle 2 was launched in 2015 and added three more sectors (Refinery, Railways & DISCOM). Under PAT-II, 535 DCs out of total 621 DCs were analyzed for M&V. • PAT Cycle-III added 116 more DCs with estimated energy savings of 1.05 Mtoe • PAT Cycle IV & V added 109 and 110 DCs respectively, which makes the total number of DCs till PAT Cycle V = 956
Industry- MSME	BEE SME Program	• Total 4 MSME clusters (Varanasi, Pali, Indore & Ludhiana) covering sector as forging, textile, food, and brick kiln are part of the programme
	GEF – UNIDO – BEE Programme	• BEE-UNIDO program is operational in 12 MSME clusters including - Hand tools, Ceramics, Dairy, Foundry, Brass. • 27 pilot projects and around 448 small scale energy efficient projects implemented in the clusters since 2015
	GEF – World Bank – BEE Programme	• Project implemented the EE measures across 25 Clusters
Domestic- Lighting & appliances	Standards & Labeling (S&L)	• Total 23 appliances in this programme covered till March 2019. • 10 appliances under Mandatory regime • 13 appliances under voluntary regime.
	UJALA	• 34.7 Crore LED lamps were distributed to replace ICL (100W) • Additionally around 76 Crore LED lights have been distributed by private retailers, due to market transformation. 73 Lakhs LED tube-lights were also distributed under UJALA
Domestic- Buildings	Eco Niwas Samhita	• ECO Niwas Samhita 2018, is an Energy Conservation Building Code for Residential Buildings (ECBC-R).
	Residential Labeling	• Labeling program takes forward EcoNiwas Samhita. • Estimated energy saving potential through labeling program is around 388 BU by year 2030

Sector/ Sub-sector	Schemes/ Programs	Status as on FY 2018-19
Commercial- Buildings	ECBC– Commercial Building	• 13 States and 1 Union Territories (UT) have notified the code • Till date 117 buildings have been registered under ECBC, of which, 23 buildings completed as ECBC compliant by March 2019.
	BEE – Star Rating Programme	• Offices, Hospitals, Shopping malls and BPOs are part of this programme. • 261 existing commercial buildings across India have adopted BEE Star ratings till 2018-19
	Building Energy Efficiency Programme (BEEP)	• 6545 existing commercial buildings across India were part of the BEEP programme. • Replacement of Lighting, EE fans & ACs is considered in this programme.
	Other Green Building Programs	• There are 3 major Green Building Rating Systems in India, viz. IGBC, LEED and GRIHA. • Energy Efficiency is a major component of these rating systems.
Agriculture- Appliances (Star Rated Pumps)	AgDSM- (Star Rated Pumps)	• 63,615 (5 HP) pumps along with smart control panels have been installed as on 2018-19.
Municipality- Lighting & Appliances	MuDSM- (SLNP and MEEP)	• Over 84 lakhs LED street-lights were replaced under SLNP across 28 States & UTs. • MEEP is being initiated to achieve energy savings potential in water supply system by retrofitting EE pumps across 500 AMRUT cities
Transport- Road Transport	Corporate Average Fuel Economy (CAFE)	• In 2015, the GoI established Corporate Average Fuel Economy (CAFÉ) Norms for passenger cars. • In August 2017, CAFÉ Norms were established for Heavy Duty Vehicles (HDV) and in 2019 Norms were established for light commercial vehicles
	Faster Adoption & Manufacturing of Electric Vehicles (FAME)	• FAME I was launched in the year 2015 to promote hybrid and electric vehicle technologies in India • Under FAME-I, a total 2.8 Lakh vehicles were supported
Transport- Railways	PAT and Non-PAT EE Initiatives	• Under PAT Cycle II, 16 Zonal Railways and 6 production units are included • Indian railways has taken several steps such as - *Mission Electrification, HOG (Head-on-Generation) Trains, 3-phase regenerative locomotives etc.* - to reduce the energy consumption in the traction segment.

Though it is difficult to estimate the impact of energy savings from the indirect effect of some of the programs and schemes, the energy savings resulting directly from all programs needs to be measured and verified to ascertain whether the programs being implemented on the ground have the desired impact or not. In this regard, annual impact assessment of all the schemes related to energy efficiency becomes more important than ever.

Towards this, BEE has hired the agency

to undertake a comprehensive review of national and state level schemes initiated for the adoption of energy efficiency in 2018-19 across all the demand sectors. The coverage of national level schemes under the study is not only limited to BEE but also extends to EE initiatives by other organizations such as EESL, SIDBI, PCRA, SDAs etc.

1.2 Scope of Work

This study aims to assess the impact of all the energy efficiency programmes in India, in terms of total energy saved and reduction in the amount of CO_2 emissions in 2018-19. In order to assess the impact, following tasks were carried out under the study:

- Review of all National level schemes pertaining to energy efficiency
- Stakeholder consultation, data collection and verification
- Data Analysis and report submission

As a part of this assignment, several stakeholders were consulted who were either directly or indirectly associated with various energy efficiency measures. These meetings

were conducted to get their inputs for the specific schemes and programs that fall under their ambit, as well as gain valuable insights on the developments that have happened during the last year on the energy efficiency front. The list of stakeholders that were consulted is presented in Table 5:

Table 5: List of major Stakeholders

Stakeholder	Scheme/ Programme
BEE	PAT, S&L, ECBC, Star Rated Buildings, BEE SME Program, Residential labeling, Eco Niwas Samhita 2018
EESL	SLNP, UJALA, BEEP, AgDSM, National EV Mission
TERI	GRIHA Rating System
CII	IGBC Rating System
GBCI	LEED Programme
DHI	FAME
ICAT	CAFÉ Norms
SIDBI	BEE-WB-GEF, PRSF
UNIDO	BEE-UNIDO-GEF Programme
PCRA	Fuel Efficiency Programme
MoMSME	Upcoming activities for improving EE in MSMEs
CEA	Electricity generation data
Ministry of Railways	EE initiatives in Traction and Non-traction system

Table 6: Conversions and Assumptions

Conversions / Units / Assumptions
1 TOE = 11,630 kWh
1 Mtoe = 1 Million tonne of oil equivalent
1 $MtCO_2$ = 1 Million tonne of carbon dioxide
1 BU = 1 Billion Unit =10^9 kWh = 1TWh
1 kWh saving = 0.82 kg of carbon dioxide emission reduction[11]
Cost/toe = INR 18,402
Cost/kWh = INR 5.00
Net energy (Total)[12] consumption in 2018-19 = 581.6 Mtoe
Net energy supply[12] in 2018-19 = 879.23 Mtoe
Electricity (Total)[13] consumption in 2018-19 = 1204 TWh

In order to calculate the impact, certain assumptions have been taken in consultation with BEE and respective stakeholders. A list of assumptions is presented in Table 6.

As implementation of all the schemes are mostly independent of each other, each individual scheme has been discussed in separate sections. Chapters 2, 3, 4, 5, 6, 7, 8 and 9 discuss about all the sector specific energy efficiency schemes/programmes. These chapters provide overview of the schemes/ programmes and their impact due to energy savings in FY 2018-19. Chapter 10 covers various initiatives undertaken in states by SDAs and other agencies. Finally, chapter 11 concludes along with the way forward.

11 http://www.cea.nic.in/reports/others/planning/pdm/growth_2018.pdf

12 This is considered with assumption of 5% increase YoY on energy values of 2018 taken from MoSPI report.

13 This is considered with assumption of 6.51% increase YoY on energy values of 2018 taken from MoSPI report.

Industries

CHAPTER 2

The Industrial segment has been contributing to the bulk of the energy consumption in the country at 307 Mtoe. (~56%) and among this large share, MSME sector contributes approximately 20-25% of overall industrial energy consumption, estimated at 68 Mtoe. The rising quantum of energy consumed by the industrial consumers signifies the immense potential for energy conservation across industrial sector.

Government of India has notified broad policies and regulations for promotion of energy efficiency in India. Additionally, Bureau of Energy Efficiency (BEE) at national level and State Designated Agency (SDA) at state level are also providing the relevant push towards energy efficiency.

In a bid to combat increasing energy consumption and related carbon emissions, the Government of India released the National Action Plan on Climate Change (NAPCC) in 2008 to promote and enable sustainable development of the country by promoting a low carbon and high resilience development path.

National Mission on Enhanced Energy Efficiency (NMEEE) is one of the eight missions which form part of India's National Action Plan on Climate Change (NAPCC), NMEEE is the flagship policy instrument of Government of India to reduce energy intensity of the economy. NMEEE has rolled out four initiatives to enhance energy efficiency in India.

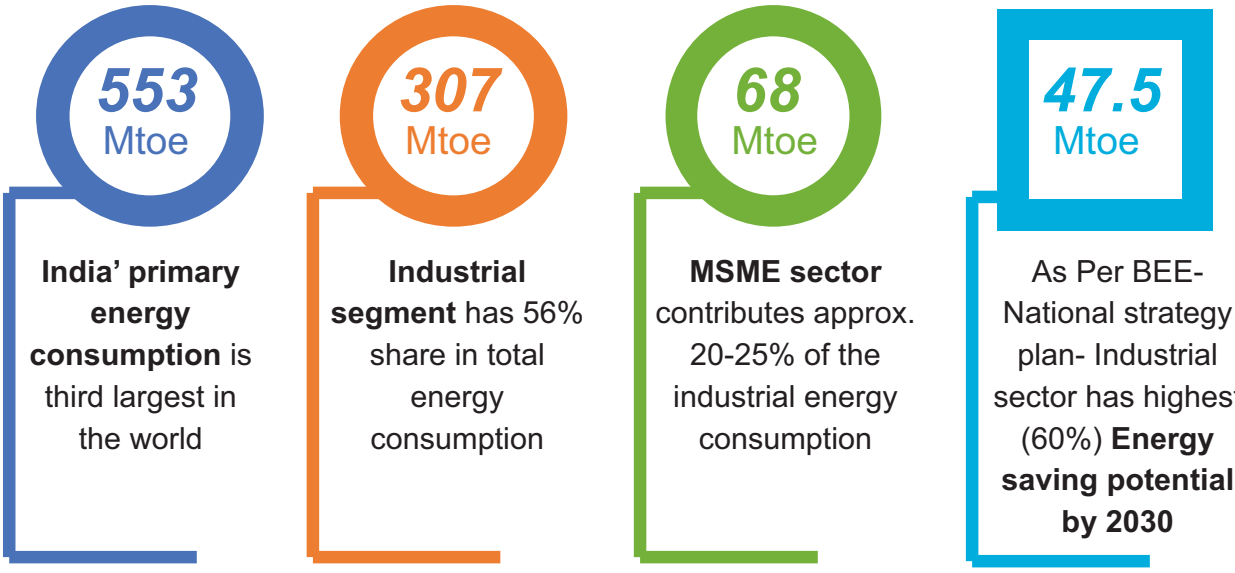


Figure 10: Energy Consumption Scenario

- Perform Achieve and Trade (PAT),
- Market Transformation for Energy Efficiency (MTEE),
- Energy Efficiency Financing Platform (EEFP)
- Framework for Energy Efficient Economic Development (FEEED)

2.1 Perform, Achieve and Trade (PAT) framework

As broadly brought out in the framework document on "National Mission on Enhanced Energy Efficiency", the Energy Conservation Act, 2001 has identified 15 large Energy Intensive Sectors for energy efficiency improvements. PAT is a market-based mechanism to enhance cost effectiveness of improvements in energy efficiency in energy-intensive large industries and facilities, through certification of energy savings that could be traded. In this mechanism, an individual target will be set for the industries by the Government to reduce their Specific Energy Consumption (SEC).

These targets can be achieved over a period of 3 years. The industries can achieve this target by implementing best practices in their industries, change the old technology to the latest one, by using energy efficient equipment and by any other suitable innovative method or they can use their R&D facilities to develop efficient processes.

Those industries that achieve and exceed the target would be issued Energy Saving Certificates (ESCerts) and those industries who could not achieve the target have to either pay penalties or buy the ESCerts from the industries who have secured ESCerts by exceeding the target assigned to them. Some of the broad steps involved in commissioning and operationalizing typical PAT cycles in industries / industry sectors are presented in Figure 11:

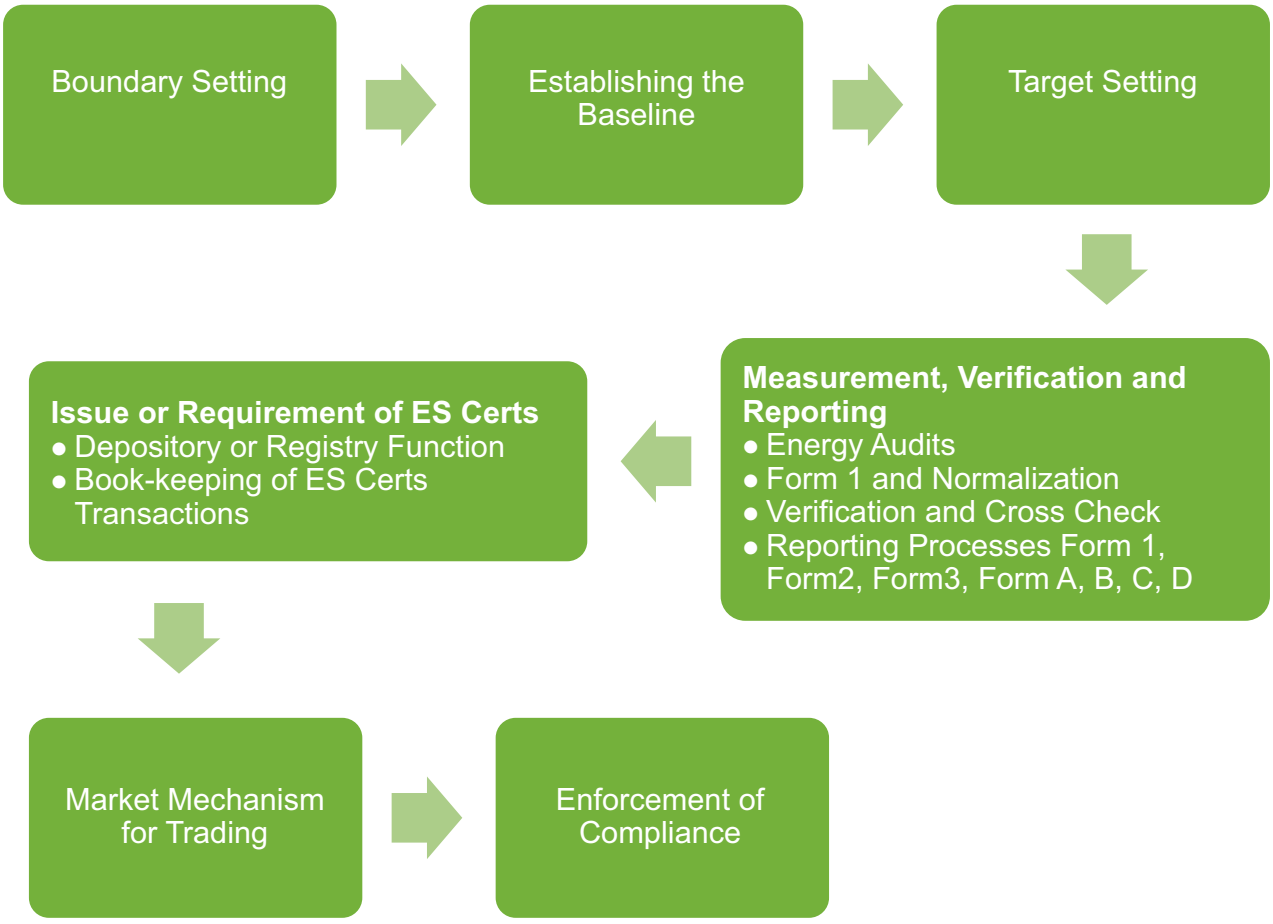


Figure 11: Design of the PAT framework

Table 7: PAT Stakeholders and responsibilities

Responsibility	Stakeholder	Responsibility	Stakeholder
Policy Maker & Administrator	Ministry of Power (MoP)	**Nodal Agency**	Bureau of Energy Efficiency (BEE)
Implementer	Designated consumer (DC)	**State Administrator**	State Designated Agency (SDA)
Adjudicator	State Electricity Regulatory Commission (SERC)	**Verifier**	Empaneled Accredited Energy Auditors
Trading Regulator, Registry	CERC, POSOCO,	**Trading Platform**	Power exchange – IEX, PXIL

2.1.1 PAT Overview

PAT cycle – I started from 1st April 2012 and its first cycle comprised of 478 industrial units from 8 sectors (Table 2) viz. Aluminum, Cement, Chlor- Alkali, Fertilizer, Iron & Steel, Paper & Pulp, Thermal Power Plant and Textile. PAT Cycle I was completed on 31st March, 2015. The energy savings achieved in PAT Cycle –I is 8.67 Mtoe which was excess of 30 percent against the target of 6.686 Mtoe. This energy saving also translates into avoiding about 31 million tonne of CO_2 emission.

Considering the success of the PAT I, PAT Cycle II was launched in 2016 with addition of three sectors, namely, Petroleum Refineries, DISCOMs and Railways. With this widening of sectors and deepening among existing sectors, 143 DC were added during PAT Cycle II, taking the total number of DCs to 621 across 11 target sectors.

Since 2017 and onwards every year, PAT Cycles are notified on rolling basis. PAT Cycle III is launched in 2017 for 116 newly identified DCs within the existing 11 target sectors. PAT

Table 8: PAT Sector Overview:

Sector	Minimum annual energy consumption for the DC (toe)	No. of DCs	
		Cycle I	Cycle II
Thermal Power Plant	30,000	144	154
Iron and Steel	30,000	67	71
Cement	30,000	85	111
Fertilizer	30,000	29	37
Aluminium	7,500	10	12
Pulp and Paper	30,000	31	29
Textile	3,000	90	99
Chlor-Alkali	12,000	22	24
Petroleum Refineries	90,000	-	18
Railways	Zonal Railways - 70,000	-	16
	Production Unit (by Name)	-	6
DISCOMs	86000	-	44
	Total	**478**	**621**

Cycle IV is launched in 2018 with expansion to two more sectors – Petrochemicals and Commercial Buildings, and 109 DCs across 13 sectors. The newly added sectors Petrochemicals and Buildings contribute 8 DCs and 37 DCs respectively.

PAT framework has come a long way in its fifth cycle, covering 13 Sectors and 956 DCs with overall energy saving targets of around 20 Mtoe till PAT Cycle–V. These industries would be among the top 1000 energy consumers, and they (including the power sector) account for significant share in the total energy consumption in India. Details are presented in Table 9.

2.1.2 PAT Cycle I

PAT Cycle I (2012-15) which was operationalized in April 2012, included 478 units, known as "Designated Consumers" (DCs), from eight energy-intensive sectors viz. Aluminium, Cement, Chlor – Alkali, Fertilizer, Iron & Steel, Pulp & Paper, Thermal Power Plant and Textile were included. The annual energy consumption of these DCs in eight sectors was around 164 million TOE.

Table 9: PAT details till Cycle V

Sector / No. of DCs	Till PAT Cycle II	PAT Cycle-III	PAT Cycle-IV	PAT Cycle- V	Total DCs
Thermal Power Plant	154	37	17	17	225
Iron & Steel	71	29	35	23	158
Cement	111	14	1	12	138
Aluminium	12	1	-	1	14
Fertilizer	37	-	-	-	37
Paper & Pulp	29	1	2	8	40
Textile	99	34	7	16	156
Chlor- Alkali	24	-	2	2	28
Refinery	18	-	-	-	18
Railways	22	-	-	-	22
DISCOMs	44	-	-	-	44
Petrochemical	-	-	8	-	8
Buildings	-	-	37	31	68
Total	**621**	**116**	**109**	**110**	**956**

These 478 DCs were provided individual targets for reduction in Specific Energy Consumption (SEC), arrived at by a detailed and methodical process in close consultation with industry bodies, so as to collectively achieve savings of 6.686 Million Tonne of Oil Equivalent (Mtoe). The outcomes of M&V are reflected in issuance of Energy Saving Certificates (ESCerts) to overachieving DCs, together with notification for obligation of ESCerts to those DCs who have underachieved their SEC reduction targets.

As such, the complete turn-around implementation of PAT Cycle I has generated outcomes in two folds, namely,

- Generation of huge quantity of first-hand, measured and verified, industrial energy consumption data
- Specific experiences among a multitude of stakeholders with respect to implementation of the PAT framework, including policy makers and implementers, DCs, institutional framework (SDAs, SERCs, etc.), industrial bodies (industry associations, think tanks, etc.), international development agencies, key market elements of EE technologies, etc.

With the completion of the PAT Cycle – I in 2015, the reported overall achievement was 8.67 Mtoe, exceeding the target for cycle -I by almost 30%. These energy savings of 8.67 Mtoe is equivalent to saving of about 20 million tonnes of coal and avoided emissions of about 31 million tonnes of CO_2. Summary of sector wise savings are presented in Table 10.

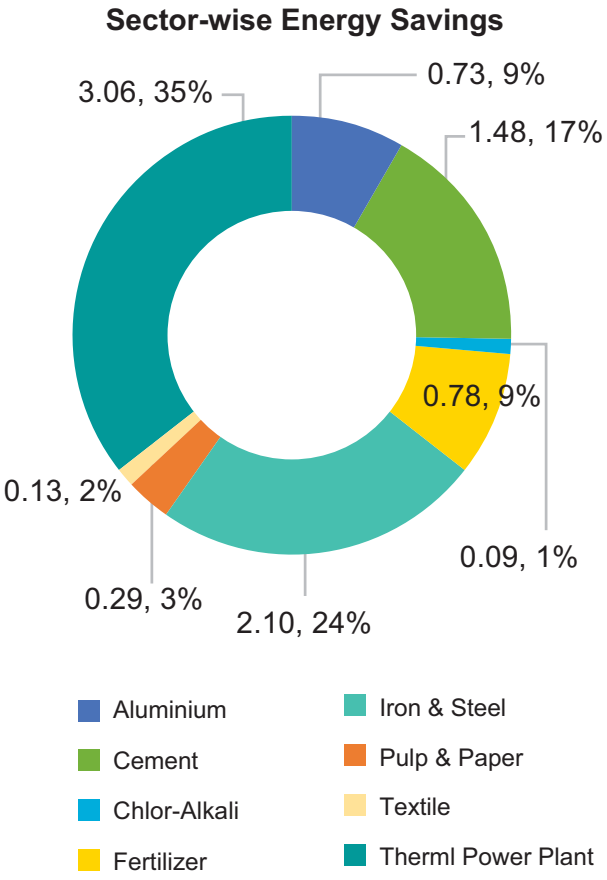


Figure 12: PAT Cycle I – Sector-wise Energy Savings

Table 10: Summary of energy saving and emission reduction PAT Cycle I

Sector	Number of DC	Energy savings Achieved (Mtoe)	CO_2 Emissions (Mn tonne of CO_2 /year)
Aluminium	10	0.73	3.10
Cement	85	1.48	4.34
Chlor-Alkali	22	0.09	0.62
Fertilizer	29	0.78	0.93
Iron & Steel	67	2.10	6.51
Pulp & Paper	31	0.29	1.24
Textile	90	0.13	0.62
Thermal Power Plant	144	3.06	13.64
Total	**478**	**8.67**	**31.00**

2.1.3 PAT Cycle –II (2016-17 to 2018-19)

In order to include new sectors and to identify new DCs under PAT Scheme, "Deepening study" – identifying new DCs in existing sectors and "Widening study" – including new sectors of PAT, was respectively carried out before the commencement of the second cycle.

Deepening study resulted into identification of 89 DCs from the existing sectors of PAT. Widening study resulted into notification of three new sectors namely Refineries, Railways and DISCOMs under PAT scheme. PAT in its second cycle (2016-17 to 2018-19) seeks to achieve an overall energy consumption reduction of 13.633 Mtoe for which energy reduction targets have been assigned and notified to DCs in these 11 sectors (eight existing sectors and three new sectors). PAT Cycle II commenced from 1st April, 2016 covering 621 DCs from 11 sectors which include eight existing sectors and three new sectors viz. Railways, Refineries and DISCOMs. Summary of target savings and DCs are presented in Table 11.

Table 11: PAT Cycle II- Base year data and target savings

S No	Sector	Number of DC	Energy savings targets (Mtoe)
1	Aluminium	12	0.466
2	Cement	111	1.117
3	Chlor-Alkali	24	0.102
4	Fertilizer	37	0.447
5	Iron and Steel	71	2.283
6	Pulp and Paper	29	0.146
7	Textile	99	0.088
8	Thermal Power Plant	154	3.134
9	Petroleum Refinery	18	1.098
10	Railways	22	0.077
	Total	**577**	**8.958**
11	DISCOM	44	4.675
	Total	**621**	**13.633**

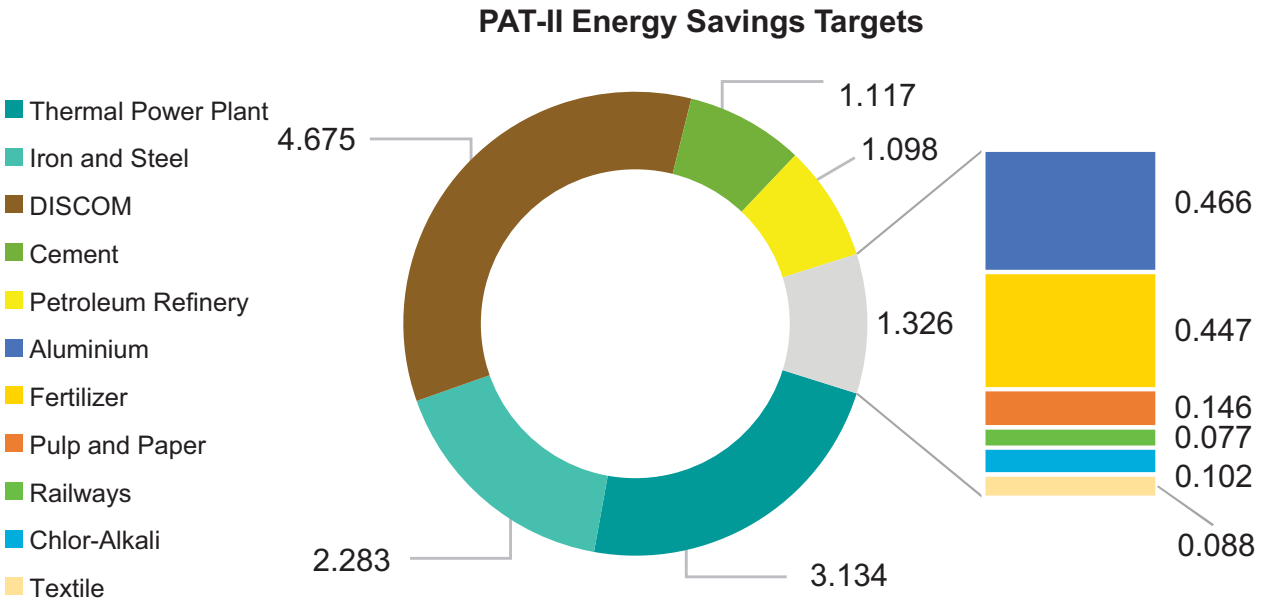
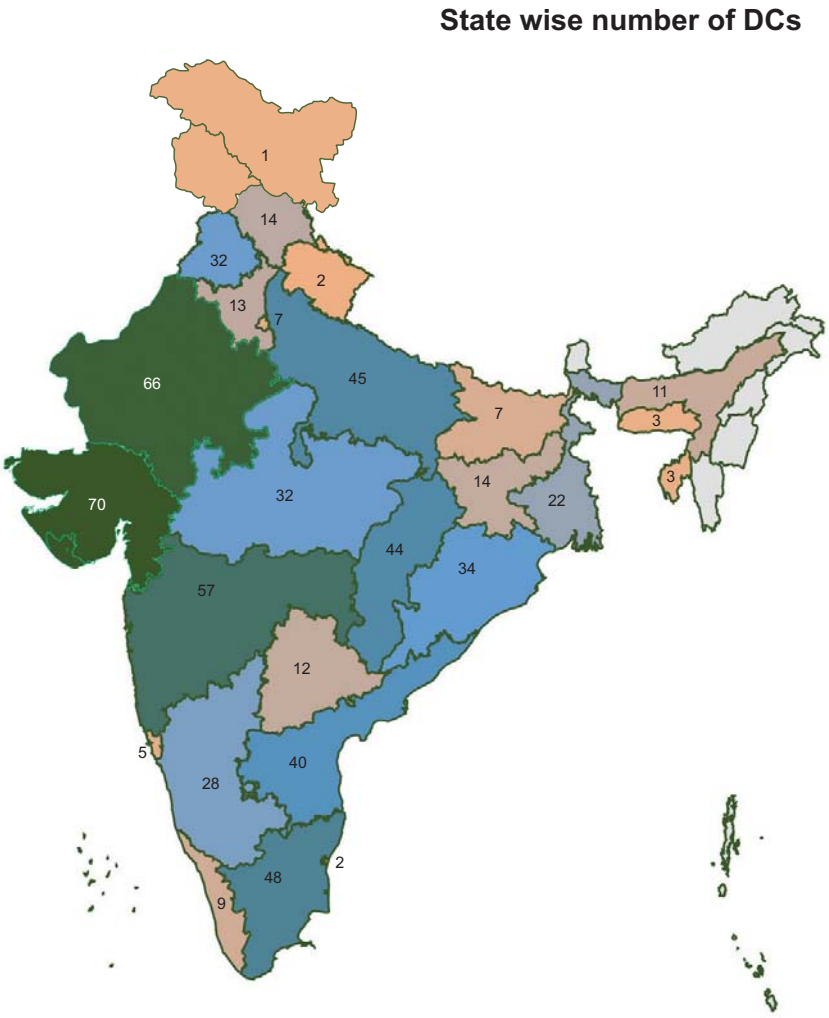
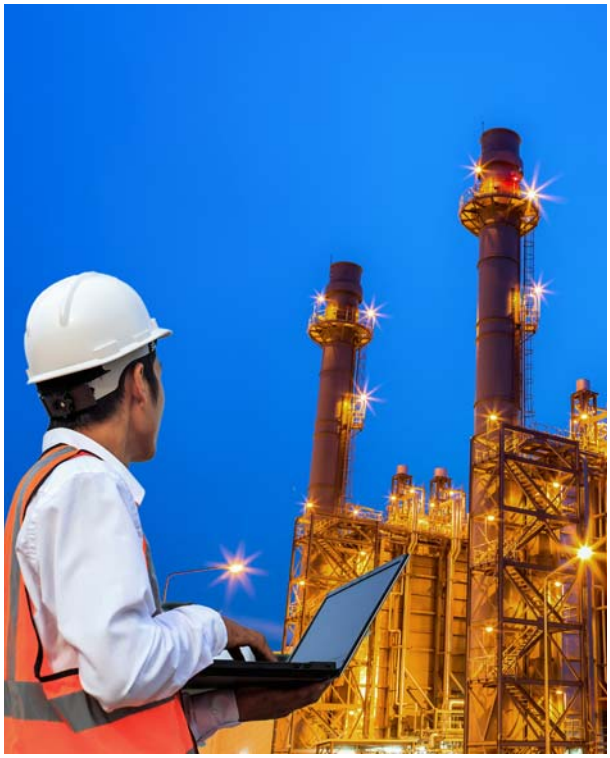


Figure 13: PAT Cycle II Energy Savings Targets



States/UTs	Number of DCs
Andhra Pradesh	40
Assam	11
Bihar	7
Chhattisgarh	44
Delhi	7
Goa	5
Gujarat	70
Haryana	13
HimachalPradesh	14
Jammu & Kashmir	1
Jharkhand	14
Karnataka	28
Kerala	9
Madhya Pradesh	32
Maharashtra	57
Meghalaya	3
Odisha	34
Puducherry	2
Punjab	32
Rajasthan	66
Tamil Nadu	48
Telangana	12
Tripura	3
Uttar Pradesh	45
Uttarakhand	2
West Bengal	22

Figure 14: PAT Cycle II State-wise No. of DCs



2.1.3.1 Methodology adopted to calculate the savings

The PAT Cycle-II concluded with Monitoring and Verification (M&V) of energy savings reported by the DCs through various reporting and assessment forms (Forms 1, 2, 3, and Form A, B and C, etc.), submitted to BEE by DCs at regular reporting intervals.

The verification of the M&V reports was carried out by the State Designated Agencies (SDAs) and at BEE. M&V completion status of the PAT cycle II is presented in Table 12

In order to calculate the savings under the PAT scheme, the 535 DCs of PAT Cycle-II and their M&V data (Assessment year 2018-19) have been considered.

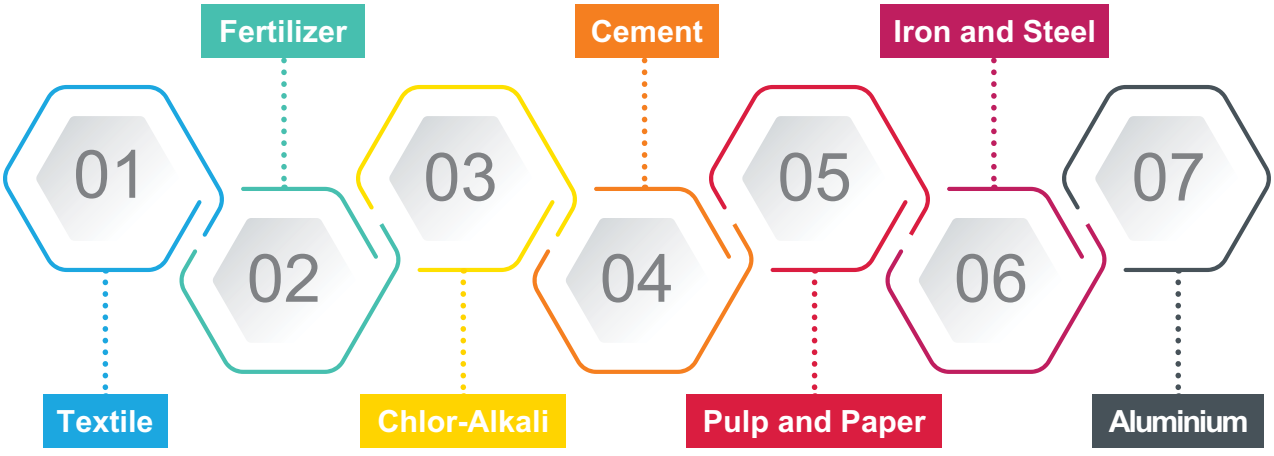
Table 12: PAT Cycle II- Number of PAT DCs Analyzed for Monitoring and Verification

Sector	Total DC	Total Finalized DCs after M&V	Closed[14]	Below Threshold	M&V Not Done
Aluminium	12	9	1		2
Cement	111	99	9	3	
Chlor-Alkali	24	24			
Fertilizer	37	36		1	
Iron and Steel	71	66	1	1	3
Pulp and Paper	29	26	2		
Textile	99	85		6	8
Thermal Power Plant	154	118	18	18	
Petroleum Refinery	18	18			
Railways	22	22			
DISCOM	44	32		1	12
Grand Total	**621**	**535**	**31**	**30**	**25**

2.1.3.2 Estimation of Energy Savings

Following set of equations are used in order to calculate the energy savings, using the data for above mentioned DCs. The production data of the baseline year of PAT Cycle II, i.e. 2014-15 has been taken into consideration, in line with PAT rules, and the M&V exercise conducted by BEE.

As increase in annual production may or may not directly lead to overall energy savings. Therefore, we have adopted the conservative estimate of energy savings based on the baseline year production for measuring the impact of PAT scheme in FY 2018-19. The following calculations were adopted for each of the below mentioned sectors:



14 Includes 7 Cement plants, which are on hold for M&V process due to ongoing litigation

- Step I: Obtain the Specific Energy Consumption (SEC) for the base year 2014-15 = $SEC_{2014-15}$
- Step II: Obtain the SEC for the M&V year 2018-19= $SEC_{2018-19}$
- Step III: $SEC_{2014-15}$ - $SEC_{2018-19}$ (Improvement in Energy Efficiency)
- Step IV: In order to calculate the Energy (thermal) Savings (ES) in Mtoe, the results of Step 3 to be multiplied by the total production of respective DCs for the year 2014-15.

  Formula = $ES_{Plant\ 1}$= ($SEC_{2014-15}$ - $SEC_{2018-19}$) x $Production_{2014-15}$
- Step V: ΣES = $ES_{Plant\ 1}$ + $ES_{Plant\ 2}$+ $ES_{Plant\ 3}$ + $ES_{Plant\ 4}$ +----------+ $ES_{Plant\ N}$

Railways:

Similarly, for the Railways, following steps were considered. The Indian railway has 16 zones and 6 production units across India that are a part of the PAT Cycle II. The 16 zones consume diesel and electricity for its operation (passenger and goods) purposes.

- Step I: In this sector, in order to calculate the energy savings, it is important to identify fuel consumption in the base year (2014-15) and M&V year (2018-19) as Fuel $Consumption_{2014-15}$ and Fuel $Consumption_{2018-19}$ respectively. The unit of fuel consumed is Liter/1000 GTKM. The GTKM means KM earned with the gross tonnage hauled including the weight of the locomotive.
- Step II: Identify 1000GTKM value for each zone.
- Step III: The energy saved for all the zones are calculated as:
- $ES_{Zone\ 1}$ = (Fuel $Consumption_{2014-15}$ - Fuel $Consumption_{2018-19}$) x $Utilization\ (1000GTKm)_{2014-15}$
- Step IV: ΣES = $ES_{Zone\ 1}$ + $ES_{Zone\ 2}$+ $ES_{Zone\ 3}$ + $ES_{Zone\ 4}$ +----------+ $ES_{Zone\ N}$

In case of railway production units, following steps were considered:

- Step I: Obtain the SEC (in kgoe/No of equivalent units) for the base year 2014-15 = $SEC_{2014-15}$
- Step II: Obtain the SEC (in kgoe/No of equivalent units) for the M&V year 2018-19= $SEC_{2018-19}$
- Step III: $SEC_{2014-15}$ - $SEC_{2018-19}$ (Improvement in Energy Efficiency)
- Step IV: In order to calculate the Energy (thermal) Savings (ES) in kgoe, the results of Step 3 to be multiplied by the total production in terms of no. of equivalent units for the year 2014-15.
- Therefore formula = $ES_{Production\ Unit\ 1}$= ($SEC_{2014-15}$ - $SEC_{2018-19}$) x $Production_{2014-15}$
- Step V: ΣES = $ES_{Production\ Unit\ 1}$ + $ES_{Production\ Unit\ 2}$+ $ES_{Production\ Unit\ 3}$ + ----------+ $ES_{Production\ Unit\ N}$

Thermal Power Plants:

In case of Thermal Power Plants, following steps were considered:

- Step I: Obtain the Net Heat Rate (kcal/kWh) for base year 2014-15= $NHR_{2014-15}$ kcal/kWh
- Step II: Obtain the Net Heat Rate (kcal/kWh) for the M&V year 2018-19= $NHR_{2018-19}$ kcal/kWh
- Step III: Identify kWh generated by the notified plant for the M&V year 2018-19= $Production_{2014-15}$
- Step IV: Adopt the following formula to calculate the Energy Savings (ES)
- Formula = $ES_{Plant\ 1}$= ($NHR_{2014-15}$ - $NHR_{2018-19}$) x $Production_{2014-15}$
- Step V: ΣES = $ES_{Plant\ 1}$ + $ES_{Plant\ 2}$+ $ES_{Plant\ 3}$ + $ES_{Plant\ 4}$ +----------+ $ES_{Plant\ N}$

Refinery:

Similarly for the Refinery sector, following steps were considered:

- Step I: Identify Million British Thermal Unit per Thousand barrels per Energy Factor (MBN) of the notified plant for base year 2014-15 = $MBN_{2014-15}$
- Step II: Identify Million British Thermal Unit per Thousand barrels per Energy Factor (MBN) of the notified plant for M&V year 2018-19 = $MBN_{2018-19}$
- Step III: Identify the crude throughput by the notified plant for the M&V year 2014-15, $Production_{2014-15}$ in Million Barrels (MBLs)
- Step IV: Identify the complexity of the refinery plant, which is expressed as NRGF. It is the composite NRGF of the plant and is calculated considering the individual energy factor and throughput of each sub-process= $NRGF_{plant\ 1}$
- Step V: Adopt the following formula to calculate the Energy Savings (ES)
- Formula = $ES_{Plant\ 1} = (MBN_{2014-15} - MBN_{2018-19}) \times Production_{2014-15} \times NRGF_{plant\ 1} \times 0.252$
- Step VI: $\Sigma ES = ES_{Plant\ 1} + ES_{Plant\ 2} + ES_{Plant\ 3} + ES_{Plant\ 4} + \text{----------} + ES_{Plant\ N}$

2.1.3.3 Impact of PAT Cycle II

The impact under the PAT scheme for this report was calculated based on the data of 535 DCs. The total energy savings for PAT cycle II totals to 12.849 Mtoe (based on baseline year production data of FY 2014-15). The share of energy saved by each sector is presented in Table 13.

The sectors mentioned in above table is further divided as demand side sectors and supply side sectors with respect to energy. The Thermal Power Plants, Refineries and DISCOMs, apart

Table 13: PAT Cycle II Energy Savings Achieved

PAT Sector (Demand Side)	PAT Sector (Supply Side)	Number of PAT DCs analyzed for M&V	Energy Savings Achieved (Mtoe)	% Share of Savings (Sector-wise)	% Share of Savings (Demand & Supply wise)
Aluminium		9	0.572	4.43%	46.51%
Cement		99	1.571	12.16%	
Chlor-Alkali		24	0.165	1.27%	
Fertilizer		36	0.370	2.87%	
Iron and Steel		66	2.706	21.06%	
Pulp and Paper		26	0.250	1.95%	
Textile		85	0.144	1.11%	
Railways		22	0.196	1.48%	
	Thermal Power Plant	118	3.539	27.54%	53.49%
	Petroleum Refinery	18	1.481	11.46%	
	DISCOM	32	1.854	14.34%	
Grand Total		**535**	**12.849**		

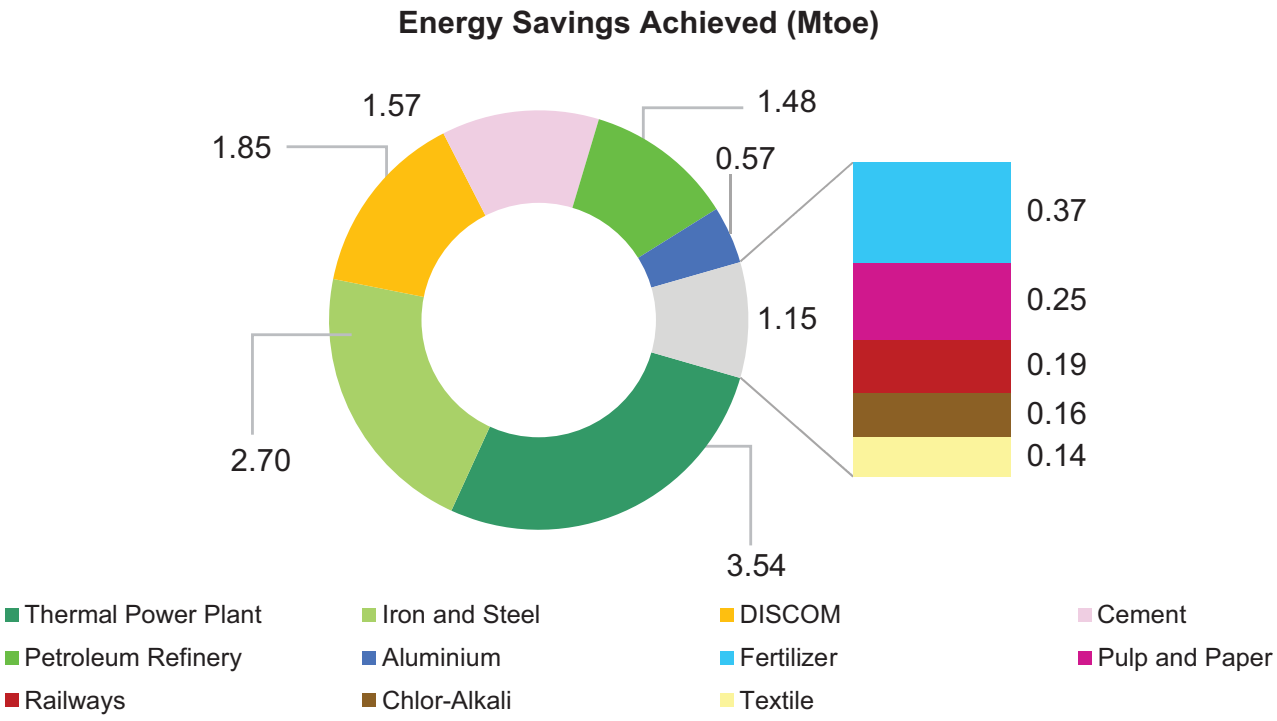


Figure 15: PAT Cycle II Energy Savings Achieved

from being consumers under PAT, are primarily a part of the energy generation and energy supply value chain. Hence energy efficiency measures in these sectors are classfied as supply side energy efficiency.

Other sectors, primarily consume energy as one of the inputs or factors of production, and hence energy efficiency measures in these sectors are classified as demand side energy efficiency. The analysed data of demand side sectors demonstrates the total energy savings of 5.975 Mtoe while the total energy savings for the supply side sectors amounts to 6.874 Mtoe for FY 2018-19.

Energy Savings as per assessment year (2018-19) production:

As increase in annual production may or may not directly lead to overall energy savings. Hence, the energy savings from the production data of the Baseline Year (BY) is considered for this report. However, the actual energy savings realized have also been estimated and reported based on the Assessment Year production (i.e. 2018-19), for comparison and calibration purposes.

The following calculations were adopted for calculating the energy savings:

- Step I: Obtain the Specific Energy Consumption (SEC) for the base year 2014-15 = $SEC_{2014-15}$
- Step II: Obtain the SEC for the M&V year 2018-19= $SEC_{2018-19}$
- Step III: $SEC_{2014-15}$ - $SEC_{2018-19}$ (Improvement in Energy Efficiency)
- Step IV: In order to calculate the Energy (thermal) Savings (ES) in Mtoe, the results of Step 3 to be multiplied by the total production of respective DCs for the assessment year 18-19.
- Formula = $\mathbf{ES_{Plant\ 1} = (SEC_{2014-15} - SEC_{2018-19}) \times Production_{2018-19}}$
- Step V: $\Sigma ES = ES_{Plant\ 1} + ES_{Plant\ 2} + ES_{Plant\ 3} + ES_{Plant\ 4}$ +----------+ $ES_{Plant\ N}$

A comparison of the energy savings based on the AY (2018-19) production across various PAT sectors vis-à-vis savings considering BY (2014-15) production is presented in Table 14.

This estimate of energy savings based on the AY (2018-19) production is significantly higher compared to the savings achieved from considering BY (2014-15) production mainly due to increase in the manufacturing output across various industrial sectors.

Table 14: PAT Cycle II Energy Savings based on AY production

PAT Sectors	Energy Savings Achieved based on BY production (Mtoe)	Energy Savings Achieved based on AY production (Mtoe)	% Increase in Energy Savings
Aluminium	0.57	0.68	18%
Cement	1.57	2.09	33%
Chlor-Alkali	0.16	0.21	25%
Fertilizer	0.37	0.40	9%
Iron and Steel	2.70	3.92	45%
Pulp and Paper	0.25	0.29	16%
Textile	0.14	0.16	8%
Thermal Power Plant	3.54	4.79	35%
Petroleum Refinery	1.48	1.79	21%
Railways	0.19	0.23	17%
DISCOM	1.85	2.21	19%
Grand Total	**12.849**	**16.77**	**31%**

Energy Savings- Target Vs Achieved

Data in Table 15 below shows that PAT II has overachieved its energy saving targets by around 16%. Most of the sectors achieved the assigned targets with Aluminium, Pulp & Paper and Railways sector achieving more than twice of their assigned targets.

Table 15: Energy savings and achievement of PAT targets by sector

Sector	Number of PAT DCs analyzed for M&V	Reduction Target from the DCs analyzed (Mtoe)	Energy Savings Achieved (Mtoe)	% Achievement Over the Energy Saving Targets
Aluminium	9	0.25	0.57	129%
Cement	99	1.05	1.57	50%
Chlor-Alkali	24	0.10	0.16	61%
Fertilizer	36	0.44	0.37	-16%
Iron and Steel	66	2.23	2.71	21%
Pulp and Paper	26	0.13	0.25	95%
Textile	85	0.08	0.14	83%
Thermal Power Plant	118	2.85	3.54	24%
Petroleum Refinery	18	1.10	1.48	35%
Railways	22	0.08	0.196	154%
DISCOM	32	2.73	1.85	-32%
Grand Total	**535**	11.049	12.849	16%

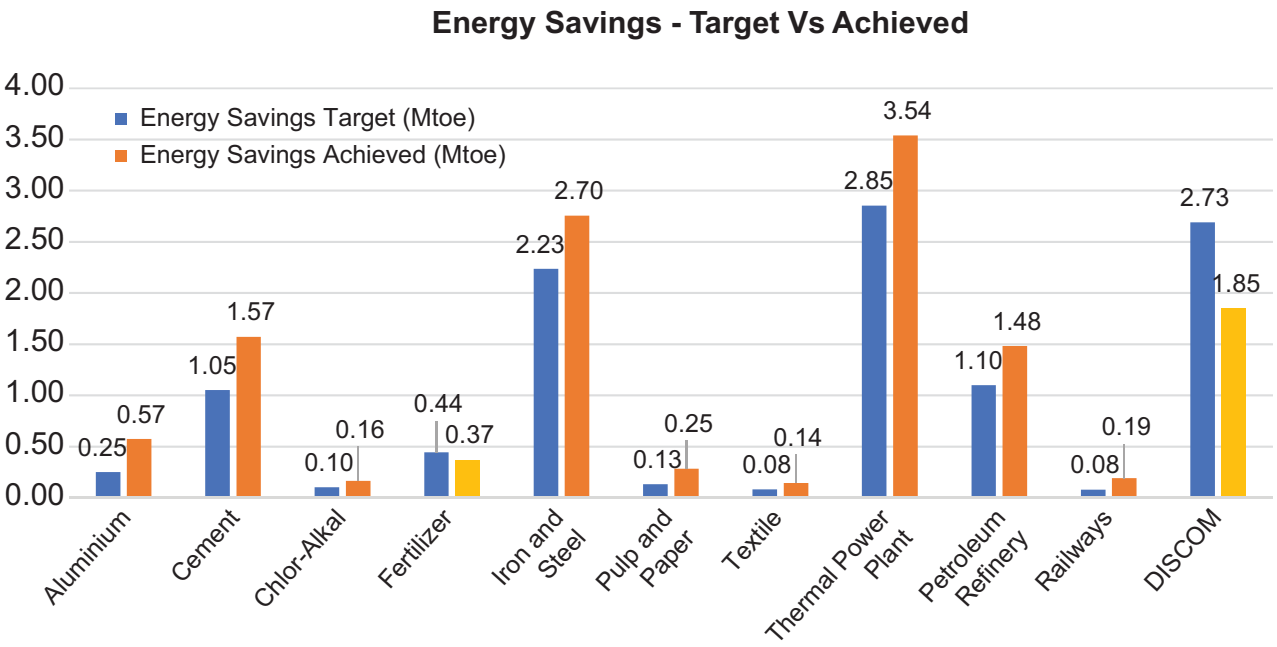
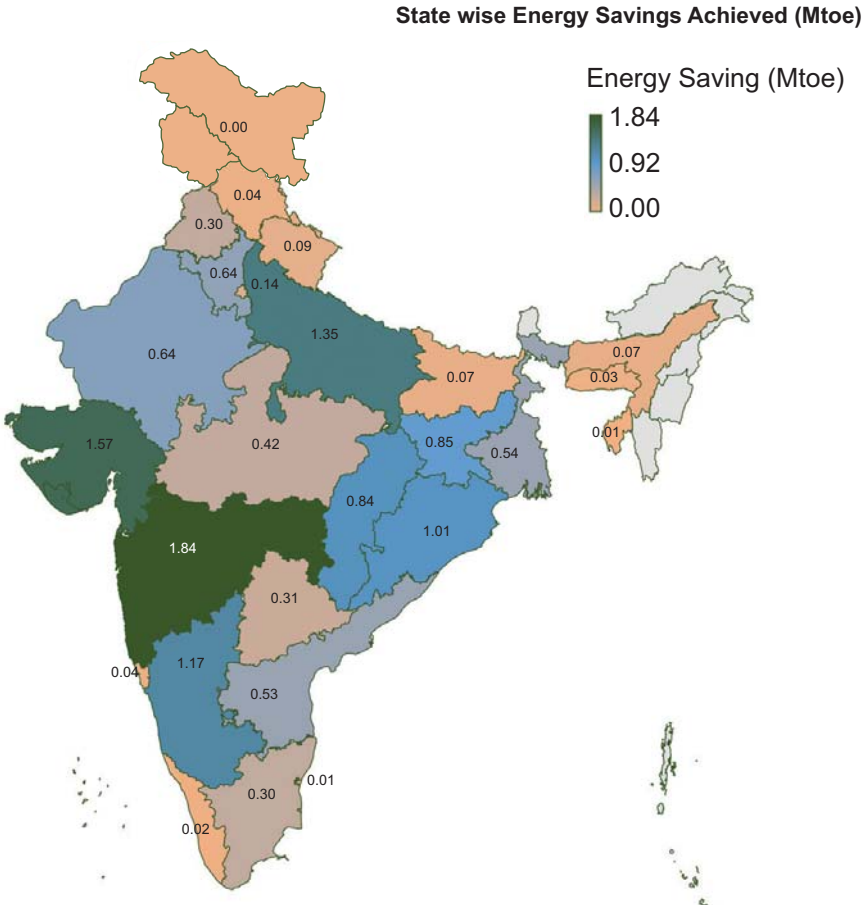


Figure 16: Energy Savings - Target Vs Achieved

State-wise Analysis:

We have also calculated the PAT data for 27 States and UTs. PAT DCs in state of Gujarat and Maharashtra have contributed to maximum energy savings across all the states in India.

State wise analysis is presented in Figure 17.



States/UTs	Energy Saving Achieved (Mtoe)
Andhra Pradesh	0.54
Assam	0.07
Bihar	0.07
Chhattisgarh	1.03
Delhi	0.14
Goa	0.04
Gujarat	1.57
Haryana	0.60
Himachal Pradesh	0.04
Jammu & Kashmir	0.00
Jharkhand	0.87
Karnataka	1.17
Kerala	0.02
Madhya Pradesh	0.30
Maharashtra	1.84
Meghalaya	0.03
Odisha	1.01
Puducherry	0.01
Punjab	0.30
Rajasthan	0.66
Tamil Nadu	0.30
Telangana	0.25
Tripura	0.01
Uttar Pradesh	1.35
Uttarakhand	0.09
West Bengal	0.54

Figure 17: PAT Cycle II State-wise Energy Savings Achieved

2.1.3.3.1 Estimation of Fuel- wise energy savings

In order to calculate the fuel-wise energy savings, percentage of fuel consumed in each PAT sector is calculated. Using these values fuel mix for each PAT sector are identified as provided in Table 16.

Table 16: Fuel-Mix for each PAT Sector

Sector	Fuel Mix %			
	Coal	Oil	Gas	Electricity
Aluminium	94.0%	4.5%	0.5%	1.0%
Cement	97.0%	1.0%	0.0%	2.0%
Chlor-Alkali	75.0%	2.0%	13.0%	10.0%
Fertilizer	8.0%	0.0%	90.0%	2.0%
Iron and Steel	83.5%	2.0%	1.5%	13.0%
Pulp and Paper	80.0%	5.0%	0.0%	15.0%
Textile	71.8%	0.9%	2.6%	24.7%
Thermal Power Plant	99.5%	0.5%	0.0%	0.0%
Petroleum Refinery	15.9%	24.3%	50.2%	9.6%
Railways	0.0%	69.0%	0.0%	31.0%
DISCOM	0.0%	0.0%	0.0%	100.0%

Conversion factor of 860 kcal/kWh is considered for calculation of electrical energy savings. Both thermal and electrical energy savings for each PAT sector is provided in Table 17

Table 17: Demand and supply side Energy saving (Thermal and electrical)

PAT Sector (Demand Side)	PAT Sector (Supply Side)	No. of PAT DCs	Thermal Energy Savings (Mtoe)	Electrical Energy Savings (BU)
Aluminium		9	0.57	0.07
Cement		99	1.54	0.37
Chlor-Alkali		24	0.15	0.19
Fertilizer		36	0.36	0.09
Iron and Steel		66	2.35	4.09
Pulp and Paper		26	0.21	0.44
Textile		85	0.11	0.41
Railways		22	0.14	0.71
	Thermal Power Plant	118	3.54	0.00
	Petroleum Refinery	18	1.34	1.65
	DISCOM	32	0.00	21.56
Grand Total		**535**	**10.31**	**29.57**

The analysed data of sector under the consumption side demonstrates the total thermal energy savings of 5.428 Mtoe and electrical energy savings of 6.37 BU. While the sector under the supply side demonstrates the total thermal energy savings of 4.877 Mtoe and electrical energy savings of 23.215 BU.

2.1.3.3.2 Estimation of reduction in CO_2 emission

In order to calculate the reduction in the total CO_2 emission, Fuel-mix for each PAT sector is considered as per Table 17. Post that following assumptions were taken for calorific values of respective fuels and CO_2 conversion factors as presented in Table 18.

Table 18: Calorific value and CO_2 conversion factors for various fuels

Gross Calorific Values	kcal/kg	kcal/kWh
Coal	4500	
Oil	10050	
Gas	9500	
Electricity		860
CO_2 Emission Factors	**kg of CO_2 / kg of fuel**	**kg of CO_2 / kWh**
Coal	1.52	
Oil	3.13	
Gas	2.69	
Electricity		0.82

Overall, the energy savings of 10.31 Mtoe and 29.57 BU under PAT Cycle II has resulted in reduction of 58.3 $MtCO_2$. Emission reduction due to PAT Cycle II is presented in Table 19.

Table 19: Share (Value) of reduction in CO_2 emission by each sector

Sector	No. of DCs	Emission Reduction ($MtCO_2$)	% Share in Total reduction
Aluminium	9	1.961	3.36%
Cement	99	5.495	9.43%
Chlor-Alkali	24	0.645	1.11%
Fertilizer	36	1.115	1.91%
Iron and Steel	66	11.313	19.41%
Pulp and Paper	26	1.073	1.84%
Textile	85	0.703	1.21%
Thermal Power Plant	118	11.941	20.48%
Petroleum Refinery	18	5.377	9.22%
Railways	22	1.002	1.72%
DISCOM	32	17.675	30.32%
Total	**535**	58.300	

Summary:

Under the PAT scheme, overall summary of energy (thermal & electrical) savings, and corresponding reduction in CO_2 emissions are presented in Table 20

Table 20: PAT Cycle II emission and energy saving summary

Parameters	Values
No. M&V Analyzed PAT DCs	535
Total Energy Savings achieved under PAT II	12.849 Mtoe
Overall reduction in CO_2 emission	58.3 $MtCO_2$
Energy (thermal) saved at consumption side	5.428 Mtoe
Energy (thermal) saved at supply side	4.877 Mtoe
Energy (electrical) saved at consumption side	6.357 BU
Energy (electrical) saved at supply side	23.215 BU

2.1.4 PAT Cycle –III (2017-18 to 2019-20)

The Parliamentary Standing Committee on Energy, Executive Committee on Climate Change under Prime Minister's Office (PMO) and Group of Secretaries recommended to include DCs annually for accelerated coverage of DCs under PAT. Consequently, PAT scheme is being implemented on a rolling cycle basis where new DCs/sectors will be included every year. In view of this PAT cycle –III has started from 1st April, 2017.

The duration of PAT Cycle III, is from 2017-18 to 2019-20 with 116 new DCs. These DCs are from 6 sectors viz. Thermal Power plant, Cement, Aluminium, Pulp and Paper, Iron and Steel and Textile. The energy consumption of these DCs is 47.85 Mtoe.

2.1.4.1 Methodology adopted to calculate the savings

As PAT Cycle III will complete in 2019-20, therefore production data of the baseline year of PAT Cycle III, i.e. 2015-16 has been taken into consideration to calculate the Energy Savings. Following set of equations prepared in order to find the energy savings:

- Step I: Obtain the Specific Energy Consumption (SEC) for the base year 2015-16 = $SEC_{2015\text{-}16}$
- Step II: Obtain the Estimated SEC target for the year 2019-20= SEC_{target}
- Step III: $SEC_{2015\text{-}16}$ - SEC_{target} (Improvement in Energy Efficiency)
- Step IV: In order to calculate the Energy Savings (ES) in Mtoe, the results of Step 3 to be multiplied by the total production of respective DCs for the year 2015-16.
- Therefore formula = $ES_{Plant\ 1}$= ($SEC_{2015\text{-}16}$ - SEC_{target}) x $Production_{2015\text{-}16}$
- Step V: $\Sigma ES = ES_{Plant\ 1} + ES_{Plant\ 2} + ES_{Plant\ 3} + ES_{Plant\ 4}$ +----------+ $ES_{Plant\ N}$

Table 21: PAT Cycle III- Energy savings targets

Sector	PAT-III (as per base year 2015-16)		
	Number of DC	Energy Consumption (Mtoe)	Energy savings targets (Mtoe)
Thermal Power Plant	37	36.71	0.406
Iron & Steel	29	7.65	0.457
Cement	14	1.74	0.0963
Aluminium	1	1.02	0.061
Paper & Pulp	1	0.06	0.003
Textile	34	0.67	0.040
Total	**116**	**47.84**	**1.06**

PAT Scheme in its third cycle seeks to achieve an overall energy consumption reduction of 1.06 Mtoe for which SEC reduction targets have been assigned to 116 Designated Consumers from six sectors is presented in Table 21.

2.1.4.2 Impact of PAT Cycle III

The duration of PAT cycle-III is 3 years, from 2017-18 to 2019-20. As Monitoring & Verification (M&V) for PAT cycle III is due for 2019-20, therefore no specific data for energy savings is available for FY 2018-19. As PAT Cycle III has completed two years till FY 2018-19, therefore in order to calculate the energy saving, two-third of estimated energy savings of PAT Cycle III is considered for FY 2018-19. Details are presented in Table 22

10% discount factor is considered for total energy savings due to PAT Cycle III, on account of change in the number of DCs due to decrease in energy consumption below the threshold value and DCs that may close during the assessment year.

Therefore, total energy savings for PAT Cycle III in FY 2018-19 is considered as 0.64 Mtoe and total reduction in CO_2 emission as 2.86 $MtCO_2$.

Table 22: PAT Cycle III- Estimated Energy savings for FY 2018-19

No. of DCs	Energy Consumption in (Mtoe)	Estimated Energy Savings for PAT Cycle III (Mtoe)	Energy Savings for FY 2018-19 = 2/3rd * PAT Cycle III Savings	Emission Reductions ($MtCO_2$)[15]
116	**47.85**	**1.06**	**0.71**	**3.18**

2.1.5 PAT Cycle – IV (2018-19 to 2020-21)

The fourth cycle of PAT has been notified on 28th March-2018. A total of 109 DCs with a total energy consumption of 24.06 million tonnes of oil equivalent have been notified under this cycle, the cycle period being 2018-19 to 2020-21. These DCs are from 8 sectors consisting of 6 existing sectors - (Cement, Pulp and Paper, Iron and Steel, Textile, Thermal Power plant, and Chlor-Alkali) and two new sectors.

15 For calculation of sector-wise thermal & electrical savings and CO_2 emission reductions, we have considered same fuel ratios as taken for PAT Cycle II

The new sectors are Petrochemicals and Buildings. Under buildings sector, hotels have been selected as the potential designated consumer sub-sector for this cycle. Other sub-sectors in the buildings sector may come up in future. Under Petrochemical, naphtha crackers and gas crackers has been considered under this cycle of PAT.

2.1.5.1 Methodology adopted to calculate the savings

As PAT Cycle IV will complete in 2020-21, therefore production data of the baseline year of PAT Cycle IV, i.e. 2016-17 has been taken into consideration to calculate the Energy Savings. Following set of equations prepared in order to find the energy savings:

- Step I: Obtain the Specific Energy Consumption (SEC) for the base year 2016-17 = $SEC_{2016-17}$
- Step II: Obtain the Estimated SEC target for the year 2020-21= SEC_{target}
- Step III: $SEC_{2016-17}$ - SEC_{target} (Improvement in Energy Efficiency)
- Step IV: In order to calculate the Energy Savings (ES) in Mtoe, the results of Step 3 to be multiplied by the total production of respective DCs for the year 2016-17.
- Therefore formula = $ES_{Plant\ 1}$= ($SEC_{2016-17}$ - SEC_{target}) x $Production_{2016-17}$
- Step V: $\Sigma ES = ES_{Plant\ 1} + ES_{Plant\ 2} + ES_{Plant\ 3} + ES_{Plant\ 4}$ +----------+ $ES_{Plant\ N}$

The target energy consumption reduction for this cycle is 0.70 million Mtoe for 106 Designated Consumers from eight sectors is presented in Table 23

Table 23: PAT Cycle IV- Energy savings targets

Sector	PAT-IV (as per base year 2016-17)		
	Number of DC	Energy Consumption (Mtoe)	Energy savings targets
Thermal Power Plant	17	16.32	0.237
Iron & Steel	35	3.23	0.193
Cement	1	0.07	0.004
Paper & Pulp	2	0.16	0.010
Textile	7	0.34	0.020
Chlor- Alkali	2	0.05	0.003
Petrochemical	8	3.82	0.230
Buildings	37	0.06	0.004
Total	**109**	**24.06**	**0.70**

2.1.5.2 Impact of PAT Cycle IV

The duration of PAT cycle-IV is 3 years, from 2018-19 to 2020-21. As Monitoring & Verification (M&V) for PAT cycle III is due for 2020-21, therefore no specific data for energy savings is available for FY 2018-19. As PAT Cycle IV has completed only one year till FY 2018-19, therefore in order to calculate the energy saving, one-third of estimated energy savings of PAT Cycle IV is considered for FY 2018-19, and same is presented in Table 24.

Table 24: PAT Cycle IV- Estimated Energy savings for FY 2018-19

No. of DCs	Energy Consumption in (Mtoe)	Estimated Energy Savings for PAT Cycle IV (Mtoe)	Energy Savings for FY 2018-19 = 1/3rd * PAT Cycle IV Savings	Emission Reductions ($MtCO_2$)[16]
109	24.06	0.70	0.23	0.85

10% discount factor is considered for total energy savings due to PAT Cycle IV, on account of change in the number of DCs due to decrease in energy consumption below the threshold value and DCs that may close during the assessment year.

Therefore, total energy savings for PAT Cycle IV in FY 2018-19 is considered as 0.21 Mtoe and total reduction in CO_2 emission as 0.76 $MtCO_2$.

2.1.6 Summary

PAT Cycle II was launched in 2016 with addition of three sectors, 143 DC were added during PAT Cycle II, taking the total number of DCs to 621 across 11 target sectors. The impact under

16 For calculation of sector-wise thermal & electrical savings and CO_2 emission reductions, we have considered same fuel ratios as taken for PAT Cycle II. For Petrochemical we have considered same fuel ratio as Petroleum Refineries, while for Buildings sector we have considered 100% electrical energy savings.

the PAT cycle II for this report was calculated based on the data of 535 DCs.

PAT II has overachieved its energy saving targets by almost more than 17% and total energy savings amounted to 12.85 Mtoe. PAT framework has come a long way now, covering 13 Sectors and 846 DCs till PAT Cycle–IV. Estimated energy savings from PAT scheme till cycle-IV for FY 18-19 is presented in Table 25 and Table 26.

Table 25: Total Energy saving Achieved from PAT cycle II, III, & IV[17]

PAT Cycle	Total Energy Savings Achieved		
	Thermal (Mtoe)	Electrical (BU)	Total (Mtoe)
PAT II	10.306	29.572	12.849
PAT III	0.595	0.504	0.638
PAT IV	0.193	0.202	0.210
Total	11.093	30.279	13.697

Table 26: Sector-wise Energy savings (both thermal and electrical) for PAT Scheme[18]

PAT Sectors	Energy Savings Achieved (Mtoe)	CO_2 Emission Reductions ($MtCO_2$)	Cost Savings (INR Crores)
Aluminium	0.609	2.117	1145
Cement	1.630	5.782	3129
Chlor-Alkali	0.166	0.649	371
Fertilizer	0.370	1.115	711
Iron and Steel	3.038	12.759	7161
Pulp and Paper	0.255	1.098	622
Textile	0.174	0.870	491
Thermal Power Plant	3.854	13.314	7091
Petroleum Refinery	1.481	5.377	3290
Railways	0.196	1.000	602
DISCOM[18]	1.854	17.680	9632
Building	0.001	0.011	7
Petrochemical	0.069	0.127	153
Total	**13.697**	**61.899**	**34405**

Interventions in large industries, DISCOMs, Railways, & Buildings under PAT Scheme has led to total energy savings of 13.697 Mtoe (Thermal energy savings of 11.093 Mtoe and 30.279 BU of the electrical energy savings) under PAT cycle II, III, and IV.

17 Energy saving of PAT Cycle – II is consolidated data for 535 DCs. For PAT Cycle III, it is assumed that 2/3 of the target savings would have been implemented till 2018-19. Further it is also assumed that only 90% of the notified industries for PAT cycle III will contribute to energy savings (balance 10% may have closed down or their energy consumption may have fallen below PAT threshold level prior to M&V phase). Similarly, for PAT Cycle -IV it is assumed that 1/3 of the target savings would have been implemented, and 90% of the notified industries will contribute to energy savings during 2018-19. These assumptions are based on trends observed in previous PAT cycles.

18 Monitory Savings are calculated considering the toe rate of 18402/toe and cost of electrical energy as 5 rupees /unit. For DISCOM weighted cost of 4.48 rupees per units is considered for the saving calculation

MSME Sector

CHAPTER 3

Indian micro, small and medium enterprises (MSME) sector contributes a significant share of 45% to the manufacturing output of the country[19]. The sector contributes to over 40% of the country's exports and 30 percent to the nation's GDP. The sector is also credited with providing employment to over 117 million personnel, making it the second largest employment provider, only after agriculture in the country. However, production practices in MSME, remain largely inefficient and are characterized by the use of vintages of plant and machinery, that are relatively less efficient. In the face of stiff global competition, it has become an urgent imperative for the MSME sector, to adopt improved technology and best practices to achieve world class effectiveness and efficiency.

3.1 BEE – SME Programme

Considering the urgent need to develop, demonstrate and disseminate energy efficient technologies at the cluster level, "National Programme on Energy Efficiency and Technology Upgradation in SMEs" was evolved by Bureau of Energy Efficiency to address the various challenges faced by SMEs in India. Major challenges faced by SME sector are the lack of know-how of modern technologies, availability of finance for energy efficient equipment and technologies, lack of proven case studies etc. To overcome these barriers, BEE initiated the BEE-SME programme in 2009. Over 375 Bankable DPR's for energy efficiency projects were prepared in 35 clusters across India. Under the programme several initiatives were taken for capacity building of Local Service Providers/Technology Providers. Also, BEE facilitated implementation of Energy Efficiency Measures through development of DPRs in 29 out of the 35 clusters for which baseline studies were undertaken.

BEE has institutionalized PRGFEE, which provides a partial coverage of risk involved in extending loans for Energy Efficiency (EE) projects. PRGFEE guarantees up to 50% of loan amount or Rs. 10 crore per project, whichever is less. PRGFEE support has been provided to government buildings, private buildings, municipalities, SMEs and industries. This guarantee is extended to participating financial institutions (PFIs) which will extend loans to ESCOs for implementing EE projects.

Under the IFC Eco-cities programme supported by BEE, investment grade DPRs are presently being prepared for EE investments at MSMEs in 4 ECO-Cities across India, wherein a pipeline for loans benefitting from PRGFEE is expected to be created.

During FY 2015-16 to FY 2018-19, under SME programme various initiatives as described

19 https://www.ibef.org/download/SMEs-Role-in-Indian-Manufacturing.pdf

below, to boost energy conservation in the SME clusters covered under the BEE-SME programme. These initiatives targeted some of the key SME sectors including food processing, forging, textile and bricks.

Indore Food Cluster – under the project several interventions such as optimization of the combustion efficiency, compressed air system energy efficiency etc. were carried out in the cluster. Up to March 2017, implementations were carried out in seven industries leading to energy savings of 22 tonnes of oil equivalent.

Varanasi Brick Cluster – India is second largest producer of red bricks in the world, and the brick kilns mostly use conventional technology. Considering the massive potential in the sector BEE has demonstrated the energy efficient zig-zag brick kiln design. BEE also conducted training programs for the operating staff to facilitate adoption of this new technology. Up to March 2017, two implementations were demonstrated which has led to saving of around 362 tonne of oil equivalent.

Ludhiana Forging Cluster – Ludhiana cluster is the largest producer of fasteners in the country, and hosts several forging and engineering SME units. Forging industries are predominant in the cluster. Under the programme, several interventions such as waste heat recovery, electrical quality control, improvements in the furnace and burner design etc. were carried out in seven units till March 2017 leading to energy savings of 472 tonnes of oil equivalent.

Pilot EE Induction furnace project was carried out in Ludhiana, this technology has significant replication potential. Post successful demonstration of the technology by BEE in the cluster, few other units have adopted this technology to improve their energy efficiency and productivity.

Pali Textile Cluster is one of the biggest SME clusters in India having over 350 member industries majorly involved in dyeing of Poplin, PC Blend and Polyester etc. Considering the potential in the sector, several interventions for energy efficiency improvements were carried out in units leading to energy savings of 309 tonnes of oil equivalent.

Methodology for estimation of energy savings considering the improvement in the specific energy consumption (SEC) due to the interventions:

Annual Energy Savings = ($SEC_{Baseline} - SEC_{Final}$) x Annual Production

Where,

$SEC_{Baseline}$ = Baseline SEC measured during energy audit, prior to EE intervention

SEC_{Final} = Improved SEC of the equipment / process after EE interventions

A summary of energy savings and emission reductions in FY 2018-19, due to interventions carried out during FY15-19 is tabulated in Table 27 and presented in Figure 18.

Table 27: Energy saving from BEE SME programme FY 18-19

Cluster	Sector	No. of Units	Energy Saved (tonnes of oil equivalent)	Reduction in CO_2 emission (tCO_2)
Indore	Food	7	21.99	209
Ludhiana	Forging	7	472.16	1296
Varanasi	Brick Kiln	2	362.97	899
Pali	Textile	5	309.07	1528
Total			**1166**	**3934**

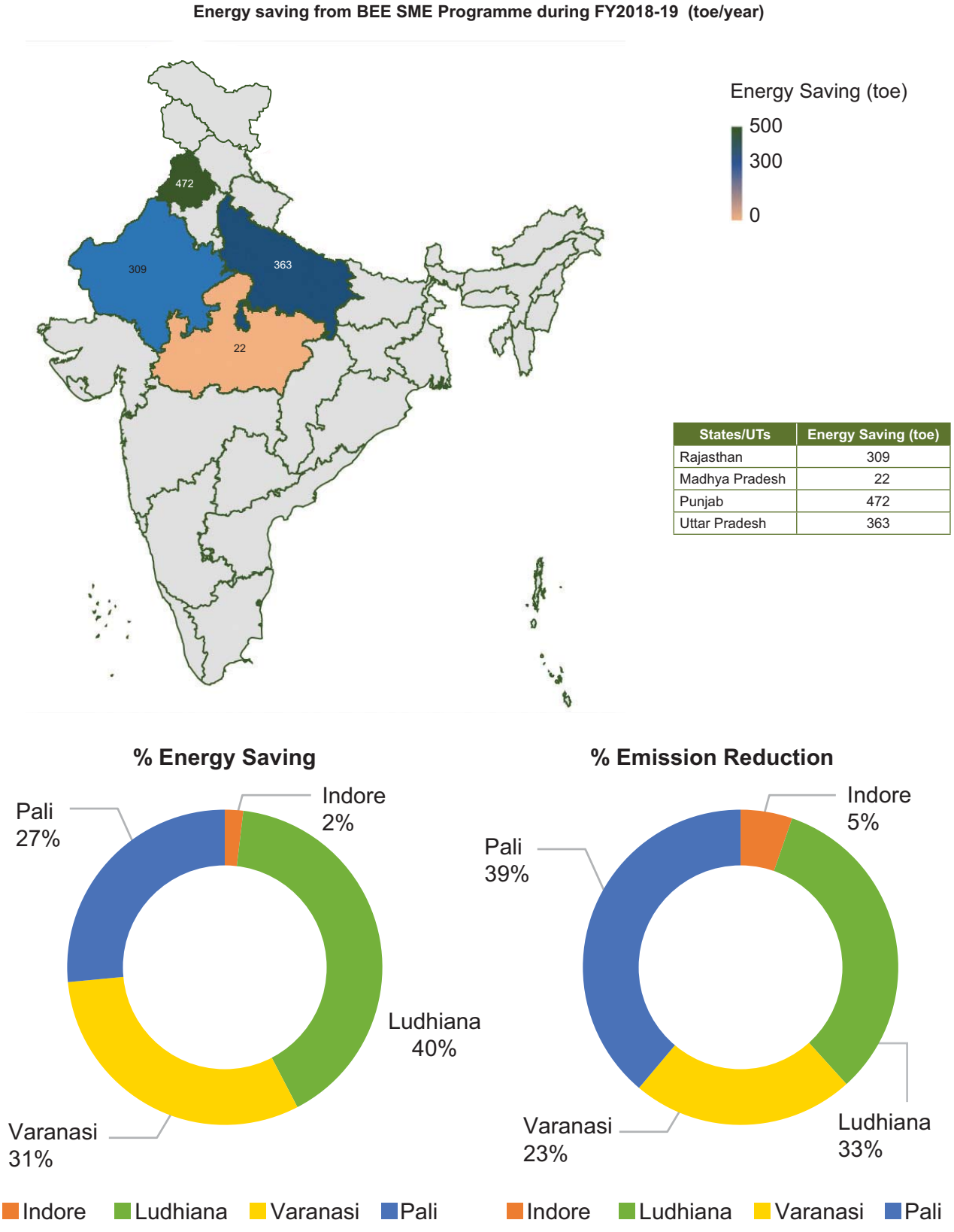


Figure 18: Energy and emission reduction across the four clusters

Effective Dissemination of EE Technologies for MSMEs: Dissemination of Recognizing the importance and effectiveness of well-presented success stories to ensure widespread replication of efficient technologies and practices, BEE has developed around 50 multimedia presentations showcasing successful case studies of implemented EE interventions for different MSME sectors. These are now being widely disseminated and are hosted in the Knowledge Management Portal "SIDHIEE" created under the BEE-SME Programme.

3.2 "Financing Energy Efficiency at MSMEs" – BEE-WB-SIDBI-GEF project

To boost energy efficiency in MSME industrial clusters, Grant agreement was signed on September 13, 2010 and effectuation of this grant took place on October 28, 2010. Considering the success of the Phase -I interventions carried out in five cluster during 2011-2015, this programme was extended during the twenty-five cluster across India. Under the programme over 750 IDGPRs were prepared and hand-holding support were provided to industries. During the phase -III over 25 workshops and 5 B2B interventions were carried out to promote the implementation phase -III of the project. Six technology multimedia were created under the programme to demonstrate the successful case studies of the interventions for different sectors. Phase -II and Phase III clusters saw implementations during 2015-19 hence are considered under impact assessment FY18-19. Details of the clusters are presented in Table 28.

Table 28: Phase wise coverage of MSME Clusters under BEE-WB-GEF Programme

Sr. No.	Cluster	Phase and Year
1	Pune	Phase-I (2011-2015)
2	Ankleshwar	
3	Tirunelveli	
4	Kolhapur	
5	Faridabad	
6	Ludhiana - Jalandhar	Phase-II (2015-17)
7	Dehradun	
8	Thane, Mumbai	
9	Delhi, NCR	
10	Varanasi	
11	Kundali, Panipat, Rai, Sonipat	Phase-III (2017-2019)
12	Ludhiana, Jalandhar, Chandigarh	
13	Rajkot, Morbi, Thangarh	
14	Coimbatore, Erode, Virudhachalam, Tirupur	
15	Surat, Vapi, Valsad	

Methodology for estimation of energy savings[20]

Annual Energy Savings = ($SEC_{Baseline}$ – SEC_{Final}) x Annual Production

Where,

$SEC_{Baseline}$ = Baseline SEC measured during energy audit, prior to EE intervention

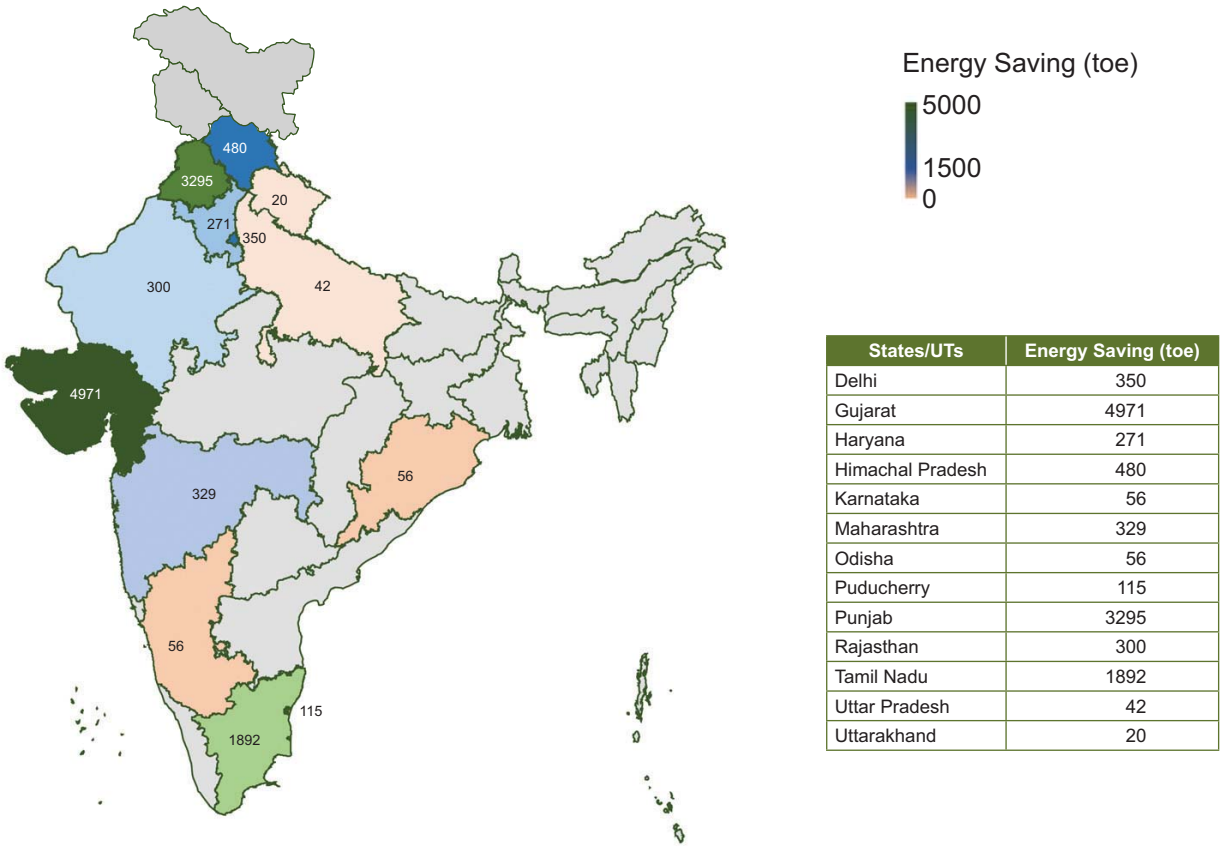
SEC_{Final} = Improved SEC of the equipment/ process after EE interventions

20 Energy savings estimated based on annual production details collected during year of EE implementation, at respective MSME unit for each implemented measure.

The WB-GEF project has also created a revolving fund to promote the financing of energy efficiency projects in MSME sectors. The fund is being used to provide financing at concessional interest rates to MSMEs for the implementation of energy efficiency interventions. Till date over 630+ industries have benefitted from the revolving fund.

Interventions carried out under the project has led to total energy savings of 12,178 tonne of oil equivalent[21] during FY 2018-19 (due to interventions carreid out during 2015-19) across 13 states and union territories. A summary of the energy savings across different states is presented in Figure 19.

Energy saving (toe/year) during FY 18-19



States/UTs	Energy Saving (toe)
Delhi	350
Gujarat	4971
Haryana	271
Himachal Pradesh	480
Karnataka	56
Maharashtra	329
Odisha	56
Puducherry	115
Punjab	3295
Rajasthan	300
Tamil Nadu	1892
Uttar Pradesh	42
Uttarakhand	20

Figure 19: Energy saving (tonne of oil equivalent) WB-GEF-SIDBI during FY 18-19

3.3 "Promoting Energy Efficiency and Renewable Energy in selected MSME clusters of India" BEE -GEF - UNIDO Project

United Nations Industrial Development Organization in collaboration with Bureau of Energy Efficiency, is executing a Global Environment Facility funded national project "Promoting energy efficiency and renewable energy in selected MSME clusters in India". Main project partners for this project are GEF, UNIDO, BEE, MoMSME and MNRE. This programme follows a holistic approach which includes conducting energy audits at MSMEs to assess the present level of operational efficiency and formualtion of the energy baseline. Other components

21 Emission reduction due to technology upgradations/changes were calculated by SIDBI implementation agencies based on each intervention and type of fuel saved. Consolidated data of SIDBI study is presented here (2015-19), Phase I of the project is not considered in energy savings

include technology identification, providing handholding support to SMEs for implementing energy efficiency. The programme also aims to build capacity on EE interventions arcoss the cluster and to strengthen the vendor and local service provider network to ease the avalibility of the technologies for SMEs. One of the important components of the program is demand aggregation to reduce the cost of the EE interventions that helps the SMEs in getting the new technology at reduced cost due to economies of scale and also helps the technology provider with a business opportunity pipeline.

The programme "Promoting Energy Efficiency and Renewable Energy in Selected MSME Clusters in India" has major four components:

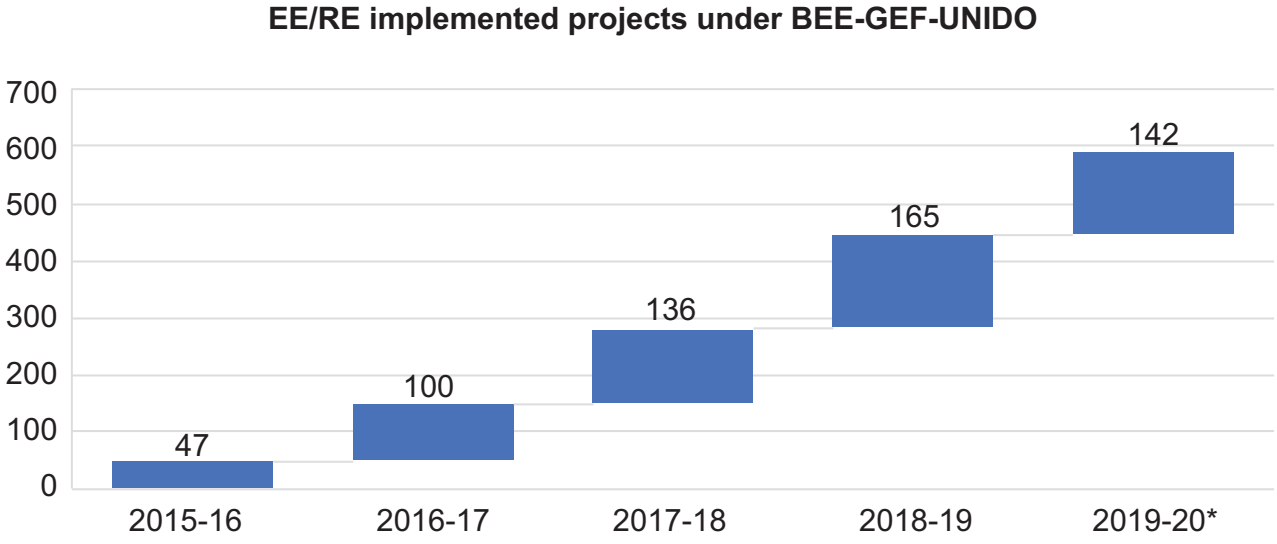


Figure 20: Numbers of EE/RE projects implemented under the project[22]

Component 1: Increased capacity of suppliers of EE/RE product suppliers/ service providers/ finance providers

Component 2: Increasing the level of end-use demand and implementation of EE and RE technologies and practices by MSMEs

Component 3: Scaling up of the project to a national level

Component 4: Strengthening policy, institutional and decision-making frameworks

Programme is operational in 12 MSME clusters in India from five sectors, respectively: Brass (Jamnagar); Ceramics (Khurja, Thangadh and Morbi); dairy (Gujarat, Sikkim and Kerala); Foundry (Belgaum, Coimbatore and Indore); and hand tools (Jalandhar and Nagaur).

Under the project several knowledge products, such as case-studies, DPRs were developed, 27 Pilot projects have been sanctioned.

305+ units owners, plant managers, shop-floor personnel have been trained on energy auditing and best operating practices through 3-days residential capacity building and training workshops at National Productivity Council, Chennai, total 84 workshops have been conducted. 373+EE and RE implementations

Facilitated installation of solar photovoltaic roof-top systems in 18 ceramic plants at Thangadh with a cumulative capacity of 800kWp. Total roof-top PV installations in the cluster reached about 1 MWp

22 2019-20 details are till December 2019.

Methodology for estimation of energy savings[23]

Annual Energy Savings = (SEC $_{Baseline}$ – SEC $_{Final}$) x Annual Production

Where,

SEC $_{Baseline}$ = Baseline SEC determined, prior to EE intervention

SEC $_{Final}$ = Improved SEC of the equipment/ process after EE interventions

Various energy efficiency interventions have been carried out during FY15-19, that has resutled in energy saving during the FY18-19. Summary of the energy saving interventions is tabluted in Table 29 and Figure 22.

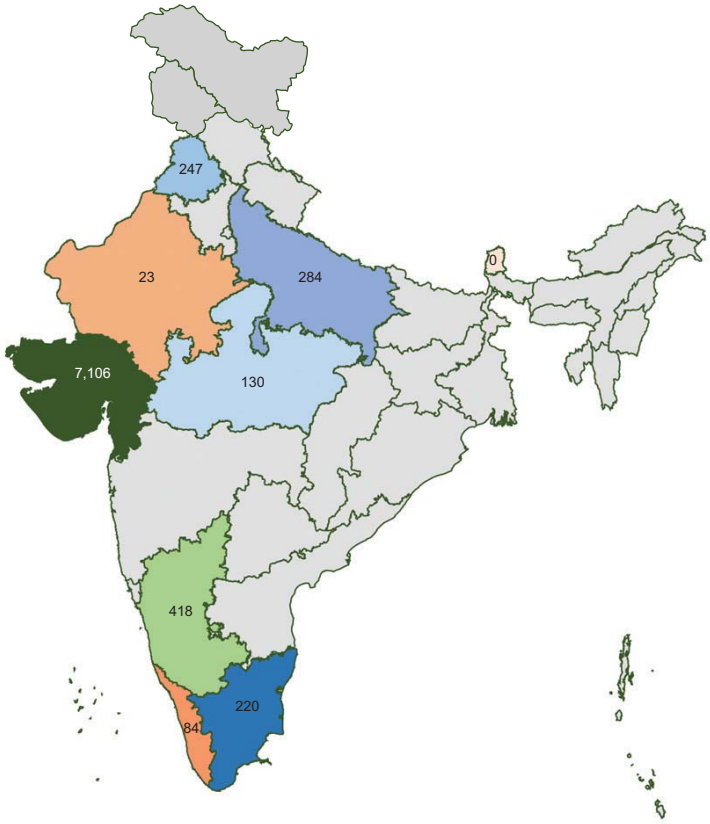
Table 29: Summary of the energy saving from BEE-UNIDO programme (FY 2015-19)

Cluster	Sector	Number of EE projects	Investment (Lakh Rupees)	CO_2 Reduction (tonne of CO_2/ year)	Energy Savings (tonne of oil equivalent)[24]
Belgaum	Foundry	71	375	2523	418
Coimbatore	Foundry	53	231	2056	220
Gujarat	Dairy	80	4190	29473	5713
Indore	Foundry	20	52	821	130
Jalandhar	Hand Tool	58	119	1892	247
Jamnagar	Brass	38	270	667	113
Kerala	Dairy	3	105	227	84
Khurja	Ceramic	7	20	1126	284
Morbi	Ceramic	11	30	1311	420
Nagaur	Hand tool	43	8	223	23
Sikkim	Dairy				
Thangadh	Ceramic	64	1049	6193	860
Total		**448**	**6449**	**46512**	**8512**

23 Baseline audits define the baseline energy consumption and operating hours. Final energy consumption is guaranteed by the technology provider.

24 Emission reduction due to technology upgradations/changes were calculated by BEE-UNIDO team based on each intervention and type of fuel saved. Consolidated data of UNIDO programme is presented in the table

Energy saving (toe/year) during FY 18-19



States	Energy Saving (toe)
Gujarat	7106
Karnataka	418
Kerala	84
Madhya Pradesh	130
Punjab	247
Rajasthan	23
Sikkim	0
Tamil Nadu	220
Uttar Pradesh	284

Figure 21: Energy saving (toe/year) due to BEE-UNIDO programme during FY 18-19 on account of the interventions carried out during FY15-19

3.4 "Promoting Market Transformation for Energy Efficiency in Micro, Small & Medium Enterprises" EESL – UNIDO – GEF programme

The Global Environment Facility has entrusted the United Nations Industrial Development Organization to implement the GEF-5 project titled 'Promoting Market Transformation for Energy Efficiency in Micro, Small and Medium Enterprises in India' in cooperation with the Ministry of MSME, Government of India and Energy Efficiency Services Limited.

EESL is implementing this project in 10 MSME clusters (Surat, Ankaleswar, Jorhat, Vellore, Jalandhar & Batala, Varanashi, Sundargarh, Howrah, East Godavari, Muzafarnagar) in India in association with UNIDO, MSME, BEE and SIDBI. A GEF grant to the tune of $3 million has been allocated to EESL to execute various activities which are at different stages of execution. The following are the highlights of the project in 2018-19.

EESL has signed MoUs with 5 Cluster Associations for implementation of GEF - 5 project. Four technologies have been identified and approved (by Working Technical Group) for proof-of-concept and scaling up.

- Replacement of Reciprocating Compressor with Variable Frequency Drive (VFD) enabled Screw Compressor with IE3 and above motor (Surat Cluster).
- Condensate and Flash Steam recovery (Surat Cluster)
- Programmable Logic Controller (PLC) based Jet Dyeing machine (Surat Cluster)
- Replacement of Existing Dryer LSU Dryer (Vellore Cluster)

Capacity building and project activies also includes - more than 200 workshops / surveys / brainstorming sessions / energy audits in the 10 project clusters. EESL is on discussion with TERI, NABARD and Oxford University, UK to put up a concept proposal to utilize Green Climate Fund (GCF) on Carbon Credit Incentive to MSME units in at least 5 technologies.

A dedicated web portal has been developed for this project for better and focused outreach to the stakeholders. Implementation under the project has started during February 2019, majority of the implementations fall during the FY 19-20 and are hence not considered under impact assessment for FY 18-19.

Demonstrations of VFD based Screw compressor with PM Motor has been completed in two textile units of Surat Cluster. The Joint Secretary, MoMSME inaugurated the pilot demonstrations.

Demonestration project for Jet deying machine is under implementation phase in textile industries in Gujarat

Buildings

CHAPTER 4

In India, buildings sector (residential and commercial) constitutes 33% of total electricity consumption in India. Buildings sector consumes about 372 billion units, as per the 2017-18 figures of the Ministry of Statistics and Programme Implementation, Government of India. If current scenario continues, electricity demand will rise from 372 TWh/year to 4,697 TWh/year and buildings will demand 55% of total electricity generated by 2047. Electricity demand in residential and commercial buildings sectors is predicted to rise by 5 folds and 3 folds respectively by 2032.

Commercial buildings consume about 9% of total electricity consumption. Commercial buildings include offices, hospitals, hotels, retail outlets, educational buildings, government offices, etc. The total built-up area of commercial buildings is expected to touch 1.9 billion m^2 by 2030. The rate of growth in commercial buildings sector is amongst the highest, and hence, this sector needs to be moderated in its energy consumption. A series of energy efficiency programmes catering to the buildings sector and specifically to the commercial buildings sector are therefore initiated. These programmes are discussed in the following sections.

Details of the national electricity consumption including the share of commercial and domestic buildings sectors are presented in Figure 22

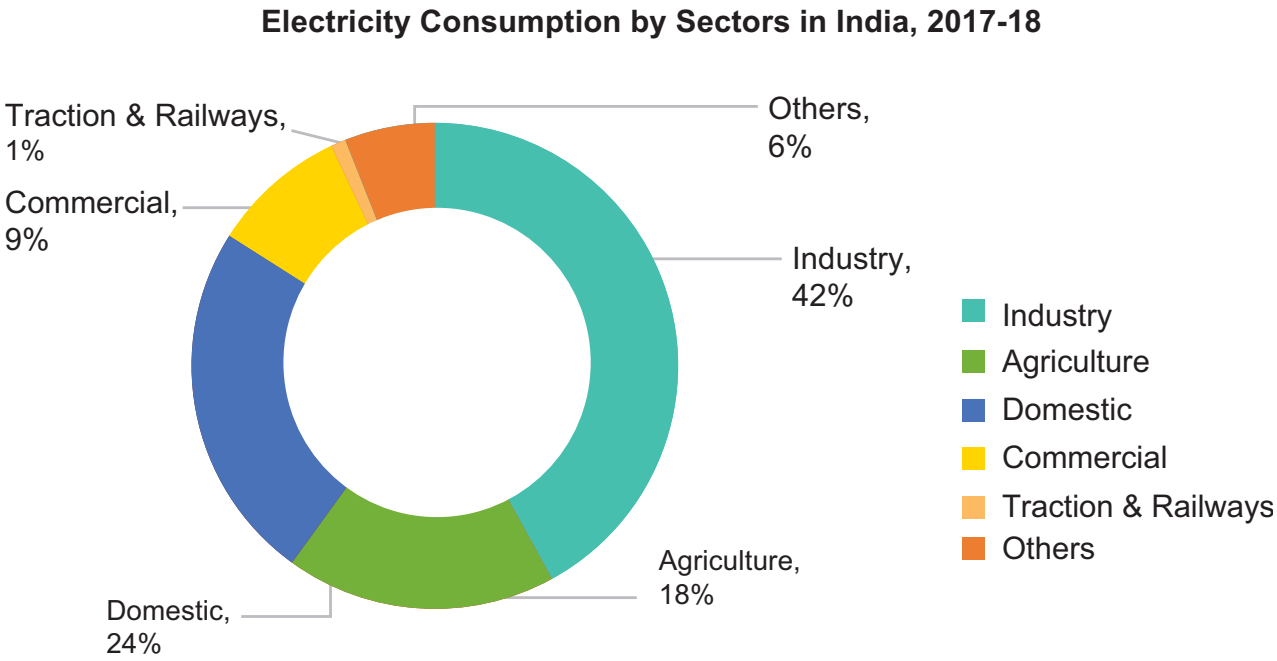


Figure 22: Energy consumption in different sectors in India

The key driver for the rapid increase of energy consumption in the buildings sector has been rising ownership levels for appliances such as air conditioners to provide comfortable indoor temperatures in urban areas in the recent years. The factors affecting energy demand in both domestic and commercial buildings sector has been divided into categories:

Lighting and Appliances: Energy consuming equipment in the commercial sector includes lighting, heating, ventilation and air conditioning (HVAC) and other office related equipment. HVAC has the greatest share in electricity consumption and its demand is primarily from air-conditioning. In residential buildings, most energy consuming equipment are lighting and appliances. With increase in electrical appliance ownership, increasing income level and reliable access, lighting and appliance loads in residential buildings are also on the rise.

Building envelope optimization: The building envelope pertains to the structural aspects of a building, which acts as a thermal barrier between the enclosed conditioned space and outside environment through which the thermal energy is transferred. By reducing the heat transfer through the building envelope, the need of energy used for space heating and cooling can be reduced significantly.

With a view of increasing electricity demand and need of managing it, an effort for energy conservation was initiated by Government of India with introduction of Energy Conservation Act published in the Gazette of India in October 2001. Bureau of Energy Efficiency (BEE) was instituted in 2002, to implement EC Act. Further first version of Energy Conservation building Code was launched by Government of India in 2007. BEE has also launched the Star rating of commercial buildings scheme in India in 2009.

EC Act was amended in 2010 with further update of Commercial ECBC in 2017. After this update, ECBC (commercial) was mandated for all commercial buildings falling in its purview (Connected load ≥100 kW or contract demand ≥120 kVA). The various initiatives and programmes undertaken by various ministries and institutions in India for buildings sector are presented in Figure 23.

4.1 Energy Conservation Building Code (ECBC) 2017

Buildings consume significant proportion of our energy resources and the ECBC is an essential regulatory tool to curb their energy footprint. Energy demand by end use in residential and commercial buildings have a distinct pattern. In residential buildings, fans and lights are major consumers whereas in commercial buildings, major part of electricity is consumed for HVAC operation. It is due to this reason that specific energy conservation code is required for each building type depending on its energy use.

Guidelines, Codes and Standards	Energy Efficiency in exisiting buildings	Rating Systems
• Energy conservation building code (ECBC) for commercial buildings • Residential labeling program focusing on energy efficiency • ECO Niwas Samhita-ECBC for Residential Buildings	• PAT scheme for building sectors • Net zero energy buildings • EESL Building Energy Efficiency Program	• BEE star rating for existing buildings • GRIHA National rating system for new building • LEED and IGBC rating system for buildings

Figure 23: Programme initiatives in buildings sector

Bureau of Energy Efficiency had launched Energy Conservation Building Code (ECBC) 2007 to establish minimum energy performance standards for buildings in India. Building energy codes are updated regularly to catch up with the curve of technology maturation and to set higher benchmarks for building energy efficiency.

Accordingly, In June 2017, ECBC 2017 was launched which considers existing as well as futuristic advancements in building technology to further reduce building energy consumption and promote low-carbon growth beyond the codes notified under ECBC 2007.

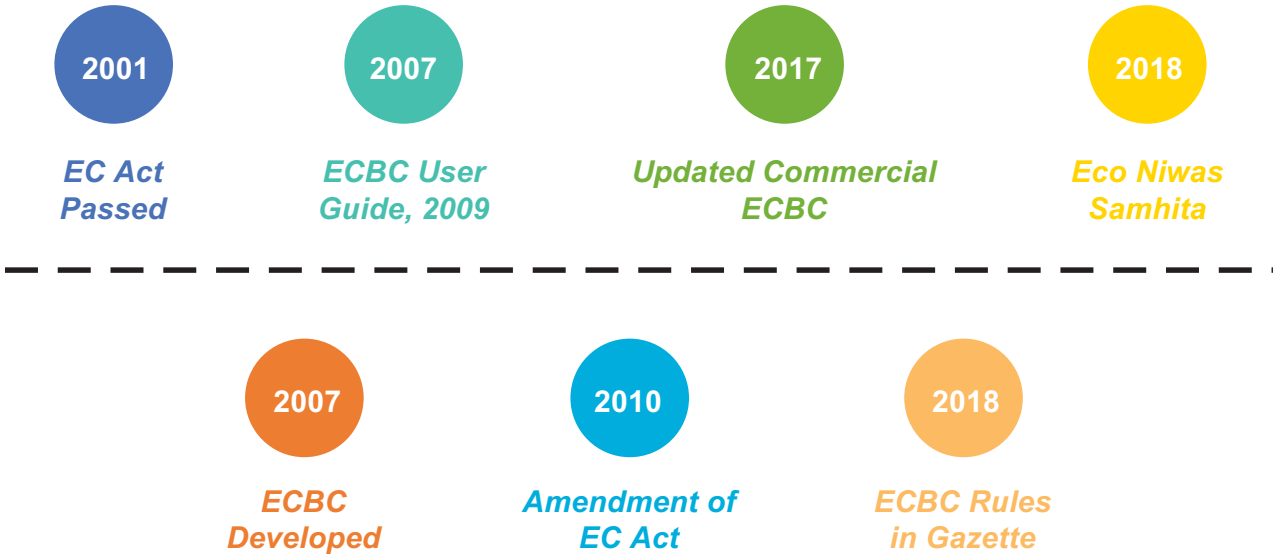


Figure 24: ECBC timeline

4.1.1 Program Overview:

Adoption of ECBC 2017 for new commercial building construction in India is estimated to lead to a 50% reduction in energy use by 2030 which would translate to energy savings of about 300 Billion Units and peak demand reduction of over 15 GW in a year. This will be equivalent to expenditure savings of INR 35,000 crore and 250 million tonnes of CO_2 emission reduction.

The Code is applicable to buildings or building complexes that have a connected load of 100 kW or greater or a contract demand of 120 kVA or greater and are intended to be used for commercial purposes. Until March 2019, while 13 states & 1 UT have made ECBC mandatory for commercial buildings through notification in their state gazettes, another 10 states are in advanced stages of making it mandatory.

There are 6 types of buildings classified under ECBC:

- Hospitality (i.e. star and no-star rated hotels, resorts),
- Educational (i.e. schools, colleges, universities, training institutions),
- Businesses (i.e. daytime use and 24-hours use- small, medium and large offices based on area)
- Assembly (i.e. theater, transport service facilities, multiplexes),
- Healthcare (i.e. hospitals, out-patient healthcare),
- Shopping facility (shopping malls, stand-alone retails, open gallery malls, supermarkets)

ECBC 2017 is technology neutral. Energy efficiency requirements have been framed to provide architects and engineers artistic and technical freedom as long as minimum

efficiency requirements are fulfilled. Provisions for installation of renewable energy generation systems is mandatory in ECBC 2017. Passive designs strategies like daylight and shading are also mandatory in ECBC 2017. Additional parameters included are related to renewable energy integration, ease of compliance, inclusion of passive building design strategies and, flexibility for the designers.

4.1.2 Level of compliance of buildings:

ECBC 2017 is one of the first building energy codes to recognize beyond code performance. One of the major updates to the code is inclusion of incremental, voluntary energy efficiency performance levels. In order to measure the level of compliance of buildings with the code, a parameter – energy performance index (EPI) has been defined. EPI is defined as the ratio of the annual energy consumption (in kWh) and total built up area (excluding unconditioned basements).

For compliance the EPI shall be calculated based on either of below approaches:

- Prescriptive Method
- Building Envelope trade-off method
- Total System Efficiency Method
- Low Energy Comfort Systems
- Whole Building Performance Method

There are now three levels of energy performance standards in the code. In ascending order of efficiency, these are ECBC, ECBCPlus and SuperECBC. The adherence to the minimum requirements stipulated for ECBC level of efficiency would demonstrate compliance with the code. Other two efficiency levels are of voluntary nature.

Energy Conservation Building Code Compliant Building (ECBC Building): ECBC Buildings shall demonstrate compliance by adopting the mandatory and prescriptive requirements listed under ECBC Compliant Building requirements in the code for all components of building systems, or by following the provisions of the Whole Building Performance (WBP) Method. Such a building is 20% more efficient than conventional building.

Energy Conservation Building Code Plus Building (ECBC+ Building): ECBC+ Buildings shall demonstrate compliance by adopting the mandatory and prescriptive requirements listed under ECBC+ Compliant Building requirements in the code for all components of building systems, or by following the provisions of the Whole Building Performance (WBP) Method. An ECBC+ building is 30-35% more efficient than conventional building.

Super Energy Conservation Building Code Building (SuperECBC Building): SuperECBC Buildings shall demonstrate compliance by adopting the mandatory and prescriptive requirements listed under SuperECBC Compliant Building in the code for all components of the building system, or by following the provisions of the Whole Building Performance (WBP) Method. A SuperECBC building is 40-45% more efficient than conventional building.

4.1.2.1 Minimum energy efficiency requirements

The ECBC provides minimum energy efficiency requirements for five building systems:

Building Envelope- Opaque construction materials and their thermal properties including thermal conductivity, specific heat, density along with thickness; fenestration U-factors, solar heat gain coefficients (SHGC), visible light transmittance (VLT) and building envelope sealing documentation; overhangs and side fins, building envelope sealing details;

Heating, Ventilation, and Air Conditioning- System and equipment types, sizes, efficiencies, and controls; economizers; variable speed drives; piping insulation; duct sealing, insulation and location; solar water heating system; requirement for balance report;

Interior and exterior lighting- lighting schedule showing type, number, and wattage

of lamps and ballasts; automatic lighting shutoff, occupancy sensors, and other lighting controls; lamp efficacy for exterior lamps;

Electrical power and motors- Electric schedule showing transformer losses, motor efficiencies, and power factor correction devices; electric check metering and monitoring system

Renewable energy systems- System peak installed capacity, technical specifications, solar zone area

Also considers the five climatic zones (Hot Dry, Warm Humid, Temperate, Composite and Cold) present in India. The National Building Code of India 2016 (NBC) is the reference standard for lighting levels, heating, ventilating, and air conditioning (HVAC), thermal comfort conditions, natural ventilation, and any other building materials and system design criteria addressed in this Code.

4.1.3 Methodology adopted to calculate the savings

In order to measure the level of compliance of buildings with the code, a parameter – energy performance index (EPI) has been defined. EPI is defined as the ratio of the annual energy consumption (in kWh) and total built up area (excluding unconditioned basements). There are total 117 buildings across India that are either in the discussion stage, design stage, construction stage or have completed their construction as per ECBC guidelines across 24 states in India. Details are presented in Table 30 and Figure 25.

This scheme is still under the voluntary stage. However, 13 states have made ECBC mandatory for commercial buildings through notification in their state gazettes, another 11 states are in advanced stages of making it mandatory.

Table 30: Details of buildings covered under ECBC

Construction Stage	No. of Buildings	Total Area in Mn. sqm
Completed	22	0.60
Design stage	83	3.38
In process	12	0.81
Grand Total	**117**	**4.79**

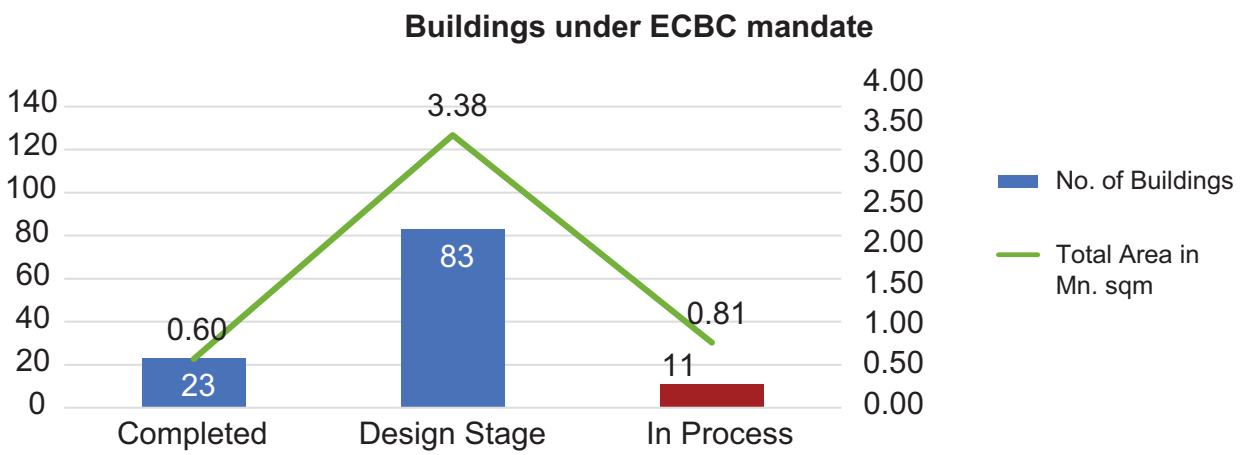


Figure 25: ECBC building status

Table 31: Category of buildings covered in ECBC

Building Type	No. of Buildings
Assembly	1
Hospital	8
Hotel	4
Institutional and IT	44
Office	48
Shopping & Recreation	12
Total	**117**

4.1.3.1 Estimation of Energy Savings

In order to calculate the energy (electrical) savings, the difference between the conventional EPI and proposed EPI of the respective buildings are considered, which is then multiplied by the total built up area in square meters (sqm). The EPI benchmarks are calculated as per the approved guidelines under ECBC programme and conventional EPIs are calculated using % Saving of ECBC[25] over and above the baseline EPI.

Annual Energy Savings = ($EPI_{Conventional}$ – $EPI_{Improved}$) x Total Built-up Area

Where,

$EPI_{Improved}$ = Measured EPI of the ECBC complaint building

$EPI_{Conventional}$ = $EPI_{Baseline}$ x (1 + % Savings as per USAID ECO III project)

$EPI_{Baseline}$ = EPI considering baseline of ECBC 2007

Total 22 buildings out of 117 buildings have completed their construction in last 4 Financial years 2015-16, 2016-17, 2017-18 & 2018-19 and are now operational. The same has been considered for the energy savings calculations. Out of these 22 buildings, 17 buildings were completed till March 2018, while for remaining 5 buildings construction was completed during FY 2018-19. These five buildings were compliant under ECBC during different months of the year; therefore, energy savings cannot be considered for entire one year.

Also, EPI for the building is calculated on annual basis to account for seasonal factors, and this EPI cannot be broken-down on monthly basis. Therefore, in order to calculate the energy savings for buildings compliant during FY 18-19, 50% of total energy savings is considered.

Table 32: Energy Saving for ECBC compliant completed buildings FY15-19

Financial Year	No. of Buildings	Energy Savings in MU	Total Area in Mn. sqm
2017	11	11.39	0.11
2018	6	27.92	0.20
2019	5	5.23	0.06
Total	**22**	**44.55**	**0.38**

25 % saving is considered as per ECBC impact analysis done by IECC under USAID ECO III project

In order to calculate the reduction in the total CO_2 emission, the conversion factor of 0.82 kg CO_2/kWh for electricity is considered. The total energy (electrical) saved under ECBC programme is 0.05 BU and total reduction in CO_2 emission is 0.04 $MtCO_2$.

Some of the electrical energy savings obtained under this scheme is due to replacement of inefficient electrical & mechanical appliances with BEE star rated appliances. Therefore, in order to avoid this duplication, only 90% of total energy savings has been considered for ECBC programme. Therefore, total electricity savings for ECBC programme in FY 2018-19 is considered as 0.04 BU and total reduction in CO_2 emission is 0.033 $MtCO_2$.

4.2 Energy efficiency in residential sector in India

Real estate sector is a globally recognized sector as one of the fastest growing and energy intensive sectors. The real estate market of India is expected to climb up to US$ 180 billion by 2020 in comparison to US$ 126 billion in 2015. Rapid commercialization, economic activities, and urbanization have collectively fueled a rise in the construction of buildings and increasing energy use over the last decade.

India, the fastest growing economy of the world, has seen tremendous construction activities in last one decade. The steep increase in urban population, coupled with demand for a better lifestyle, has led to a high demand of residential buildings. The sector has been growing at Compounded Annual Growth Rate (CAGR) of 6% and by year 2030; it is estimated that around 3 billion m^2 of new area will be added w.r.t year 2018.

The economic importance of the residential sector in India can be judged by the estimate that for every Indian rupee (INR) invested in the housing and construction, INR 0.78 is added to the gross domestic product[26] of the country. With such surging demand, it has been estimated that residential (housing) sector is expected to contribute around 11 per cent to India's GDP by 2020. Thus, it is imperative to constantly provide a firm fillip to housing sector to meet the target of housing for all by Honorable Prime

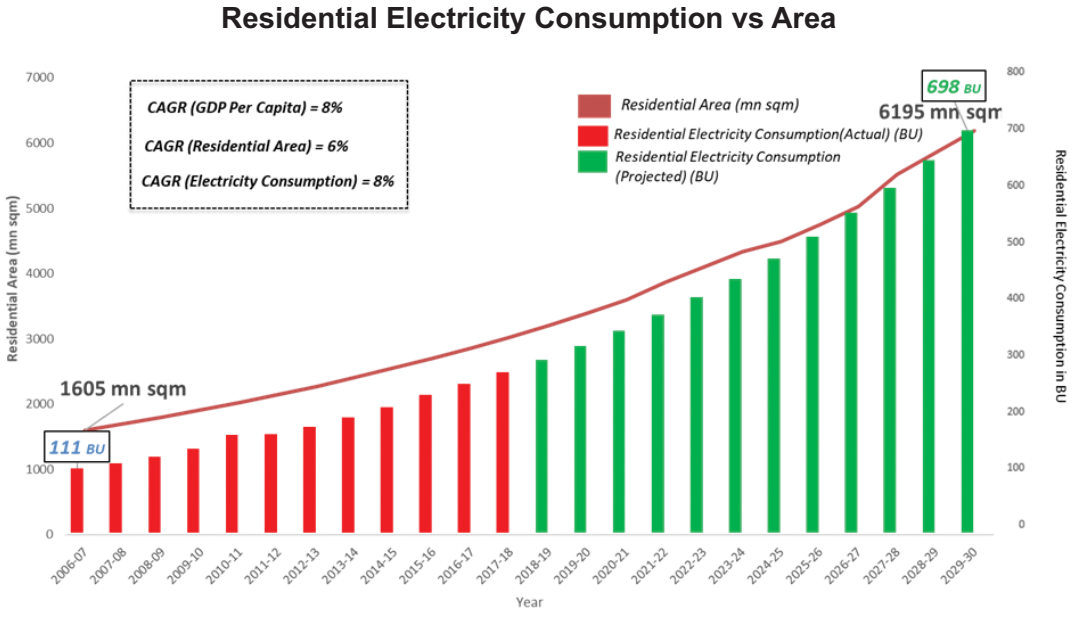


Figure 26: Area of the buildings in residential space and energy consumption forecast

26 https://economictimes.indiatimes.com/news/economy/indicators/economic-survey-housing-sectors-share-in-gdp-of-india-to-rise-to-6/articleshow/12276533.cms

Minister of India under the Pradhan Mantri Awas Yojna (PMAY) and to keep India at the trajectory of expected growth.

Such urbanization and high GDP growth rate has fueled the electricity consumption in residential sector as well[2]. Electricity demand in residential sector has been increasing at a CAGR of 8% per year on average. This robust growth shall lead to an increase in electricity consumption from 2730 BU in 2017[27] to almost 700 BU in 2030.

4.2.1 About Eco Niwas Samhita ENS – Scope and Requirement

Ministry of Power, Government of India launched the ECO Niwas Samhita 2018, which is an Energy Conservation Building Code for Residential Buildings (ECBC-R). The implementation of this Code will provide a fillip to energy efficiency in residential sector. It aims to benefit the occupants and the environment by promoting energy efficiency in design and construction of single and multi-dwelling units.

The provisions of this code apply to all residential buildings and residential parts of mixed land-use projects, both built on a plot area of ≥500 m^2. However, the actual plot area is subjective to the respective states and municipal bodies on the prevalence in their area of jurisdiction.

The following are excluded from the definition of 'residential building' for this code.

Lodging and rooming houses: This includes inns, clubs, motels, and guest houses.

Dormitories: This shall include school and college dormitories, students, and other hostels and military barracks.

Hotels: These shall include any building or group of buildings under single management, in which sleeping accommodation is provided, with or without dining facilities.

4.2.1.1 Building components covered under ENS

Energy Conservation Building Code – Residential (ECBC-R) (Part I: Building Envelope) sets the minimum building envelope performance standards to limit heat gains and to limit heat loss, as well as for ensuring adequate natural ventilation and daylighting potential. The code provides design flexibility to innovate and vary important envelope components such as wall type, window size, type of glazing, and external shading to windows to meet the compliance.

Below five are the key components of ENS Part 1 – Building Envelope:

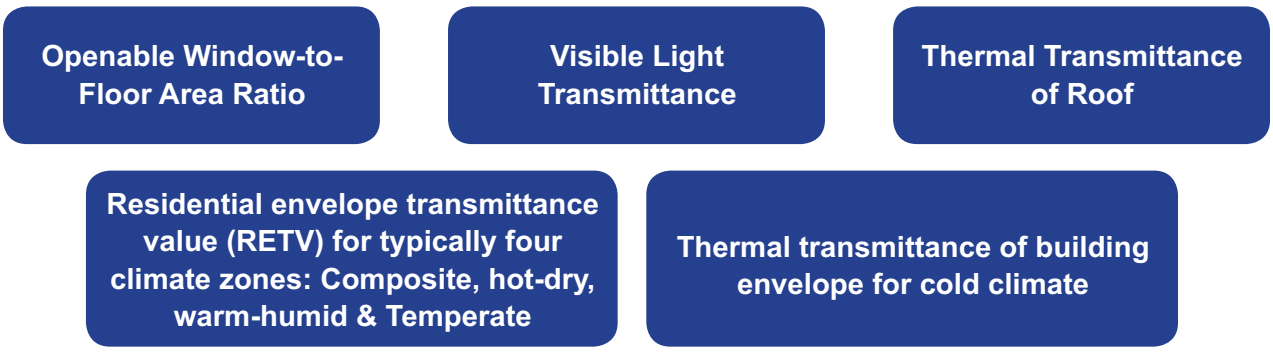


Figure 27: Key components of ENS part-1 building envelope

27 Energy statistics, 2019- MoSPI

4.2.2 Residential Labeling Program

The challenge in terms of soaring energy consumption in the housing segment is needed to be tackled with a multi-faceted approach. Making houses energy efficient is certainly a way of avoiding a long-term futile electricity consumption liability in residential buildings. This program helps the country in the same direction by designing an energy efficient residential labeling system.

Ministry of Power has already launched EcoNiwas Samhita 2018 on 14th December 2018, which prescribed the minimum energy performance through energy efficient envelop design. The proposed labeling program takes forward EcoNiwas Samhita 2018 and motivates consumers to move forward to design more efficient construction. Energy labels help consumers to make efficient decisions through the provision of direct, reliable and costless information.

4.2.2.1 Objective of the labeling program

The key objective of the programme is to make a transparent instrument over the energy performance of a home which will gradually lead to an effective model taken into consideration while deciding over the home prices in future. The objectives of the proposed labeling program are to provide:

- information to consumers on the energy efficiency standard of the Homes
- a benchmark to compare one home over the other on the energy efficiency standards
- a consumer driven market transformation business model solution for Energy Efficiency in housing sector
- steering the construction activities of India towards international best practices norms

4.2.2.2 Scope of the program

Proposed Labeling program will cover all types of residential buildings in India. All the envisaged objectives can be achieved through

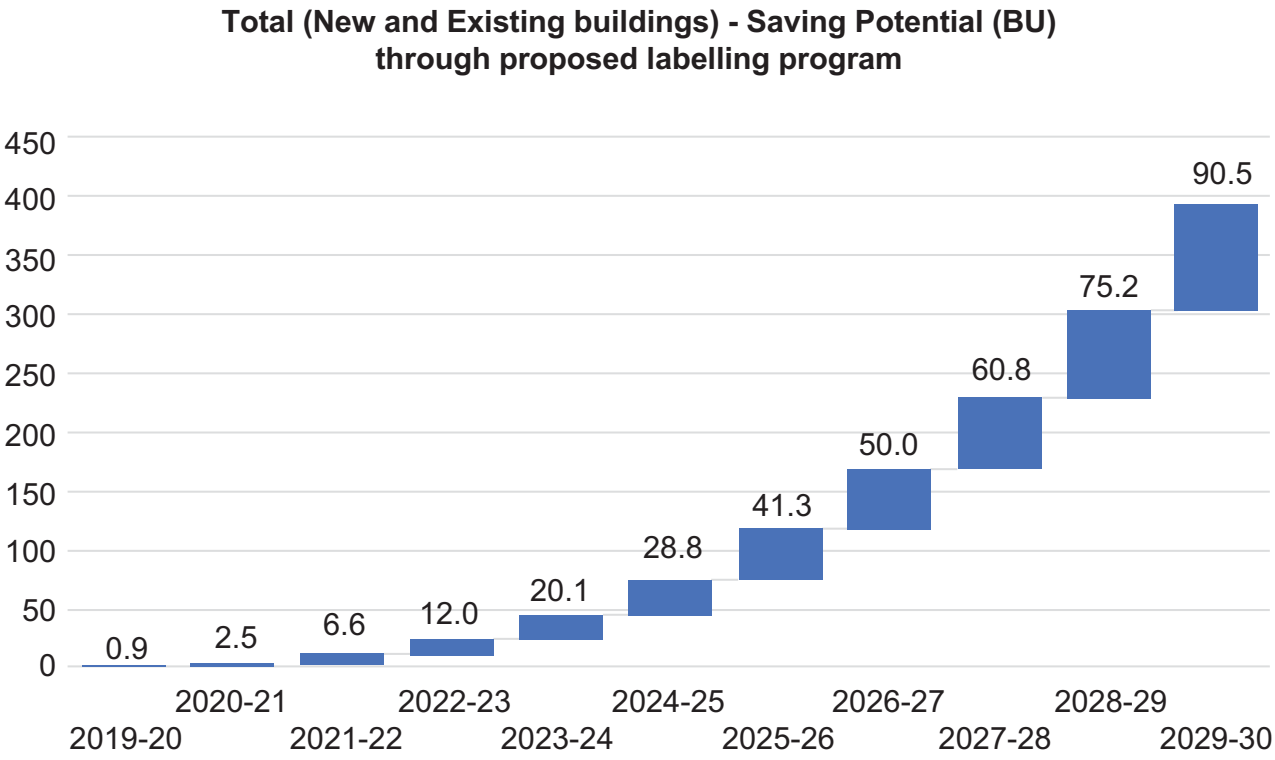


Figure 28: Energy saving potential in buildings through labeling programme

the proposed labeling mechanism by making it as a mandatory information required in any real estate transaction/ leasing.

4.2.2.2 Benefits of the program

The proposed labeling program is expected to save a large amount of energy through imparting energy efficiency to houses nationwide. The estimated energy saving potential through proposed labeling program is around 388 BU by year 2030 which is greater than the energy consumption in 2016 (250 BU).

In conjunction to this, the program also brings up various ancillary benefits which are following:

- The proposed labeling program shall act as an embryo to **stimulate the larger energy efficient materials and technologies market**. In order to seek the energy efficiency label, customers shall demand energy efficient building materials which in turn, would give enough impetus to suppliers to produce the same.

- Post implementation of labeling mechanism, the housing value chain shall need additional set of professionals to expedite the complete process of residential label granting. By this way, the label regime shall also be a stimulant to Indian job market.

- The proposed labeling program will also motivate material manufacturers to invest in energy efficient material manufacturing in India thus supports Make in India program.

- Labeling mechanism shall cause reduction in energy bills. This will empower individuals with a greater disposable income that can be consumed at other avenues, saved for future contingencies or invested for cash generating asset creation for the overall economic growth.

- It helps the nation in working towards fulfillment of Global Sustainable Development Goals 7 of United Nations: Affordable and Clean Energy. Proliferation of energy efficient houses through the proposed labeling scheme shall increase the rate of energy efficiency.

4.3 BEE star rating for existing buildings

BEE introduced the Star Rating for existing buildings as a voluntary policy measure to reduce the adverse impact of buildings on the environment. BEE has launched the Star rating of commercial buildings scheme in 2009. The star rating programme is based on the actual performance of a building in terms of its specific energy usage in kWh/sqm/year. This programme rates office buildings on a 1-5 Star scale, with 5 Star labelled buildings being the most efficient. The scheme is propagated on a voluntary basis and the label provided under it is applicable for a period of 5 years from the date of issue.

Under this programme, there are 5 categories of buildings that have been identified viz. office buildings (day use and business process outsourcing (BPOs)), shopping malls, hotels, hospitals and IT parks in the 5 climatic zones of the country. This national energy performance rating is a type of external benchmark that helps energy managers to assess how efficiently their buildings use energy, relative to similar buildings nationwide. Additionally, building owners and managers can use the performance ratings to help identify buildings that offer the best opportunity for improvement and recognition.

4.3.1 Program Overview

Under the present labeling scheme, the buildings are being labeled as per their actual Energy Performance Indices (EPI) on a scale of 1 to 5. The sets of standard EPI bandwidths developed to rate buildings under this scheme for different climatic zones indicate the range of variations in the energy performances of different office building types lying in a particular climatic zone.

To apply for rating of office buildings, a standardized format is developed for collection of actual energy consumption: data required includes building's built up area, conditioned and non-conditioned area, type of building, hours of operation of the building in a day, climatic zone in which building is located, and other related information of the facility.

Based on the data provided by BEE, 261 buildings have been star rated under different categories of buildings as on date. BEE had launched the Star rating program for Offices (February 2009), BPOs (December 2009), Shopping Mall (January 2011) and Hospitals (July 2014). Memorandum of Understanding (MoU) is also signed between BEE and CPWD on 10th January 2019 for "Energy Efficiency in CPWD managed Buildings". Details are presented in Figure 29 and Table 33

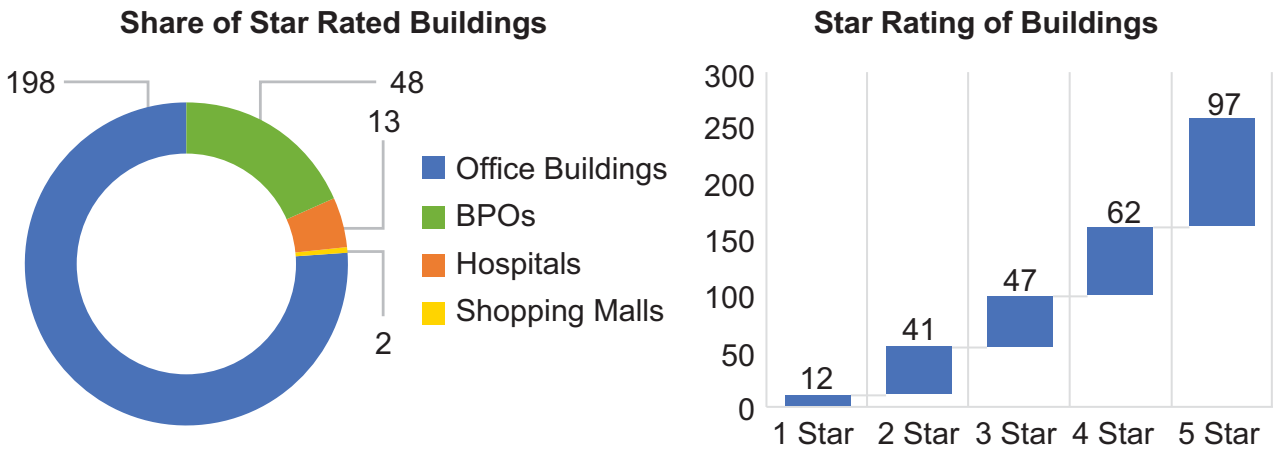


Figure 29: Share of Star Rated buildings

Table 33: BEE star rated buildings

Category	Number of Buildings
Office Buildings	198
BPOs	48
Hospitals	13
Shopping Malls	2
Total	**261**

4.3.2 Star Rating System

Energy Performance Index (EPI) in kWh / sqm/ year is considered for rating the building. The table indicating the EPI with the corresponding Star Label under the various climatic zones are provided in below sections for reference- For buildings having air-conditioned area greater than 50% of their built-up area & For buildings having air conditioned area less than 50% of their built up area. Details are presented in Figure 30

Star Rating for building with >50% of air-conditioned built up area			
Star Label	EPI for composite climate zone	EPI for warm & humid climate zone	EPI for hot & dry climate zone
1	190-165	200-175	180-155
2	165-140	175-150	155-130
3	140-115	150-125	130-105
4	115-90	125-100	105-80
5	Below 90	Below 100	Below 80

Star Rating for building with <50% of air-conditioned built up area			
Star Label	EPI for composite climate zone	EPI for warm & humid climate zone	EPI for hot & dry climate zone
1	80-70	85-75	75-65
2	70-60	75-65	65-55
3	60-50	65-55	55-45
4	50-40	55-45	45-35
5	Below 40	Below 45	Below 35

Figure 30: Baseline EPI for Star rated buildings

Under this programme, the user affixes the building rating label as per the label design and specification (both in terms of size and material), manner of display, and the rating plan as prescribed by the Bureau for the particular building type. BEE is continuously reviewing its technical approach to the development of the rating system to ensure an accurate, equitable, and statistically robust rating, because each building type has unique features that impact energy efficiency. BEE has also taken up the exercise of standardization of energy data collection which assists in comparative assessment and target setting in existing buildings.

4.3.3 Methodology for Energy Savings

EPI shall be kWh/sqm/year in terms of purchased & generated electricity divided by built up area in sqm. However, the total electricity would not include electricity generated from on-site renewable sources such as solar photovoltaic etc. The rating is normalized to account for the operational characteristics that define the building use, hours of operation, climatic zone and conditioned space.

Methodology adopted for assessing the energy savings of star rated buildings is based on the difference between the reported EPI value and

max EPI for star 1 rated building, multiplied by the total built-up area. The bandwidths considered for building energy star rating programme is provided in the above section.

Annual Energy Savings = (EPI $_{Conventional}$ – EPI $_{Improved}$) x Total Built-up Area

Where,

EPI $_{Conventional}$ = Max EPI of 1 Star Labeled building for specific category of building in specific climate zone

EPI $_{Improved}$ = Measured EPI of the Star Labeled building

4.3.3.1 Type of Buildings and Climate Zones

The programme targets the following 4 climatic zones for air-conditioned and non-air-conditioned buildings:

- Warm & Humid
- Composite
- Hot and Dry
- Temperate

Number of the buildings labeled across 2015-19 are presented in Figure 31.

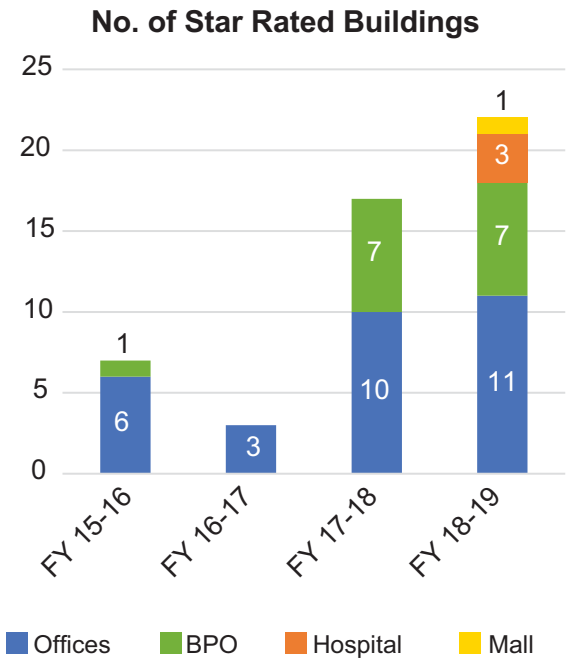


Figure 31: Number of Star rated buildings

There are total four types of commercial establishments that are part of this report, viz. Offices, Hospitals, BPOs and Shopping Malls.

1 ***Office Buildings:*** BEE Star Rating Scheme for Office Buildings is notified in year 2009. The baseline EPIs considered for star rating programme in more than 50 % air-conditioned built-up area and less than 50 % air-conditioned built-up area are given in Table 34

Table 34: EPI for star rated office buildings

Star Label	Climatic Zone	EPI (kWh/sqm/year)	
		<50% air conditioned	>50% air conditioned
1 Star	Composite	80-70	190-165
1 Star	Warm & Humid	85-75	200-175
1 Star	Hot & Dry	75-65	180-155

2 ***BPO Buildings*:** Star Rating Scheme for BPO buildings notified in December 2009. Average Annual hourly Energy Performance Index (EPI) i.e., (AAhEPI) in (Wh / hr/ sqm) has been considered for rating the BPO building. The table indicating the AAhEPI with the corresponding Star Label under the various climatic zones are presented in Table 35

Table 35: EPI for star rated BPO buildings

Star Label	Climatic Zone	Average Annual hourly EPI (AAhEPI) in (Wh / hr/ sqm) >50% Conditioned Area only
1 Star	Composite	52-46
1 Star	Warm & Humid	54-48
1 Star	Hot & Dry	37-31
1 Star	Temperate	47-41

3 ***Shopping Malls:*** BEE Star Rating Scheme for Shopping Malls is notified in year 2011. Energy Performance Index (EPI) in kWh / sqm/ year is considered for rating the mall. The table indicating the EPI with the corresponding Star Label under the various climatic zones is presented in Table 36

Table 36: EPI for star rated Shopping Malls

Star Label	Climatic Zone	EPI (kWh /sqm/year) >50% Conditioned Area only
1 Star	Composite	350-300
1 Star	Hot & Dry	300-250
1 Star	Temperate	275-250
1 Star	Warm & Humid	450-400

4 ***Hospitals:*** BEE had launched the Star rating program for Hospitals in July 2014. A benchmarking tool called the ECO bench, available online is used for evaluating the star rating for hospitals. This tool gives the performance distribution curve, EPI, Performance Rank and relevant Stars to hospital buildings.

4.3.4 Impact of BEE Star Rating Programme

As the star rating is valid for 5 years and there are 49 number of buildings that had received star rating from 2015-16 to 2018-19; so, it has been assumed that these buildings have been sustaining the energy savings post the star rating certification.

Out of these buildings, total 22 commercial establishments have received BEE star ratings in FY 2018-19. These buildings were given BEE star rating during different months of the year; therefore, energy savings cannot be considered for entire one year.

As star rated EPIs are calculated on annual basis considering seasonal factors, therefore it cannot be broke-down on monthly basis. Therefore, in order to calculate the energy savings for star rated buildings certified during FY 18-19, 50% of total energy savings is considered.

On account of total number of star-rated buildings in last 4 years, the total energy (electrical) saved by these commercial establishments in the year 2018-19 is 82.5 MU. This has led to reduction of 0.068 Million Tonnes of CO_2. Details are presented in Table 37 and Figure 32.

Table 37: Energy saving summary of star rating scheme

Building Type	Energy Savings in MU					CO_2 Emission Reductions
	2015-16	2016-17	2017-18	2018-19	Total	
Offices	14.2	0.5	6.2	3.9	**24.9**	0.020
BPO	2.5	0.0	28.6	20.4	**51.4**	0.042
Hospital	0.0	0.0	0.0	1.7	**1.7**	0.001
Mall	0.0	0.0	0.0	4.5	**4.5**	0.004
Total	**16.7**	**0.5**	**34.8**	**30.5**	**82.5**	**0.068**

As the electrical energy savings obtained under this programme is mainly due to replacement of inefficient electrical & mechanical appliances with BEE star rated electrical & mechanical appliances, therefore in order to avoid any duplication, the energy savings of Star Rating Programme has been already considered under S&L programme.

4.4 Building Energy Efficiency Programme

EESL is driving on a large – scale transformation to retrofit commercial buildings in India into energy efficient complexes. Through these future ready solutions, EESL is creating a market for clean energy in India. The buildings sector consumes over a third of India's electrical energy, to meet the growing demand for lighting, space heating and cooling. In response, Energy Efficiency Services Limited (EESL) has introduced Buildings Energy Efficiency Programme which offers a uniquely designed solution for buildings of the government, industry, and institutions to implement and retrofit energy efficient appliances and systems at affordable prices.

EESL is undertaking implementation of the Buildings Energy Efficiency Programme (BEEP), which was launched in May, 2017 by the Indian Government. EESL's Building Programme enables clients & stake holders to overcome technical & financial barriers to promote energy efficiency implementation in commercial buildings of the country.

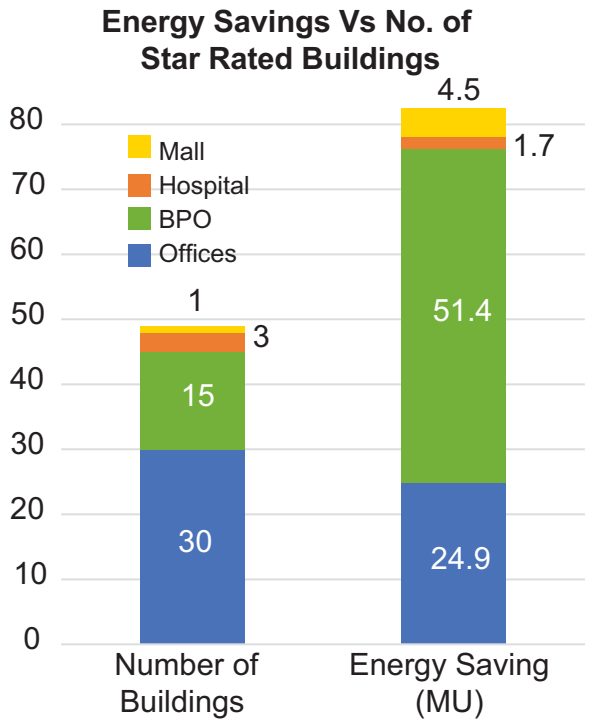


Figure 32: Energy savings of buildings in BEE star ratings scheme

4.4.1 Program Overview

EESL has applied its proven model of demand aggregation as a means of ensuring affordability for the energy efficient appliances, implementation, and systems maintenance to the buildings sector. Till date, EESL has signed agreements to unlock the dormant energy efficiency potential of over 15,000 buildings including railway stations across India.

Not only is the programme unlocking their energy efficiency potential at a significant scale, but also ensuring economies of scale for the appliances, systems, and services it offers. The

cost effectiveness, and high rates of returns in the form of savings on electricity has created a market momentum in the commercial buildings space.

4.4.1.1 Business Model

A business model that suits diverse building efficiency needs: Its approach offers two attractive pathways to clients: Energy Service Company (ESCO) Mode and Project Management Consultancy (PMC) model. Under the ESCO model, the entire up-front cost is borne by EESL and this cost is paid back by the building owner from the energy saving resulted by the intervention. In the PMC model, EESL is fully paid for its strategic input, implementation, and equipment maintenance.

4.4.1.2 Building Management System:

As part of their Buildings Energy Efficient Programme offering, EESL gives building facility managers access to a Building Management System to track power consumption in real-time and identify how they can cut down power wastage from lighting, audio-visual and information technology equipment, and other appliances left on when not in use. The system can also give facility managers a snapshot of energy use comparison, energy cost comparison, and an overall energy sustainability report.

4.4.2 Program Coverage

EESL aims to bring energy efficiency solutions to 20,000 large Government and Private buildings by 2020. With an investment of around INR 2,000 crore (equivalent to USD 30.8 crore), EESL will retrofit around 2 crore LED lights, 25 lakh energy efficient ceiling fans, and 2 lakh energy-efficient ACs. EESL's programme will be expanded to include centralized air conditioning, Energy Audits, and New Generation Energy Management System.

Under BEEP programme, the Super - Efficient Air Conditioning Programme (ESEAP) is now being executed. EESL has launched Super Energy Efficient Air Conditioners in India which are higher than BEE 5 - star rating. The retrofitting work of Air Conditioners has started under EESL's Building Energy Efficiency Program (BEEP) and is under progress.

EESL has launched "National Building Dashboard" www.eeslbeep.com, which provides information of real time / deemed energy savings in all buildings on PAN India basis. It also gives information about annual CO_2 emission reductions and avoided peak demand due to retrofit of energy efficient equipment.

Government of India has issued an instruction to all Departments and Ministries in August, 2017 to ensure all the buildings become energy efficient. As on date, EESL has completed building energy efficiency projects in 6648 buildings including Railway stations and Airports.

Share (numbers) of commercial buildings under BEEP across India is presented in Figure 33 and Table 38

Coverage of commercial buildings in different states across India

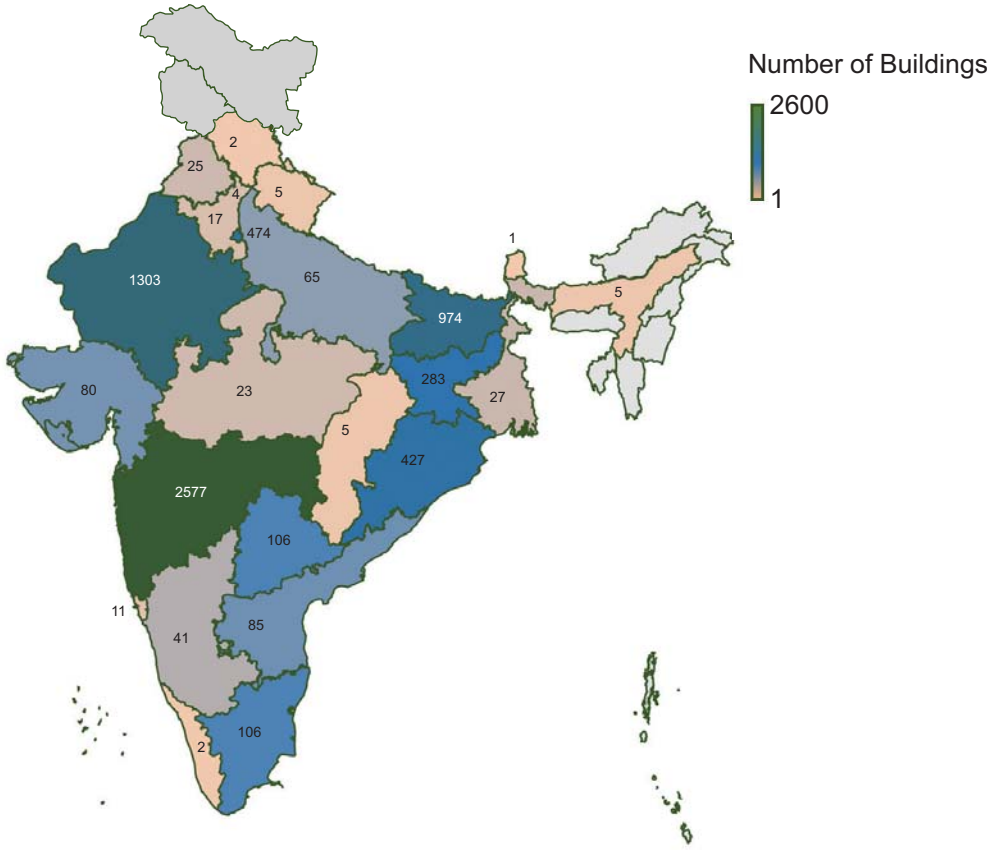


Figure 33: Coverage of commercial buildings in different states across India

Table 38: Coverage of commercial buildings in different states across India

State Name	No. of Buildings	State Name	No. of Buildings
Maharashtra	2577	**West Bengal**	27
Rajasthan	1303	**Punjab**	25
Bihar	974	**Madhya Pradesh**	23
Delhi	474	**Haryana**	17
Odisha	427	**Goa**	11
Jharkhand	283	**Assam**	5
Andhra Pradesh	106	**Chhattisgarh**	5
Tamil Nadu	106	**Uttarakhand**	5
Telangana	85	**Chandigarh**	4
Gujarat	80	**Himachal Pradesh**	2
Uttar Pradesh	65	**Kerala**	2
Karnataka	41	**Sikkim**	1

Building Ownership

There are a total 6648 commercial buildings under this programme. The type of commercial building includes, Central Govt. Buildings, District Courts, PWD Buildings and Railway Station buildings. The share of buildings under this programme till FY 2018- 19 is presented in Figure 34 and Figure 35.

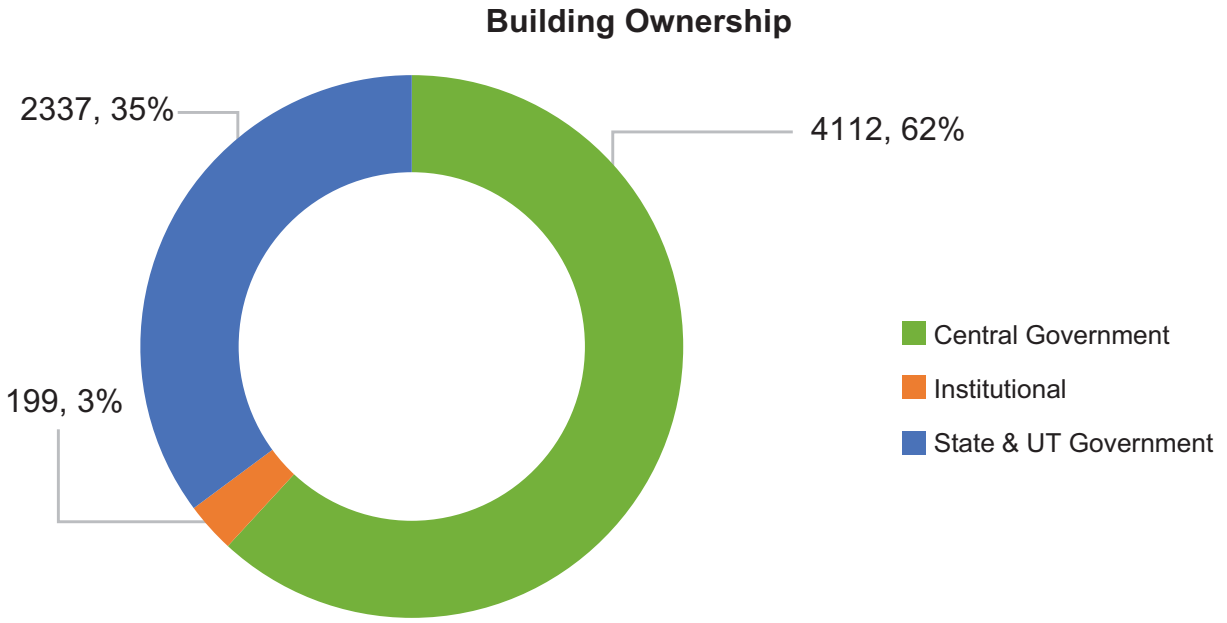
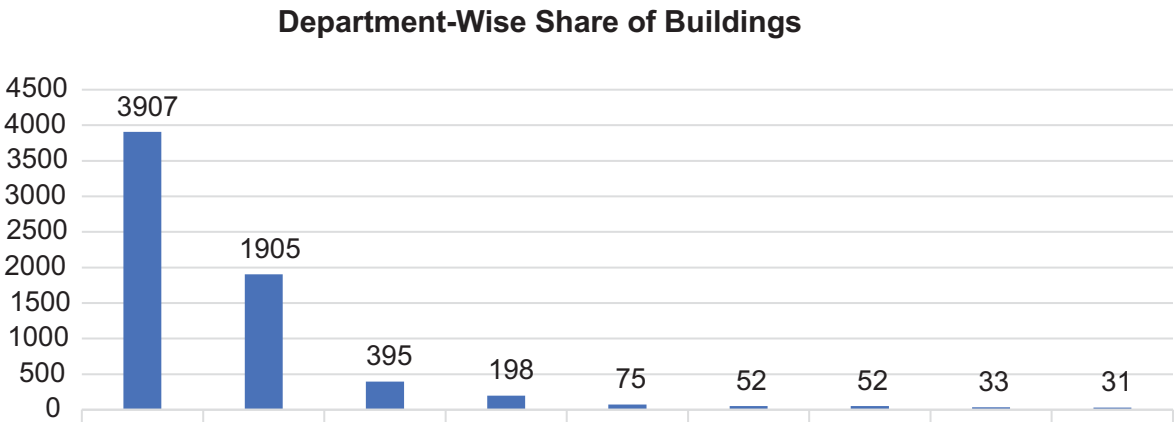


Figure 34: Share of buildings under BEEP programme



	Ministry of Railways	Public Works Depart-ment	SDMC	Food & Public Distri-bution	Ministry of Finance	Ministry of Housing and Urban Affairs	Others	Malaviya Regional Engine-ering College, Jaipur	Ministry of Civil Aviation
No. of Buildings	3907	1905	395	198	75	52	52	33	31

Figure 35: Department wise share of buildings under BEEP

4.4.3 Methodology for Energy Savings

The major interventions in buildings are in area of lighting and air - conditioning systems. EESL retrofits LED lights, energy efficient ceiling fans, and energy-efficient ACs under the BEEP. In order to calculate the energy (electrical) savings under the BEEP, following information is collected and then energy savings for Lighting and HVAC systems is calculated.

Table 39: Methodology for energy saving estimation in BEEP

Building Information		Existing Appliance			Energy Efficient Appliance			Annual Operating Hours	Energy Savings Achieved
Name	Department/ Ministry	Type	No.	Watt	Type	No.	Watt		
									No. of Appliances x (Conventional Wattage minus Energy efficiency Wattage) x Annual no. of hrs.

In order to calculate the reduction in the total CO_2 emission, the conversion factor of CO_2 for electricity is considered as 0.82 kg CO_2/kWh. Based on the results as obtained, the impact under the BEEP is discussed next.

4.4.3.1 Impact of the Building Energy Efficiency Programme

EESL also conducted energy audits in these buildings and estimated the energy saving potential to the tune of up to 30-50% in these buildings. Prior to FY 2017-18, very few buildings were part of this programme. Almost 6500 buildings became a part of this programme in FY 2017-18, 2018-19 only.

Out of these buildings, more than 5000 commercial buildings covered during FY 2018-19. Retrofitting work in these buildings was completed during different months of the year; therefore, energy savings cannot be considered for entire one year. Therefore, in order to calculate the energy savings for buildings completed in FY 18-19, 50% of total energy savings is considered. The impact of the BEEP in terms of energy (electrical) saved across India cumulatively for last four FY 2015-16, 2016-17, 2017-18 & 2018-19 is presented in Table 40

Table 40: State-wise energy savings under BEEP Programme

State	No. of Buildings	Energy Savings in MU	Reduction in tCO_2
Maharashtra	2575	64.856	53181.9
Delhi	470	7.885	6465.0
Rajasthan	1259	6.070	4977.0
Uttar Pradesh	65	5.795	4751.6
Jharkhand	283	4.243	3479.1
Andhra Pradesh	101	3.730	3058.4
Bihar	974	2.849	2336.4
Punjab	23	2.487	2039.4
Gujarat	77	2.339	1918.2
Odisha	425	2.119	1737.6
Tamil Nadu	106	1.953	1601.2
Karnataka	33	1.571	1288.0
Haryana	17	1.258	1031.3
Telangana	84	0.996	816.8
Madhya Pradesh	19	0.937	768.3
Goa	11	0.311	254.7
Assam	4	0.277	227.4
Chandigarh	4	0.226	185.0
Chhattisgarh	4	0.216	177.0
West Bengal	1	0.141	115.3
Kerala	2	0.018	14.9
Uttarakhand	5	0.009	7.4
Himachal Pradesh	2	0.003	2.7
Sikkim	1	0.002	1.3
	6545	**110.3**	**90436.0**

The total energy (electrical) saved under the BEEP scheme in the last four FY 2015-19 is 0.110 BU and total reduction in CO_2 emission[28] equals to 0.090 Million Tonne of CO_2, details are presented in Table 41 and Figure 36

Table 41: Appliances and Energy saving details of BEEP programme

FY	No. of Buildings	No. of Appliances Retrofitted in 000'	Energy Savings in MU
2015-16	1	6.2	0.3
2016-17	11	12.7	1.4
2017-18	1470	144.7	15.3
2018-19	5063	1,438.5	93.4
Total	**6545**	**1,602.1**	**110.3**

28 http://www.cea.nic.in/reports/others/thermal/tpece/cdm_co2/user_guide_ver13.pdf

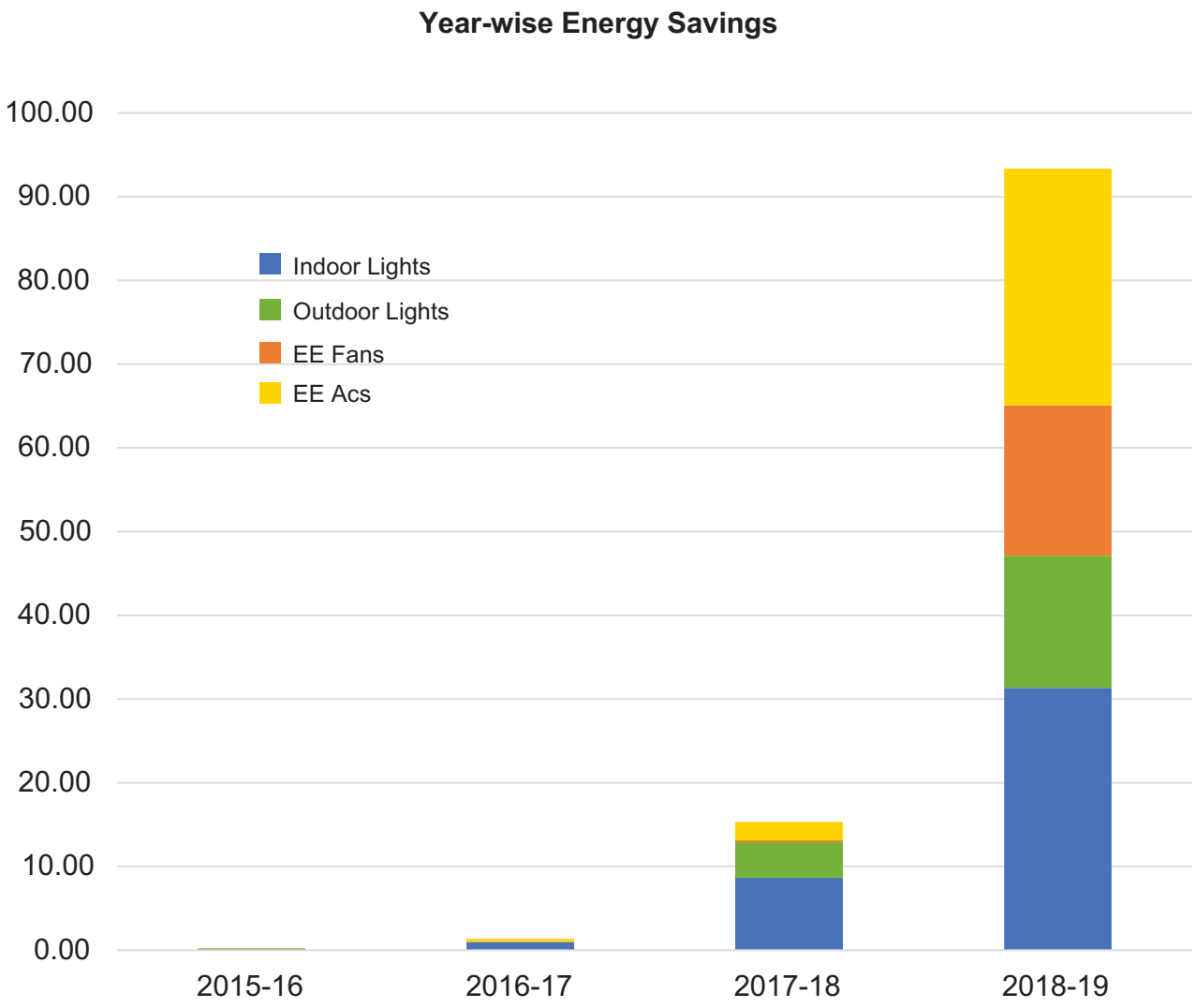


Figure 36: Energy Savings from BEEP programme

As the electrical energy savings obtained under this scheme was due to replacement of inefficient electrical & mechanical appliances with BEE star rated electrical & mechanical appliances, therefore in order to avoid any duplication, the energy savings of BEEP has been already considered under S&L programme.

4.5 Leadership in Energy and Environmental Design (LEED)[29]

Leadership in Energy and Environmental Design (LEED) is an international symbol of sustainability excellence that signifies a building is lowering carbon emissions, conserving resources and cutting costs, while prioritizing sustainable practices and creating a healthier environment. Developed by the non-profit U.S. Green Building Council (USGBC), LEED includes a set of rating systems for the design, construction, operation, and maintenance of green buildings, homes, and neighborhoods that aims to help building owners and operators be environmentally responsible and use resources efficiently. Under the LEED rating system, the following certification levels are presented in Table 42.

29 BEE is not endorsing the data in this section, Data reported in the section is based on consultations carried out during the course of study with stakeholder

Table 42: LEED rating category

Rating	Points Required
LEED Certified	40-49
LEED Certified Silver Level	50-59
LEED Certified Gold Level	60-79
LEED Certified Platinum Level	80 Points and above

4.5.1 LEED-India

India's commitment to reducing carbon emissions and moving towards efficient measures has gained global recognition. This is in large part due to strong leadership from our government. India has been a long-time leader in green building, and in recent years has become an engine of green growth.

LEED-INDIA is the Indian chapter of LEED International which provides a green rating to a structure, whether an apartment, independent home or office, based on the stipulations provided under the LEED rating system.

4.5.2 LEED Certification Check-list

Buildings that are LEED-certified create healthier spaces for people, as well as use less energy and water, reduce air pollution, provide cleaner air indoors and save money for businesses and families. They also generate fewer emissions compared to traditional buildings — not only during the construction stage but also after they are occupied and throughout the entire lifecycle of a building.

The points are provided based on certain criterion for new construction building, which are presented in Table 44.

Table 43: LEED rated buildings

LEED Rating	No. of Building in India
Certified	21
Silver	103
Gold	808
Platinum	478
Pre-certified Certified	1
Pre-certified Silver	1
Pre-certified Gold	53
Pre-certified Platinum	13
Total	**1478**

Table 44: Project check list for LEED rating

Project Check-List	Possible Points
Integrative Process	1
Location and Transportation	16
Sustainable Sites	10
Water Efficiency	11
Energy & atmosphere	33
Materials and Resources	13
Indoor environment quality	16
Innovation	6
Regional Priority	4
Total	**110**

Major parameters covered under "Energy & atmosphere check-list" for the rating criterion, and the details of LEED certified buildings are presented in Table 45 and Table 46 respectively.

Table 45: Check list for LEED rating

Energy & atmosphere check-list	
Minimum Energy Performance	Advanced Energy Metering
Building-Level Energy Metering	Demand Response
Fundamental Refrigerant Management	Renewable Energy Production
Enhanced Commissioning	Enhanced Refrigerant Management
Optimize Energy Performance	Green Power and Carbon Offsets

Table 46: Details of LEED certified buildings

State	No. of LEED Certified Buildings	Area in Million Sqm
Maharashtra	371	10.25
Karnataka	303	9.70
Tamil Nadu	178	5.41
Haryana	139	5.91
TG	106	4.14
Uttar Pradesh	95	4.76
Delhi	72	3.07
Gujarat	57	2.25
West Bengal	40	1.99
Kerala	24	0.59
Rajasthan	21	0.90
Orissa	14	0.16
Punjab	14	0.30
Andhra Pradesh	11	0.10
Uttarakhand	11	0.11
Chandigarh	5	0.19
Madhya Pradesh	5	0.05
Goa	4	0.06
Assam	3	0.07
Chhattisgarh	2	0.02
Himachal Pradesh	2	0.01
Bihar	1	0.00
Total	1478	50.03

4.5.3 Major highlights

- India is now the fourth largest market in the world for LEED with more than 2,900 registered and certified commercial projects participating in LEED, totaling more than 1.39 billion square feet.
- IT Parks, Offices, Banks, Airports, Convention centers, Educational institutions, Hotels and Residential complexes are the major structures that register for a LEED rating.
- Many government buildings have chosen to certify to LEED and several government

agencies, including key state governments have started offering incentives around LEED.

- The Top 10 states for LEED are home to more than 840 million Indians, and together include more than 500 million gross square feet of LEED-certified space. From the states mapped, Maharashtra tops the list, followed by Karnataka, Tamil Nadu and Haryana. The detailed rankings are presented in Table 46.

4.6 Green Rating Integrated Habitat Assessment[30]

GRIHA council is an independent not-for-profit society established jointly by The Energy and Resources Institute (TERI) and Ministry of New and Renewable Energy (MNRE), Government of India (GoI). It promotes and facilitates GRIHA- National rating system for green buildings in India.

GRIHA is a rating tool which evaluates the environmental performance of a building, based on quantitative and qualitative criteria, thereby providing a definitive standard for green buildings and habitat. Rating system was adopted as the national rating system for green buildings by the Government of India in 2007.

GRIHA measures a building's environmental performance on a scale of 1–5 stars. Major areas considered while evaluation of the building under GRIHA are four main categories- Energy efficiency, Renewable energy, Water resources, Waste management, which is further sub divided in 31 categories such as site planning, construction management, occupant comfort and wellbeing, sustainable, and innovation.

GRIHA uses the energy performance index to capture the energy requirement of the buildings. All buildings except industrial complexes with built up area of more than 2,500 m^2 during the design stage are eligible for the GRIHA rating. GRIHA rating is evaluated on 31[31] parameters on the scale on 100, with threshold value of 25.

Star rating index with threshold value for the different star category is illustrated in Table 47

Table 47: GRIHA Rating Thresholds values

1 Star	2 Star	3 Star	4 Star	5 Star
25-40	41-55	56-70	71-85	86

Some of the key benefits for adoption of GRIHA rating, that supports the thrust for promoting the adoption of the rating across the building are :

- Additional floor area ratio for free across the different states varying from 3% up to 15% depending upon the star label
- Pune municipality provides the discount in development premium and rebate on property tax up to 15% for 5 star rated GRIHA building
- Fast track environmental clearance for the buildings from (MoEF&CC)
- Andhra government provides the subsidy on capital investment up to 25% and also provides the 20% reduction on permit fee for all GRIHA certified 5 stat buildings

With all the above measures till date 1733 buildings across the India have been GRIHA certified. Total number of 1044 buildings have been certified during the FY 2015-19. Summary of registered buildings along with

30 BEE is not endorsing the data in this section, Data reported in the section is based on consultations carried out during the course of study with stakeholder

31 https://www.grihaindia.org/griha-rating (GRIHA Version 2015

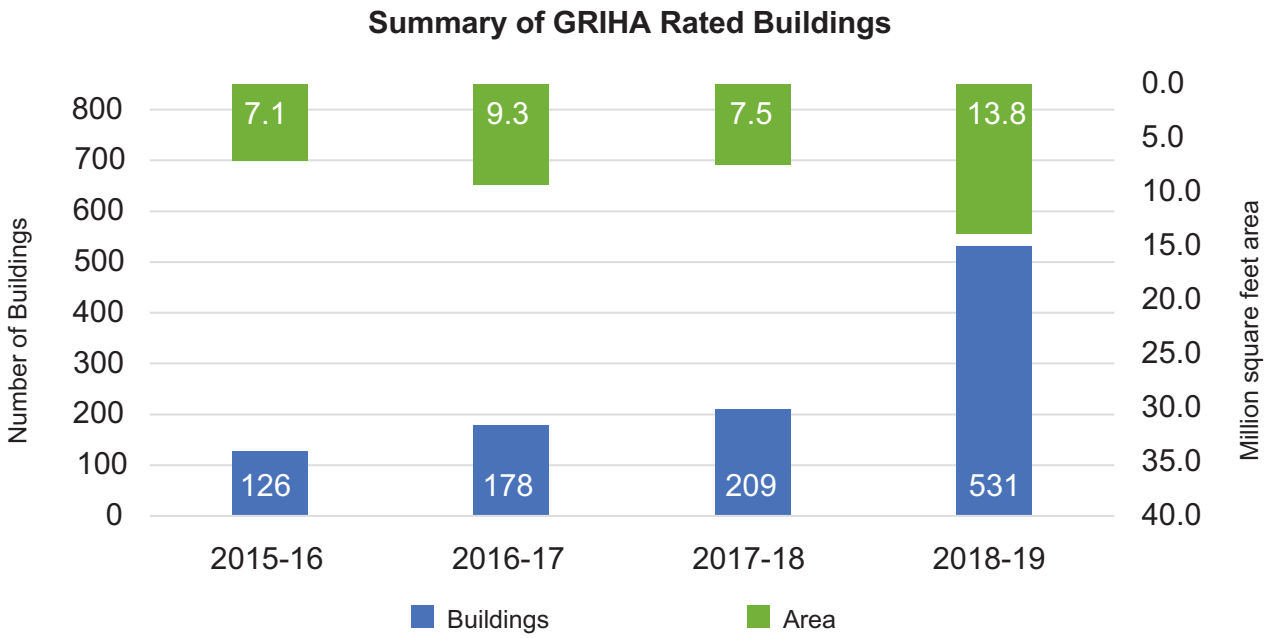


Figure 37: Summary of GRIHA rated buildings

footprint area is shown in Figure 37

Till date, 1733 projects have been registered and 422 newly constructed projects have been completed under GRIHA till date. 44 newly constructed buildings with built up area of 1.14 MN sqm have been completed under GRIHA rating during FY 15-19.

Out of these buildings, 13 building completed during FY 2018-19. As the work was completed during different months of the year; therefore, energy savings cannot be considered for entire one year. Therefore, in order to calculate the energy savings for buildings completed in FY 18-19, 50% of total energy savings is considered.

Initiatives under GRIHA during FY15-19 had resulted in saving of 69.9 MU and avoidance/ reduction of 57,340 tonnes of carbon dioxide emission during FY18-19. These implementation during FY15-19 have also added the 58.1 MW of renewable energy.

4.7 Indian Green Building Council (IGBC) [32]

The Indian Green Building Council (IGBC), part of the Confederation of Indian Industry (CII) was formed in the year 2001. All the stakeholders of construction industry comprising of architects, developers, product manufacturers, corporate, Government, academia and nodal agencies participate in the council activities through local chapters. The council also closely works with several State Governments, Central Government, World Green Building Council, bilateral multi-lateral agencies in promoting green building concepts in the country.

Across India, IGBC has launched 24 local chapters, which works closely with the stakeholders in facilitating the growth of green buildings and built environment across the Country. IGBC local chapters are involved in

- Policy Advocacy
- Training & capacity building

32 BEE is not endorsing the data in this section, Data reported in the section is based on consultations carried out during the course of study with stakeholder

- Networking & business opportunities
- Awareness & sensitization programmes

The council offers a wide array of services which include developing new green building rating programmes, certification services and green building training programmes. Green building rating brings together a host of sustainable practices and solutions to reduce the environmental impacts while providing an integrated approach considering life cycle impacts of the resources used.

The IGBC Green Building Rating Systems are present for all type of the buildings including- Government, IT Parks, Offices, Residential, Banks, Airports, Convention Centre, Institutions, Hospitals, Hotels, Factories, SEZs, Townships, Schools, Metros etc.

Green projects rated by IGBC fall under one of the following levels (in ascending order): Certified, Silver, Gold and Platinum. IGBC certifies the green projects which are conceptualized, designed, constructed and operated as per IGBC Ratings. Benefits of adopting IGBC green building rating systems includes:

- Demonstrated and proven savings of 30 to 40 % on energy cost (Approx. 15,000 MWh of energy savings per million sq. ft per annum)
- 20 to 30 % savings in water consumption (Approx. 45,000 kL of less water consumption per million sq. ft)
- Fully indigenized and designed to address National priorities
- In-line with National Standards and Codes including- National Building Code (NBC), Energy Conservation Building Code (ECBC),
- Align with Ministry of Environment & Forests (MoEF) and Central Pollution Control Board (CPCB) guidelines

Started in the year 2003, in last 16 years, IGBC has facilitated the spread and growth of green buildings across the length and breadth of the Country. As on 31 December 2019 more than 5,723 Green Buildings projects with a footprint of over 7.09 Billion sq. ft are registered with the Indian Green Building Council (IGBC). Out of these, 1,932 Green Building projects are certified and fully functional in India.

Standards and Labeling

CHAPTER 5

The fast-growing economies and escalating domestic, agriculture and commercial energy needs are set to dominate global demand in coming years. Energy demand in India has increased more than two-fold in last decades. Growth of electrical energy consumption in these sectors is primarily on account of the increasing access to electricity and increased used of the electrical appliances in these sectors.

Conserving energy and promoting energy efficiency requires a range of policy options. One set of options is improving energy efficiency of appliances through Standards & Labeling (S&L) programme. The standards ensure that the worst performing products are removed from the market, while labels encourage consumers to purchase increasingly more efficient products.

The S&L program provides long-term policy signals and can be applied in various end-use sectors. The standards and labeling apply not only to specific appliance, technology or system, e.g. refrigerators or buildings, but are also used to control the quality of information, particularly at the point-of-sale of energy-using appliances. The S&L program has received huge acceptance around the world and is

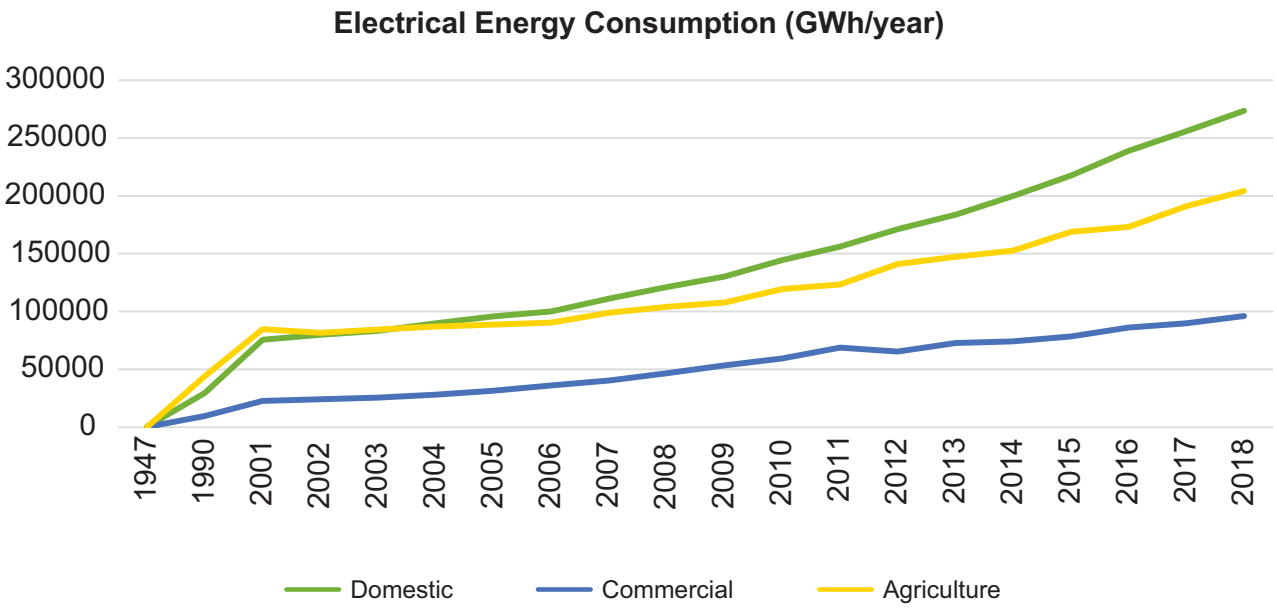


Figure 38: Energy consumption profile[33]

33 http://www.cea.nic.in/reports/others/planning/pdm/growth_2018.pdf

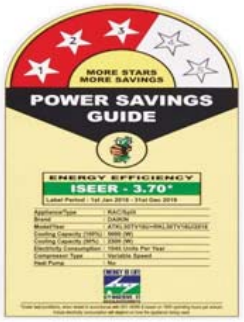
now a common tool for energy efficiency. In India, the Bureau of Energy Efficiency, or BEE, initiated the Standards and Labeling scheme for appliances and equipment in the year 2006. The S&L programme started in 2006 with voluntary labels for refrigerators and fluorescent tube lights. Since inception number of appliances have been added year on year under the S&L programme. First mandatory label was notified on 12th January, 2009 making labeling mandatory for *"Room Air Conditioners, Tubular Fluorescent lamps, Frost Free Refrigerators, Distribution Transformers".* Today twenty-four appliances are covered under the scheme, ten under the mandatory labeling regime and fourteen under the voluntary regime. There are two components under the Standards and Labeling programme.

Standards: Standards prescribe limits on the energy consumption (or minimum levels of energy efficiency) of manufactured products. Based on the standard, a prescribed energy performance of the manufactured products can be set, sometimes prohibiting sale of products that are less efficient than a minimum level. Standards may mean well-defined test protocols (or test procedures) to obtain a sufficiently accurate estimate of the energy performance of a product, or at least a relative ranking of its energy performance compared to that of other models.

Labeling: Energy efficiency labels are informative labels affixed to products to describe energy performance (usually in the form of energy use, efficiency, or energy cost); these labels give consumers the necessary information to make informed purchases.

There are two type of labels that are issued by BEE for the various appliances. First is comparative label which allow consumers to compare the energy consumption of similar products, and factor lifetime running cost into their purchasing decision. The other is endorsement label which provides a 'certification' to inform prospective purchasers that the product is highly energy efficient for its category. Samples of both labels are illustrated in Table 48

Table 48: Energy efficiency labels



A key objective of S&L is to provide the consumer an informed choice about the energy saving and thereby the cost saving potential of the relevant marketed product. The scheme targets display of energy performance labels on high-energy end-use equipment & appliances and lays down minimum energy performance standards.

For the labeling program, the Bureau works through technical committees of experts and stakeholders, comprising of representatives from industry, industry association, consumer organizations, academia, Non-Government Organizations (NGOs), Research &Development (R&D) institutions, testing laboratories, government organizations and regulatory bodies etc.

S&L in India works on a model in which the permittee provides information related to energy efficiency of the product on the label as prescribed for the respective product by the Bureau from time to time. A star rating, ranging from 1 to 5 in the ascending order of energy efficiency is provided to products registered with the Bureau. Labels get updated almost every two years; old inefficient products are replaced with more energy efficient products. For example air conditioners with 1 star earlier had been notified in 2009 with EER value of 2.3, and under present label scheme this EER/ ISEER value for 1 star had been revised to 3.1.

5.1 Appliances under S&L

The appliances covered[34] are presented in Table 49.

Table 49: List of S&L appliances[35]

Appliance	Category	Label	Primary indicator on Star label
Frost Free Refrigerator	Mandatory	Comparative Label	Annual Energy consumption
Tubular Fluorescent Lamps	Mandatory	Comparative Label	Lumen /Watt
Room Air Conditioners (RAC)	Mandatory	Comparative Label	ISEER
RAC (Cassette, Floor Standing Tower, Ceiling and Corner AC)	Mandatory	Comparative Label	ISEER
Distribution Transformer (DT)	Mandatory	Comparative Label	Total losses at 50% and 100% loading
Direct Cool Refrigerator	Mandatory	Comparative Label	Annual Energy consumption
Stationary Storage Type Electric Water Heater (Geyser)	Mandatory	Comparative Label	Standing energy loss in 24 hours
Color Television	Mandatory	Comparative Label	Annual Energy consumption
Variable Capacity Air Conditioners	Mandatory	Comparative Label	ISEER
LED Lamps	Mandatory	Comparative Label	Lumen /Watt
Induction Motors	Voluntary	Comparative Label	Motor efficiency class
Agricultural Pump sets	Voluntary	Comparative Label	Performance factor of the pump set
Ceiling Fans	Voluntary	Comparative Label	Service value
Domestic Liquefied Petroleum Gas (LPG) Stoves	Voluntary	Comparative Label	Thermal efficiency of the burner
Washing Machine	Voluntary	Comparative Label	Energy consumption (E) per cycle kWh/kg/cycle
Computer (Notebook/Laptops)	Voluntary	Endorsement label	
Ballast (Electronic/Magnetic)	Voluntary	Comparative Label	Ballast Efficiency Class
Office equipment (printer, copier, scanners)	Voluntary	Endorsement label	
Solid State Inverter	Voluntary	Comparative Label	Conversion of DC to AC efficiency of the Inverters at 0.8 PF
Microwave Oven	Voluntary	Comparative Label	Watthour per cycle
Diesel Pump sets	Voluntary	Comparative Label	Specific fuel consumption
Diesel Generator	Voluntary	Comparative Label	Specific fuel consumption
Chillers	Voluntary	Comparative Label	ISEER of cooling

34 Source: Guidelines for Permittee – Standards and Labeling Programme of Bureau of Energy Efficiency, Version 1, January 2016.

35 All appliances except pump sets and DT are considered to be sold in domestic residential sector for estimation of the sectoral savings. Pump sets are considered in agriculture sector and DT are considered in commercial sector.

5.2 Methodology adopted for estimating energy savings

Methodology adopted for the evaluation of the impact of the S&L programme is shown in Figure 39[36]

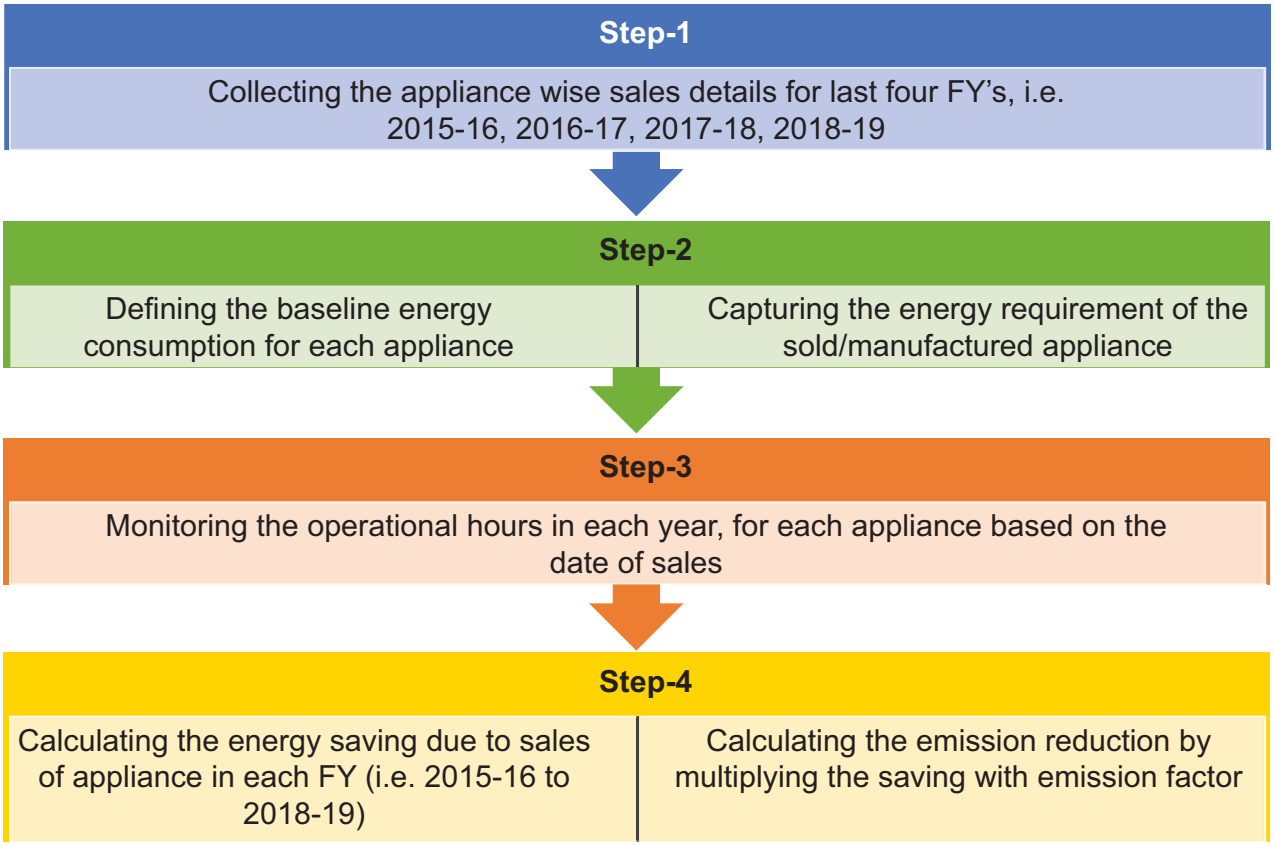


Figure 39: Methodology for impact assessment

5.3. Estimation of impact from S&L

5.3.1. Step-1: Sales Volumes of Star Labeled Appliances

5.3.1.1. Appliances considered for S&L impact assessment

To evaluate the impact of the S&L programme the sales have to be captured for registered appliances under the S&L scheme. Till 31st March 2019; 23 appliances were registered under the programme, out of which 13 have significant sales based on data reported under the programme. For the other 10 appliances the sales are presently low, and consequently the savings accrued due to these appliances is not significant. These appliances are presently included under voluntary category. A list of the 13 appliances being considered for impact assessment is presented in Table 50:

36 Average life of the appliances in considered as four years, hence energy savings due to the sales of Star labeled appliances from FY 2015-16 to FY 2018-19 are considered while evaluating the impact of the scheme for FY 2018-19 in this report.

Table 50: List of appliances covered under S&L programme for impact assessment[37]

Sr.No	Appliance
Mandatory Appliances	
	Color Television
	Direct Cool Refrigerator
	Distribution Transformer
	Frost Free Refrigerator
	LED Lamps
	Room Air Conditioner (Fixed Speed)
	Room Air Conditioner (Cassettes, Floor Standing Fixed speed)
	Room Air Conditioner (Variable Speed)
	Stationary Storage Type Electric Water Heater (Geyser)
	Tubular Fluorescent Lamp (TFL)
Voluntary Appliances	
	Ceiling Fan
	Computer
	Pump Set (Open well Submersible, Monoset, Submersible)

37 For this study, 'Room Air conditioner (fixed speed)' and 'Room Air Conditioner (Cassettes, Floor Standing Fixed speed)' is taken as one item under the head of fixed speed air conditioner

5.3.1.2 Sales Volumes of the appliances for the respective FY(2015-16 to 2018-19)

Sales of the appliances considered under the evaluation is presented in Table 51:

Table 51: Sales figures of appliances[38]

Appliance	FY 2015-16[39]	FY 2016-17	FY 2017-18	FY 2018-19	FY 2015-19
Mandatory Appliance					
Color Television	4,550,837	2,617,893	9,479,658	9,177,957	25,826,345
Direct Cool Refrigerator	8,761,774	9,506,713	10,014,626	9,863,187	38,146,300
Distribution Transformer	299,331	289,019	347,515	420,016	1,355,881
Frost Free Refrigerator	1,971,685	1,955,699	2,578,277	2,650,743	9,156,404
LED LAMPS	Nil	11,754,592	27,290,510	228,363,503	267,408,605
Room Air Conditioner (Fixed Speed)	4,676,022	5,741,229	5,384,058	3,287,843	19,089,152
Room Air Conditioner (Variable Speed)	25,006	702,652	2,267,364	3,909,378	6,904,400
Stationary Type Water Heater	1,789,877	2,406,708	2,741,279	3,231,948	10,169,812
TFL	106,540,118	97,395,586	81,219,925	63,187,569	348,343,198
Voluntary Appliance					
Submersible Pump Set	238,172	533,170	864,002	1,070,196	2,705,540
Monoset Pump	20,909	37,187	53,860	72,305	184,261
Open well Submersible Pump Set	102,771		167,894	251,254	521,919
Computer	116,875	2,592			119,467
Ceiling Fan	1,797,692	2,747,053	3,393,289	2,287,941	10,225,975

38 Assumption the production of the appliances is same as sales of appliances during the particular FY and each quarter of FY 2018-19.

39 Appliances with sales volumes indicated as nil are notified in FY 16-17

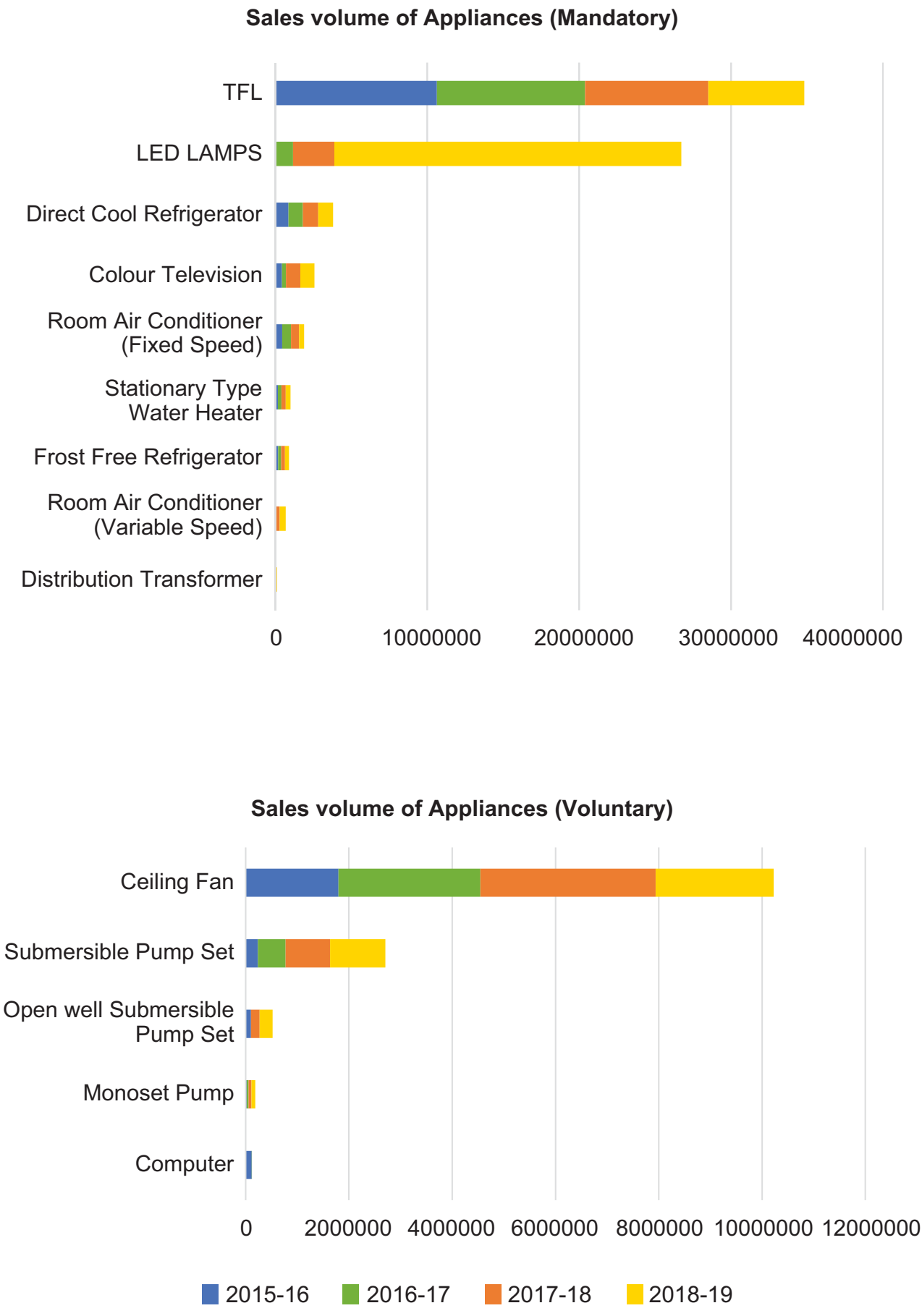
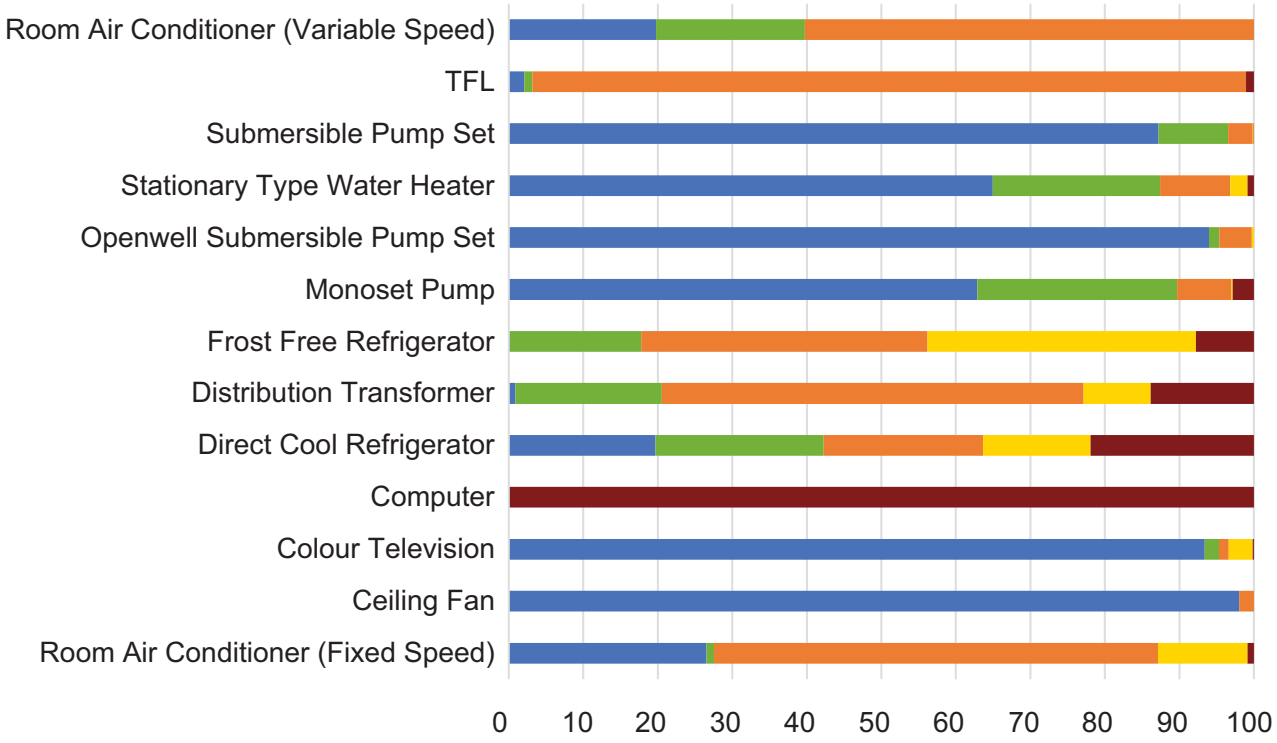


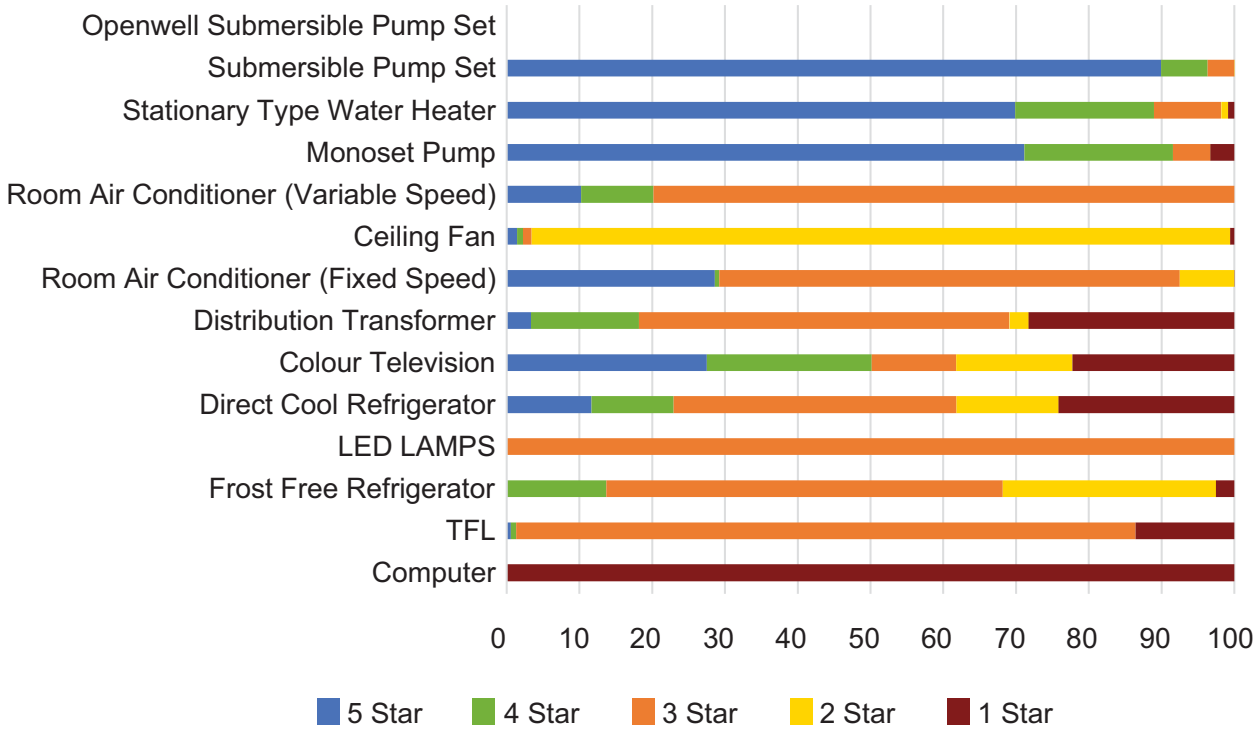
Figure 40 Sales volume of appliances in FY 2015-19

Percentage Sales of the appliance with respect to the star label categories from 1 to 5 stars is presented in Figure 41for FYs from 2015-16 to 2018-19 .

%Sales of Star Rated Appliances in FY 2015-16



%Sales of Star Rated Appliances in FY 2016-17



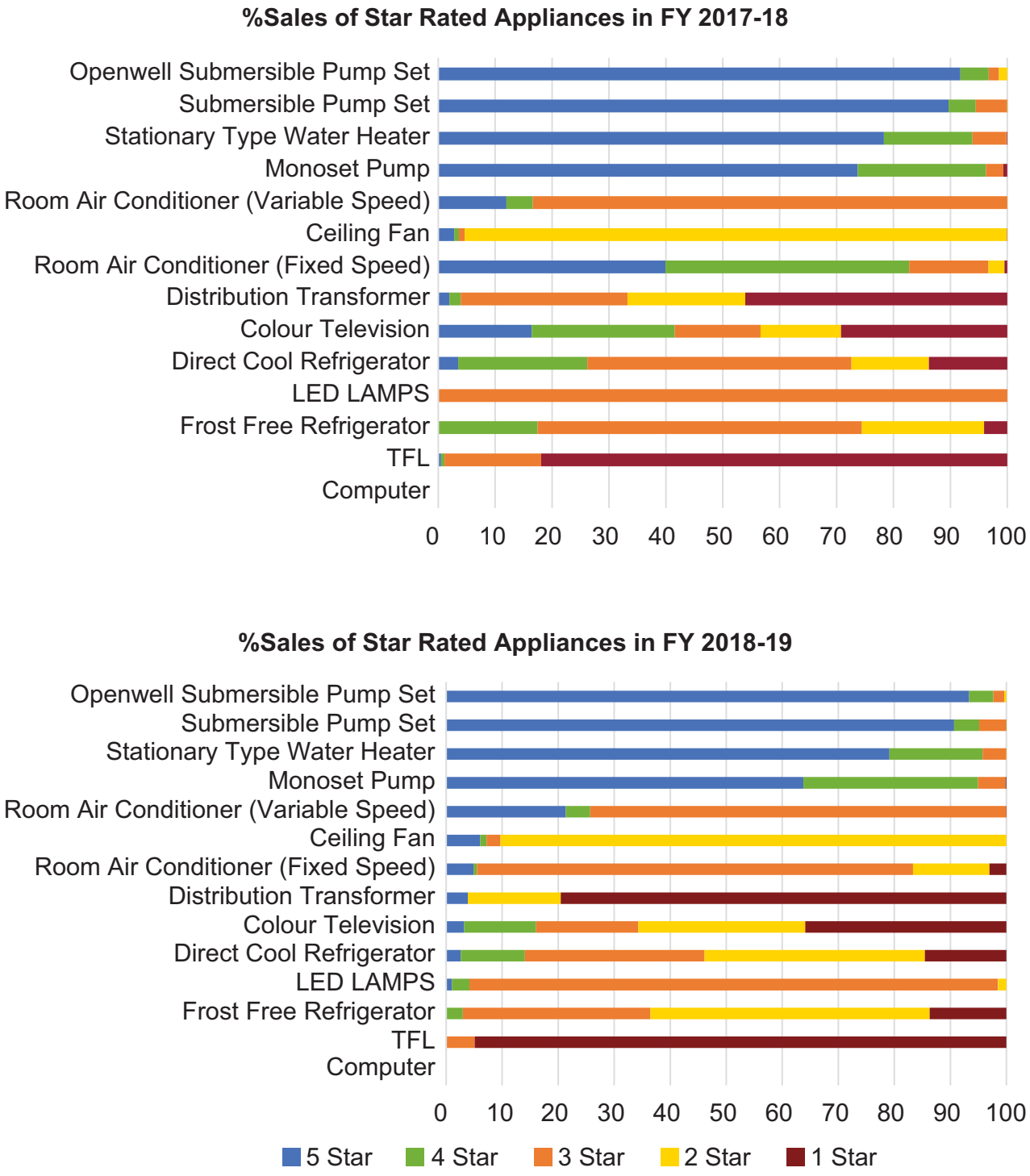


Figure 41: Sales as % of total Sales, for different appliances in FY 2015-19

It can be inferred from the analysis above that the maximum percentage of 5 star labeled appliances sold during FY 2015-19 are pump sets followed by water heaters and air conditioners and color televisions. Majority of sales of LED lamps and tube lights contribute to 3-star label category. % Sales of five star rated celling fan has dropped over the years.

5.3.2 Step-2: Defining the baseline

For evaluation of the energy savings, defining of the energy consumption baseline is very crucial for the appliances under consideration. Each appliance is separately notified under S&L program and the date of initial notification and energy consumption parameters are separate for each appliance. Savings from the different appliances are evaluated by multiplying the sales volumes of the respective star rating with the energy saving potential i.e. *Sales Volume x (Baseline energy consumption of the appliance – energy consumption of the star rated appliance sold)*.

Details of baseline energy consumption for different appliances are presented in Table 52.

Table 52: Baseline energy consumption for appliances

Appliance	Label (primary details)	Baseline formula
Frost Free Refrigerator	Annual Energy consumption	Baseline energy consumption = 759 + adjusted volume*0.8716
Tubular Fluorescent Lamps	Lumen /Watt	Baseline lumen/watt = 61 (Lumen/watt of 1 star Light)
Room Air Conditioners (RAC)	ISEER	Baseline energy consumption = Cooling capacity / (2.3 EER of 1star AC)
RAC (Cassette, Floor Standing Tower, Ceiling and Corner AC)	ISEER	Baseline energy consumption = Cooling capacity / (2.3 EER of 1star AC)
Distribution Transformer	Maximum loss at 50% and 100% of the loading	Base energy consumption is measured by the % loss corresponding to specific rating (in kVA) of transformers and operational voltage (V of primary incomer)[40]
Direct Cool Refrigerator	Annual Energy consumption	Baseline energy consumption = 561 + adjusted volume*0.645
Electric Geysers/ Stationary water heaters	Standing energy loss in 24 hours	Baseline loss (Watt/day/45 degree centigrade) is calculated on the basis of the capacity of the geyser (liters) as per matrix defined under BEE S&L[41]
Color Television	Annual Energy consumption	Baseline energy consumption for CRT is = 0.1494*screen area in m^2 + 4.38
Variable Capacity Air Conditioners	ISEER	Baseline energy consumption = Cooling capacity (CSTL)/ (2.3 EER of 1star AC)
LED Lamps	Lumen /Watt	Baseline lumen/watt = 79 (Lumen/watt of 1 star Lamp)
Pump sets	Performance factor of the pump set	Base line energy consumption considering the efficiency of the pump sets as defined for type of pump set at given duty point (head and flow) defined by the IS 14220:1998, IS 8034:2002 and IS 9079: 2002 for
Ceiling Fans	Service value	Baseline energy consumption for 1200 mm fan is 65 Watt, with service value of 3.1

40 http://www.beestarlabel.com/Content/Files/DTnoti.pdf

41 https://beestarlabel.com/Content/Files/GeyserNote.pdf

5.3.3 Step-3: Defining the operating hours

Annual energy savings (FY 15-16 to 17-18)[42]

Annual Energy savings (kWh/year) = [$kW_{Baseline} - kW_{Star\ rated}$] x $Sales_{FYn}$ x Hr_{Annual}

Where,

- $kW_{Baseline}$ = *Baseline energy consumption of respective appliance (Ref. Table 53)*
- $kW_{Star\ rated}$ = Energy consumption of star rated appliance
- $Sales_{FYn}$ = *Sales Volume of the star rated appliance for the respective FY*
- Hr_{Annual} = *Annual Operating Hours of the appliance*

Annual energy saving (FY 18-19)[43]

Annual Energy savings (kWh/year) = $ES_{Q1} + ES_{Q2} + ES_{Q3} + ES_{Q4}$

Where,

- $ES_{Q1\ to\ Q4}$ = *Energy Savings for the respective Quarter (Q1 to Q4)*
  = *[$kW_{Baseline} - kW_{Star\ rated}$] x $Sales_{Qn}$ x Hr_{Qn}*
  $kW_{Baseline}$, $kW_{Star\ rated}$ have same meaning as previous case (FY 15-16 to 17-18)
- $Sales_{Qn}$ = *Sales Volume of the star rated appliance for the respective Quarter (Q1 to Q4)*
- Hr_{Qn} = *Quarterly Operating Hours of the appliance for the respective Quarter (Q1 to Q4)*

Energy saving for the FY 2018-19 is calculated considering the sales of the appliance on quarterly basis. For example, if VAC is having the 1600 annual operation hours Appliance sold in Q1 can be operated for 100% of the operational hours i.e. 1600 hours, and if appliance is sold in Q2, then appliance can operate to max of 75% of the available operation hours i.e. 1200 hours; if appliance is sold in Q3 then it can only work for 50% of the annual operation hours for that FY i.e. 800 hours; and if sales occurs in Q4 then appliance can only work for 25% of operation hours during that particular FY i.e. 400 hours.

Details of the operation hours for the different appliance is defined in Table 53

Table 53: Annual operation hours for appliance[44]

Appliance	Annual operation hours[45]
Frost Free Refrigerator	8760
Tubular Fluorescent Lamp	1200
Room Air Conditioners (RAC)	1200
RAC (Cassette, Floor Standing Tower, Ceiling and Corner AC)	1200
Distribution Transformer	8760
Direct Cool Refrigerator	8760
Electric Geyser/ Stationary water heater	6000

42 Appliances sold before 1st April 2018 will operate for 100% of annual operating hours of the respective appliance

43 Quarterly sales of the appliances are multiplied by the respective operating hours corresponding to the quarter of the sale. It is assumed that appliances sold in Q1, Q2, Q3, and Q4 will operate respectively for 100%, 75%, 50% and 25% of the annual operating hours of the respective appliance

44 https://beeindia.gov.in/content/standards-labeling

45 https://beeindia.gov.in/content/standards-labeling

Appliance	Annual operation hours[45]
Color Television	8760
Variable Capacity Air Conditioner	1600
LED Lamp	1200
Pump set	2000 = (250 days and 8 hours a day)
Ceiling Fan	3600

5.3.4 Step-4: Estimation of the energy savings and emission reduction

Energy saving for each appliance is calculated using the formula defined in step 2 and operating hours defined in step 3. Energy saving for the different appliances is presented in Table 54.

Table 54: Energy Savings in FY 18-19 for appliances sold during FY 2015-19[46]

Appliance	Savings (MU) due to sales of appliance in				Total Savings (MU) in FY: 2018-19
	FY: 2015-16	FY: 2016-17	FY: 2017-18	FY: 2018-19[47]	
Mandatory Appliances					
LED LAMPS	-	28	65	-	93
Distribution Transformer	315.4	263	403	302	1283.4
Stationary Type Water Heater	299	410	472	344	1525
TFL	725	636	570	236	2167
Room Air Conditioner (Variable Speed)	-	447	1461	593	2501
Frost Free Refrigerator	1428	1473	1967	1329	6197
Room Air Conditioner (Fixed Speed)	3293	3364	3329	457	10443
Color Television	1463	1032	3806	2466	8767
Direct Cool Refrigerator	3568	4059	4459	3003	15089
Voluntary Appliances					
Submersible Pump Set	739	1310	1921	1481	5451
Open well Submersible Pump Set	287	368	426	371	1452
Computer	3.5	6	0	0	9.5
Monoset Pump	30.7	43	46	30	149.7
Ceiling Fan	104.3	162	191	106	563.3
Total Savings (BU)	**12.2**	**13.6**	**19.1**	**10.7**	**55.7**

46 Energy savings estimated for LED is not included in total. These savings are reflected in UJALA program from 2018-19 onwards

47 Based on quarterly sales and corresponding operating hours of appliances

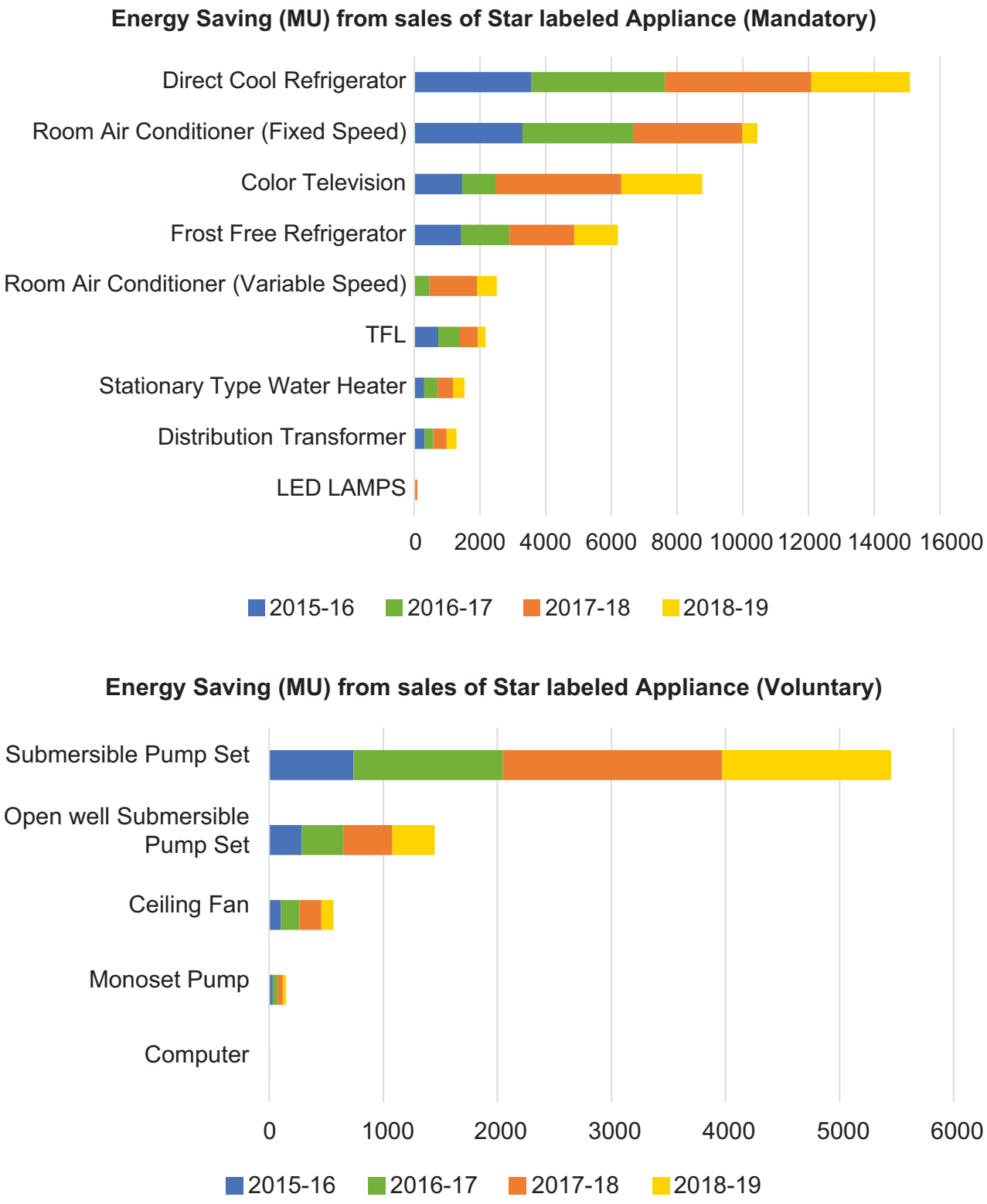


Figure 42: Energy savings for different appliances in FY2015-19

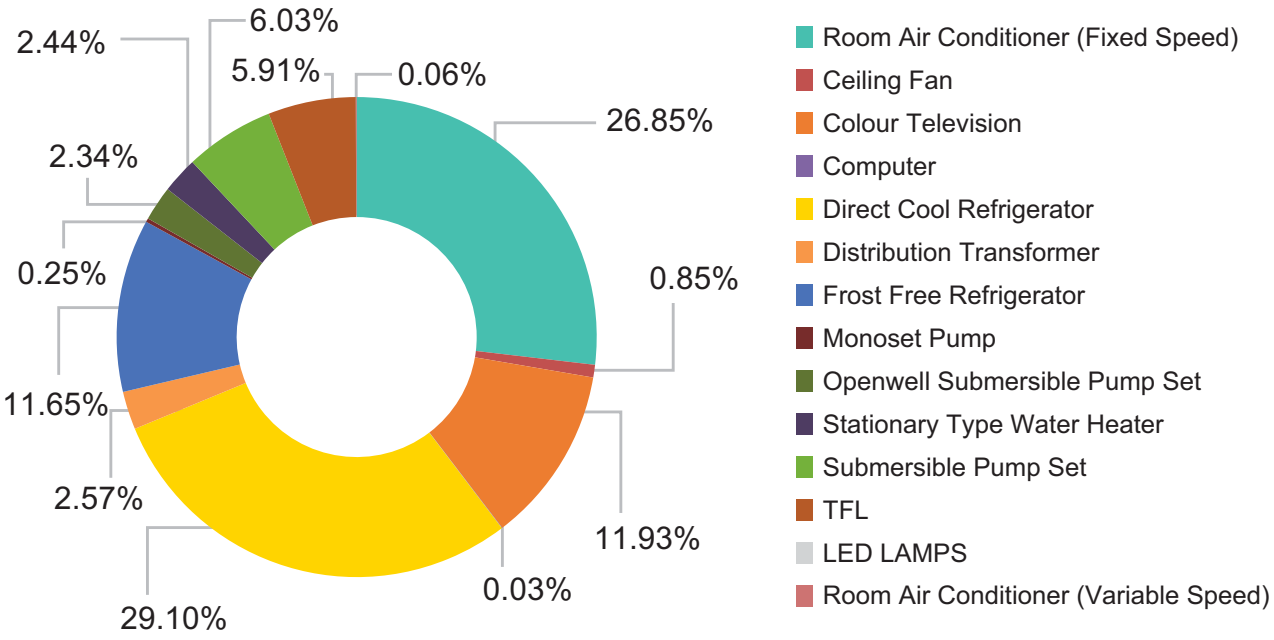


Figure 43: Energy saving share of different appliances sold in FY 2015-16

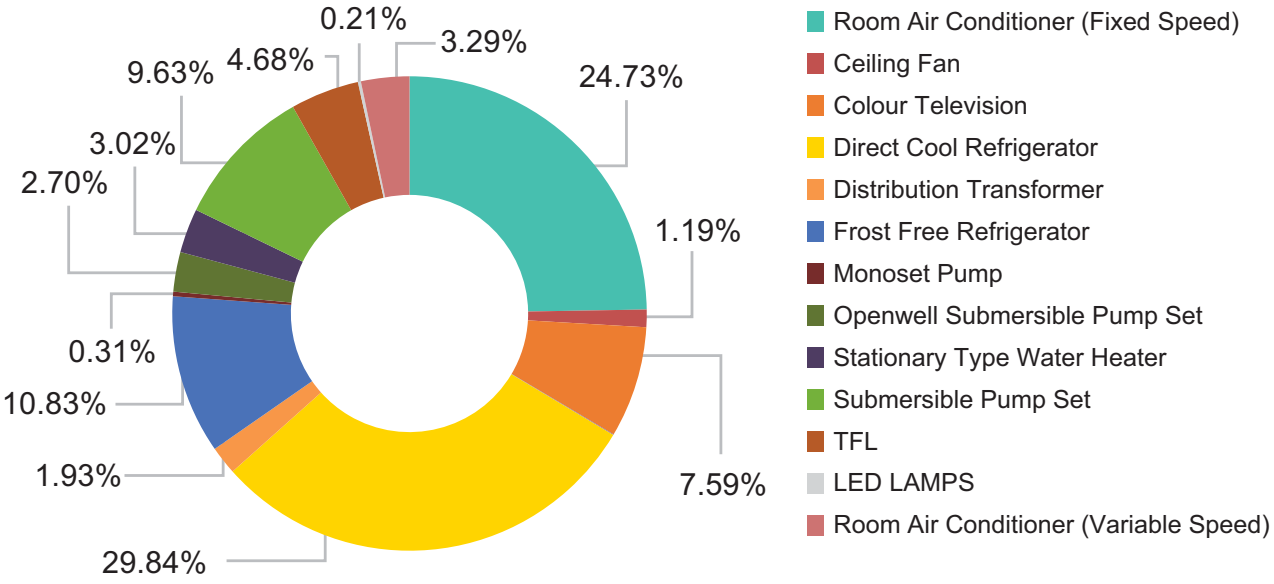


Figure 44: Energy saving share of different appliances sold in FY 2016-17

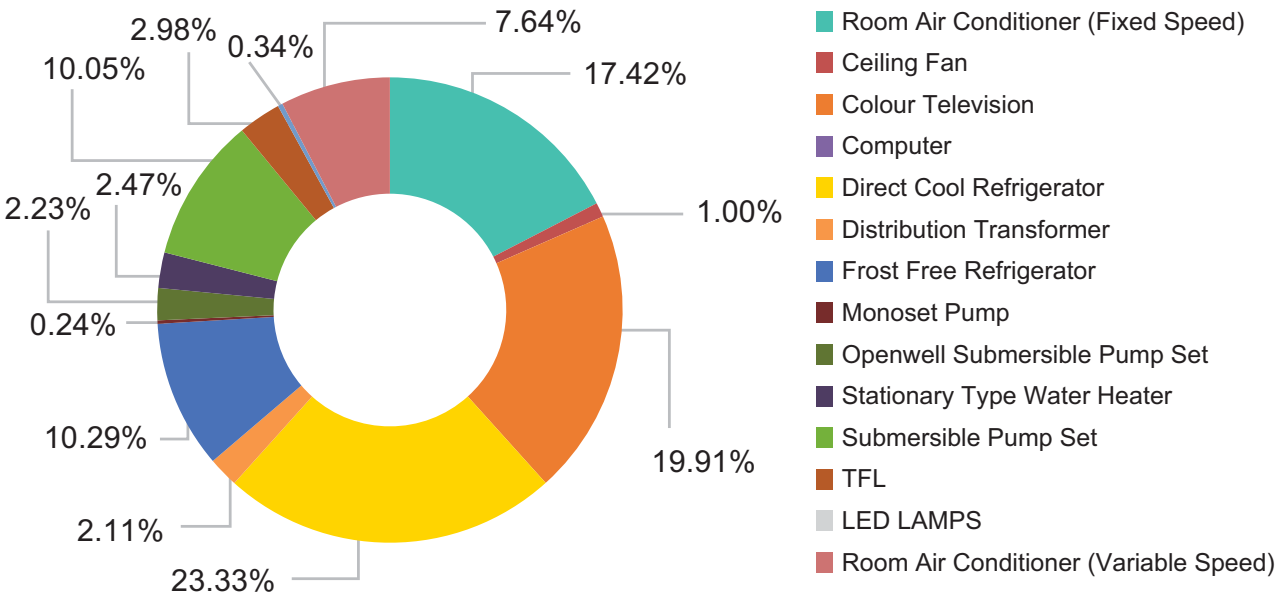


Figure 45: Energy saving share of different appliances sold in FY 2017-18

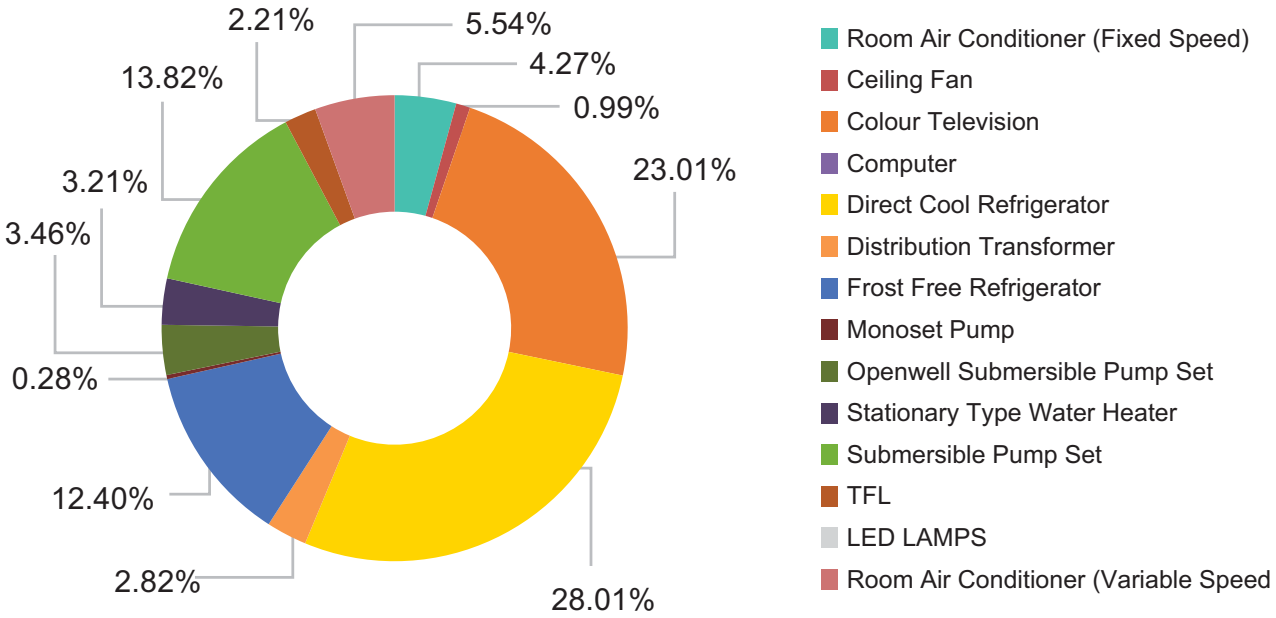


Figure 46: Energy saving share of different appliances sold in FY 2018-19

It can be inferred from the figures above (Figure 43 to Figure 46) that Direct Cool and Frost Free Refrigerator, Room ACs, Color TV, and pump sets contribute to 75% of the savings due to sales of the appliances under S&L programme.

S&L programme has led to saving of 55.7 BU during 2018-19 due to interventions carried out during the FY2015-19

Emission reduction by the initiatives under the programme is evaluated considering the grid emission factor of 0.82 kg of CO_2 emission reductions per kWh of the energy saved[48]

Summary of the emission reduction is tabulated in Table 55

Table 55 : Emission reduction (Mn tonne of CO_2 annually) due to S&L programme[49]

Appliances	Emission reduction due to sales of appliances during				Total emission reduction during FY2018-19
	FY2015-16	FY2016-17	FY2017-18	FY2018-19	
Mandatory Appliances					
Direct Cool Refrigerator	2.93	3.33	3.66	2.46	12.37
Room Air Conditioner (Fixed Speed)	2.70	2.76	2.73	0.37	8.56
Color Television	1.20	0.85	3.12	2.02	7.19
Frost Free Refrigerator	1.17	1.21	1.61	1.09	5.08
Room Air Conditioner (Variable Speed)	0.01	0.37	1.20	0.49	2.06
TFL	0.59	0.52	0.47	0.19	1.78
Stationary Type Water Heater	0.25	0.34	0.39	0.28	1.25
Distribution Transformer	0.26	0.22	0.33	0.25	1.05
LED LAMPS	0.00	0.02	0.05	0.00	0.08
Voluntary Appliances					
Ceiling Fan	0.09	0.13	0.16	0.09	0.46
Monoset Pump	0.03	0.03	0.04	0.02	0.12
Open well Submersible Pump Set	0.24	0.30	0.35	0.30	1.19
Submersible Pump Set	0.61	1.07	1.58	1.21	4.47
Computer	0.003	0.000	0.000	0.000	0.003
Total (Million tonne to CO_2)	10.1	11.1	15.7	8.8	45.7

S&L programme has led to reduction of 45.7 Mn tonne of carbon dioxide emissions during 2018-19 due to interventions carried out duri ng the FY2015-19

48 https://beeindia.gov.in/content/standards-labeling

49 CO2 emission reductions estimated for LED lamps are not included in total. These savings are reflected in UJALA program from 2018-19 onwards

Lighting

CHAPTER 6

Lighting sector accounts for about 20% of the total electricity consumption in India. It has been estimated that the use of LEDs in domestic and public lighting could result in up to 50% reduction in energy consumption.

The Hon'ble Prime Minister Sri Narendra Modi launched the Unnat Jyoti by Affordable LEDs for All (UJALA) and Street Lighting National Program (SLNP) on 5th January, 2015. Under the Street Lighting National Program, conventional street lights are to be replaced with energy efficient LED street lights. The national UJALA programme envisions replacement of incandescent bulbs with energy efficient LED bulbs. LEDs provide better light output than conventional lights and are 88% energy efficient as compared to incandescent bulbs. Further LED lights are 50% energy efficient as compared to CFLs. National objective of the programme includes reducing the energy consumption in the lighting sector across the country, reduction in the peak demand of DISCOMs, and promoting the use of the most efficient lighting technology at affordable rates to domestic consumers thus reducing their energy bills. Another objective is to increase the demand of LED lights by aggregating requirements across the country and to thus provide an impetus to domestic lighting industry through economies of scale.

Gram Swaraj Abhiyan (GSA) and Extended Gram Swaraj Abhiyan (EGSA) - UJALA scheme was one of the seven schemes selected for the GSA where EESL has distributed 68 lakh LED bulbs covering 65,000 villages across India under Government of India's GSA and EGSA.

UJALA scheme aims to promote efficient use of energy at the residential level; enhance the awareness of consumers about the efficacy of using energy efficient appliances and aggregating demand to reduce the high initial costs thus facilitating higher uptake of LED lights by residential users. It may be noted that the scheme was initially labelled as DELP (Domestic Efficient Lighting Program) and was relaunched as UJALA.

Under UJALA programme, EESL is prompting the energy efficiency through the LED bulbs, energy efficient LED tube lights and energy efficient fans. EESL has sold 34.74 Crore LED bulbs during the FY 2015-19 out of total sales of 36.13 Crore LED bulbs till December 2019. EESL's UJALA programme sold around 30% of the total LEDs sold in the country since inception of this programme in all sectors of economy.

In addition to LED sales under the programme EESL has sold 73 lakh LED tube lights and 22.3 lakh fans during last three financial years. Under the programme EESL has been a leading demand aggregator, which has led to the economics of the scales leading to the reduction in the price of the LED by over 50% in past three years. Details of the programme for all appliances are available online on the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link - http://ujala.gov.in/ which is updated every minute.

EESL has evolved a service model where it works with electricity distribution companies (DISCOMs) through a benefit sharing approach. The Unnat Jyoti by Affordable LEDs for All (UJALA) obviates the need for DISCOMs to invest in the upfront cost of LED bulbs; EESL procures the LEDs bulbs and provides to consumers at concessional rate less than 10% of the market price of the LED's. EESL has adopted two models for this programme: On-bill financing and DISCOM cost recovery model. Support is also provided for the replacement of defective LED bulbs under guarantee. Since the inception of the programme, the average failure rate for the LEDs lamps is less than 1% of the total sales. All LED procurements done by EESL complies to BIS specification IS 16102 (Part 1) and (Part 2): 2012. The Domestic lights supplied by EESL comes with 1 year free replacement warranty against technical defects and street lights are covered by a warranty for 7 years. Consumers can also purchase the energy efficient appliances at upfront cost and gets benefitted by savings in their electricity bill.

6.1 Methodology for estimation of the saving

Methodology adopted for the energy saving for the UJALA programme is illustrated in Figure 47.

Total number of different appliances retrofitted under UJALA programme is shown in Figure 49: State wise LED sold under UJALA programme by EESL Table 56 and Figure 48.

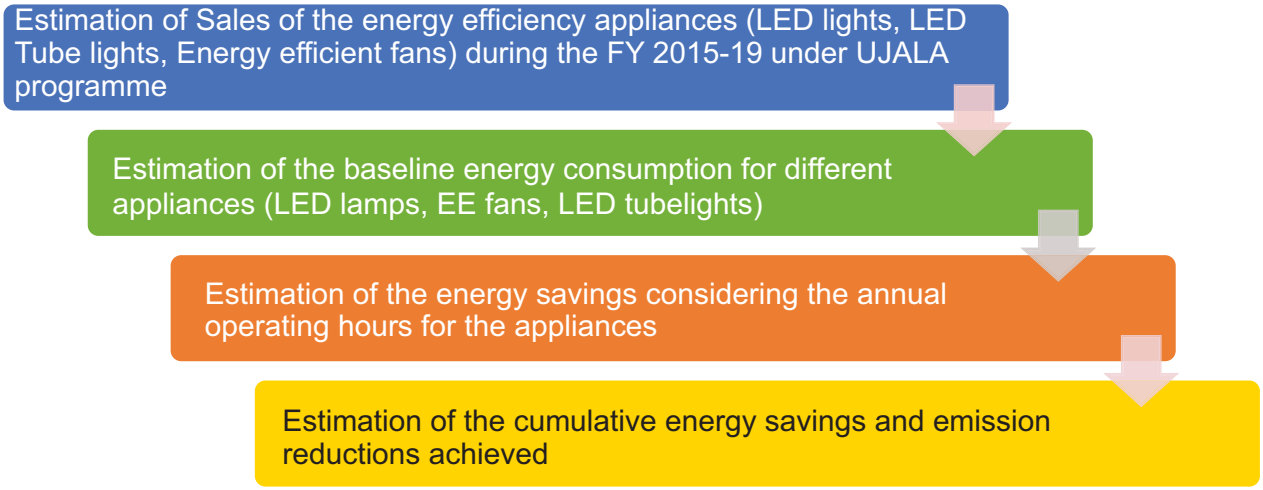


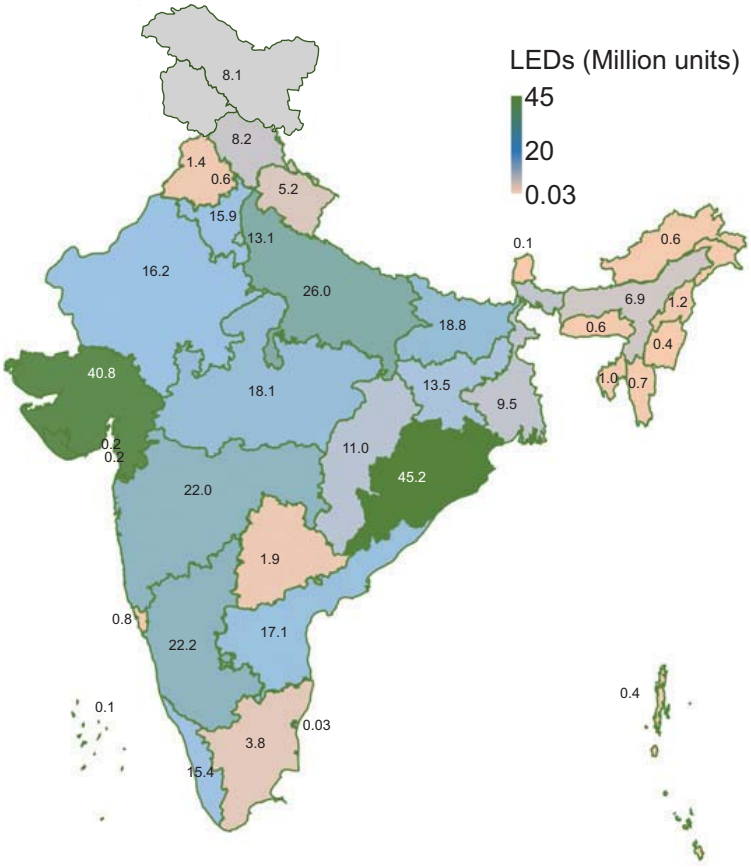
Figure 47: Methodology for estimation of energy savings under UJALA scheme

Table 56: Sales of appliances under UJALA programme

Year	Number of units distributed (Million)		
	LED bulbs	LED Tube lights	EE Fans
FY 18-19	58.20	1.52	0.57
FY 17-18	79.80	4.26	1.06
FY 16-17	124.3	1.57	0.59
FY 15-16[50]	85.1		
Total	**347.4**	**7.35**	**2.22**

50 State wise breakup for 15-16 was not available

Sales of LED across different states (Million Units)



States/UTs	LEDs (Million units)
Andaman & Nicobar Islands	0.4
Andhra Pradesh	17.1
Arunachal Pradesh	0.6
Assam	6.9
Bihar	18.8
Chandigarh	0.6
Chhattisgarh	11.0
Dadra & Nagar Haveli	0.2
Daman & Diu	0.2
Delhi	13.1
Goa	0.8
Gujarat	40.8
Haryana	15.9
Himachal Pradesh	8.2
Jammu & Kashmir	8.1
Jharkhand	13.5
Karnataka	22.2
Kerala	15.4
Lakshadweep	0.1
Madhya Pradesh	18.1
Maharashtra	22.0
Manipur	0.4
Meghalaya	0.6
Mizoram	0.7
Nagaland	1.2
Odisha	45.2
Puducherry	0.03
Punjab	1.4
Rajasthan	16.2
Sikkim	0.1
Tamil Nadu	3.8
Telangana	1.9
Tripura	1.0
Uttar Pradesh	26.0
Uttarakhand	5.2
West Bengal	9.5

Figure 48: State wise LED sold under UJALA programme by EESL[51]

Odisha has the highest distribution of the LED bulbs under the UJALA programme, followed by Gujarat.

Baseline power consumption and power consumption of the energy efficient appliance replaced under the programme is tabulated in Table 57

Energy savings are estimated considering the operation of led lights for 7 hours a day and 365 days a year, tube lights are considered for operation for average of 6 hours a day with 365 days of operation during the year. Similarly, the assumed operation hours for the fans is 16 hours a day and with average operation of 240 days a year. Energy saving estimations are tabulated in Table 58.

Table 57: Power saving estimation per appliance

Appliance	Base line wattage of appliance	Wattage of energy efficient appliance	Reduction in wattage
LED Lamp[52]	59	9	50
LED tube light	40	20	20
EE Fan[53]	75	50	25

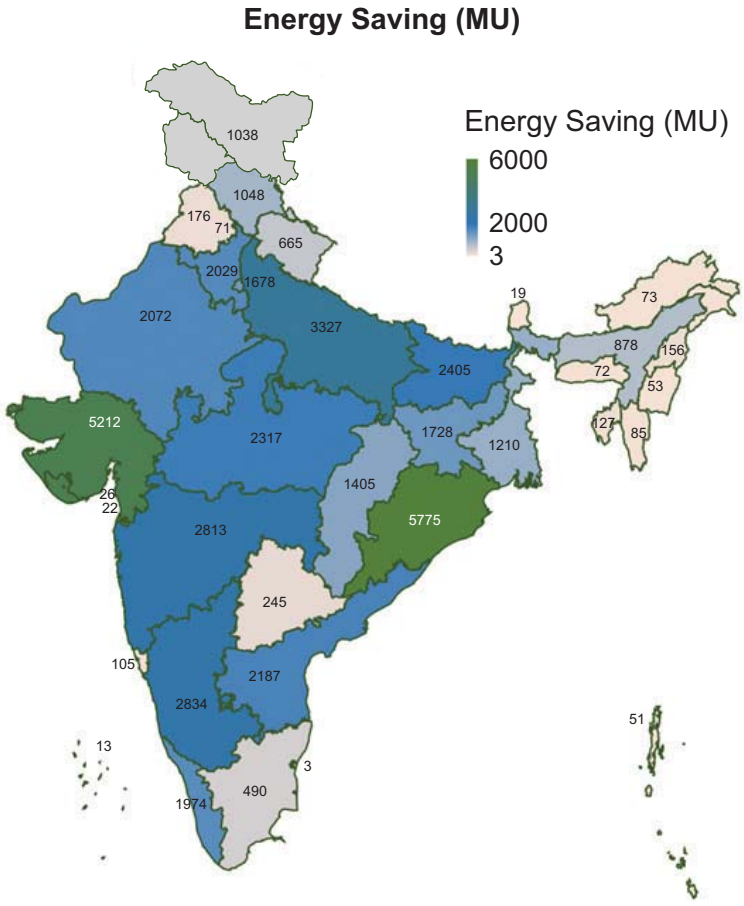
51 Details of sales are approximate values from best available data

52 Wattage of 59 is considered using the assumption that LED lamps replace the incandescent bulbs and CFL , with 100 W and 18W as the respective wattage. It is assumed the equal proportion of incandescent and CFL are replaced

53 EE fan is 5 star rated 50 W BEE fan

Table 58: Energy saving from UJALA programme[54]

Year	Energy savings (MU): LED lamps	Energy savings (MU): LED Tube lights	Energy savings (MU): EE Fans
FY 15-16	10,867		
FY 16-17	15,883	55	53
FY 17-18	10,195	153	99
FY 18-19	7,436	57	55
Total	**44,381**	**264**	**207**



States/UTs	Energy Saving (MU)
Andaman & Nicobar Islands	51
Andhra Pradesh	2,187
Arunachal Pradesh	73
Assam	878
Bihar	2,405
Chandigarh	71
Chhattisgarh	1,405
Dadra & Nagar Haveli	26
Daman & Diu	22
Delhi	1,678
Goa	105
Gujarat	5,212
Haryana	2,029
Himachal Pradesh	1,048
Jammu & Kashmir	1,038
Jharkhand	1,728
Karnataka	2,834
Kerala	1,974
Lakshadweep	13
Madhya Pradesh	2,317
Maharashtra	2,813
Manipur	53
Meghalaya	72
Mizoram	85
Nagaland	156
Odisha	5,775
Puducherry	3
Punjab	176
Rajasthan	2,072
Sikkim	19
Tamil Nadu	490
Telangana	245
Tripura	127
Uttar Pradesh	3,327
Uttarakhand	665
West Bengal	1,210

Figure 49: Sate wise energy saving under UJALA programme by EESL (FY18-19)

LED's contribute to 98.95% of the total energy savings under the programme, and tube lights contribute 0.5% of the savings. CO_2 emission reductions are calculated considering the grid emission factor as 0.82 kg/kWh.[55]

UJALA programme has led to energy savings of 44.654 BU during 2018-19 on account of the implementations carried out during the FY 2015-19

UJALA programme has led to reduction of 37 Million tonnes of carbon dioxide emissions during 2018-19 on account of the implementations carried out during the FY 2015-19

54 Saving of the fans is considered under S&L programme

55 http://www.cea.nic.in/reports/others/thermal/tpece/cdm_co2/user_guide_ver13.pdf

Municipality

CHAPTER 7

BEE initiated Municipal Demand Side Management (MuDSM) programme in 2007. The basic objective of the programme was to improve the overall energy efficiency of the ULBs, which could lead to substantial savings in electricity consumption, thereby resulting in cost reduction/savings for the ULBs. Situation Analysis Survey across 23 states and 171 ULBs was done to form the basis of preliminary energy audits of the MuDSM Programme in 2008.

MuDSM programme aimed to improve the energy efficiency across water pumping, sewage pumping, street lighting and public buildings in the country. Launched in 2015 this programme is being implemented by EESL in across different states.

SLNP: Under the programme EESL is working in across India for promoting EE in street lights, with an aim to retrofit 13.4 Million street lights.

MEEP: EESL has signed MoUs with 22 states and 3 union territories for promoting energy efficiency in municipal pumping sector. These MoU agreements cover 390 cities across India as on 31st March 2019

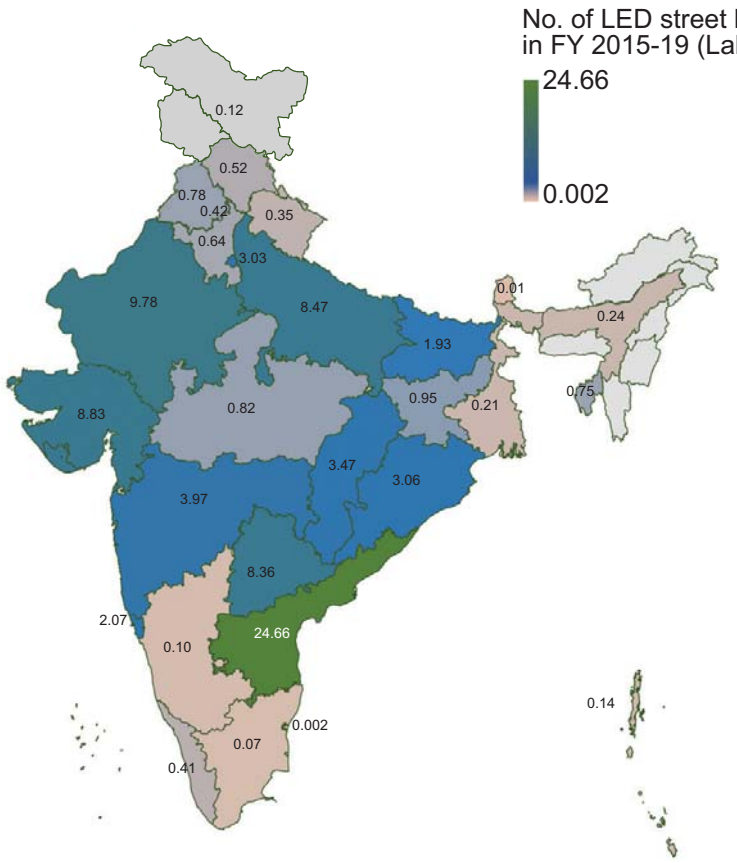
BEEP: EESL is also promoting energy efficiency in public buildings, presently covering 23 states as on 31st March 2019. Details are covered under BEEP programme in building chapter.

7.1 Municipal energy efficiency programme

MEEP is being implemented in conjunction with Atal Mission for Rejuvenation and Urban Transformation (AMRUT) to unlock India's immense potential for savings in energy, and cost of water supply by retrofitting energy efficient pumps across 500 AMRUT cities. Till date agreement with 390 ULB in 22 states and 3 union territories have been completed. Investment grade energy audit (IGEA) are being conducted across the different ULB's. EESL will carry out the upgradation of the pumping system including efficient pumps matched with system requirements, essential valves in the pipelines and improved electrical system for operation of the pump sets. EESL will also help the ULBs to build the CCMS based central controlling and monitoring station as per the requirement of the ULB. EESL will carry out the energy efficiency measures at no upfront cost to the municipal bodies and recover investment from savings in energy costs from the ULBs. By aggregating the demand of ULBs and leveraging the economies of scale, EESL will bring down the cost of the energy efficient pumps, making them financially attractive. Along with installation, EESL will also provide 7 years of repair and maintenance as well provide managerial, technical and turnkey project implementation support. EESL maintains the

Over 250 ULB's have been audited during FY 2015-19 and discussions are being held with ULBs for implementation.

State wise LED lights installation FY 2015-19



States/UTs	No. of LED street lights (Lakhs)
Andaman & Nicobar Islands	0.14
Andhra Pradesh	24.66
Assam	0.24
Bihar	1.93
Chandigarh	0.42
Chhattisgarh	3.47
Delhi	3.03
Goa	2.07
Gujarat	8.83
Haryana	0.64
Himachal Pradesh	0.52
Jammu & Kashmir	0.12
Jharkhand	0.95
Karnataka	0.10
Kerala	0.41
Madhya Pradesh	0.82
Maharashtra	3.97
Odisha	3.06
Puducherry	0.002
Punjab	0.78
Rajasthan	9.78
Sikkim	0.01
Tamil Nadu	0.07
Telangana	8.36
Tripura	0.75
Uttar Pradesh	8.47
Uttarakhand	0.35
West Bengal	0.21

Figure 50: LED street light installations

dashboard where the detailed status of the progamme are made online for the public : https://meep.eeslindia.org/dashboard/

7.2 Street Lighting National Programme

Under SLNP programme, EESL is working across India, to replace the conventional street lights with energy efficient street lights with no upfront cost to ULBs. Working on an ESCO based model, EESL will recover the cost from the savings generated by the replacement of street lights. EESL also provides operation and maintenance service of the replaced street lights for a duration of 7 years. EESL has carried out the, Results of post-installation studies conducted by EESL to estimate the energy savings due to retrofitting of LED street lights in different locations, indicated energy savings of more than 50% across the different ULBs.

Over 84 lakh LED street lights have been installed during the FY 2015-19 across India

Over 23 lakh LED street lights have been installed in Andhra Pradesh during the FY 2016-19

LED street lights installed by EESL under the programme are equipped with Central Control and Monitoring System (CCMS), which allows remote monitoring and operation. This ensures that street lights are automatically switched on,

once the sun sets and switched off after dawn (Switching on and off is also linked to the solar timings at particular location around the year). This promotes energy savings by optimal control of lights. The system also sends alerts for each light that needs attention, to reduce failure and the need for sudden repairs. Details of implementation, and resulting energy savings, and emission reductions achieved through SLNP programme are presented by EESL on a publicly available dashboard at the link - https://slnp.eeslindia.org/ .

7.3 Methodology for energy saving estimations

Energy savings due to number of inefficient street lights that have been replaced by LED street lights during FY 2015-19, are calculated. In order to calculate the energy (electrical) savings and emission reduction, following steps are used:

7.3.1 Step-1: Identification of the lights installed during the FY 2015-19

Total number of lights installed during the FY15 -19 are presented in Table 59.

Table 59: State wise installations of LED street lights[56]

States/UTs	No. of LED street lights installed in FY				Total No. (Lakh) of LED street lights installed in FY-2015-19
	2015-16	2016-17	2017-18	2018-19	
Andaman & Nicobar Islands		0	13,364	136	0.14
Andhra Pradesh	157250	367,179	436,616	1,505,402	24.66
Assam		5,203	15,691	2,757	0.24
Bihar		150	16,450	176,471	1.93
Chandigarh		0	41,394	548	0.42
Chhattisgarh		10,639	254,566	82,136	3.47
Delhi	117500	142,994	41,839	250	3.03
Goa		83,917	122,874	0	2.07
Gujarat		139,186	708,680	35,632	8.83
Haryana		179	11,226	52,596	0.64
Himachal Pradesh		19,041	32,864	515	0.52
Jammu & Kashmir		700	11,291	0	0.12
Jharkhand		5,093	88,386	1,380	0.95
Karnataka		0	9,592	290	0.10
Kerala		9,685	1,535	30,032	0.41
Madhya Pradesh		9,643	49,710	22,518	0.82
Maharashtra		33,731	37,428	326,110	3.97
Odisha		1,879	49,349	254,397	3.06

56 EESL has installed a cumulative total of 5,74,413 lights across various states and UTs during FY 2015-19

States/UTs	No. of LED street lights installed in FY				Total No. (Lakh) of LED street lights installed in FY-2015-19
	2015-16	2016-17	2017-18	2018-19	
Puducherry		0	100	50	
Punjab		3,772	21,380	52,866	0.78
Rajasthan	177500	491,708	229,478	79,712	9.78
Sikkim		0	868	0	0.01
Tamil Nadu		0	6,689	0	0.07
Telangana	1050	21,370	763,772	49,926	8.36
Tripura	33700	9,589	30,028	1,559	0.75
Uttar Pradesh	13000	36,429	474,378	323,644	8.47
Uttarakhand		500	26,164	8,715	0.35
West Bengal		0	14,971	5,568	0.21

7.3.1 Step-2: Estimation of the energy saving

Energy saving due to SLNP intervention is calculated by multiplying the numbers of lights with saving details as per SLNP dashboard. Annual operational hours considered are 11 hours per day and 365 days a year, Savings due to the implementation is illustrated in Table 60 and Table 61.

Table 60: Energy savings 2015-19 from Street-Lighting programme

FY	Number of Installations	Number of States	Annual energy saving MU
2015-16	5,00,000	6	336
2016-17	13,92,587	21	934
2017-18	35,10,683	28	2356
2018-19	30,13,210	24	2022
Total	**84,16,480**	**28**	**5647**

7.3.1 Step-3: Estimation of the emission reduction[57]

Table 61: Energy saving and emission reduction from SLNP programme (state wise)

States/UTs	Number. of LED street lights installed in FY-2015-19	Energy Savings in FY 2018-19 (MU)	Emission reduction (Million Tonne of CO_2)
Andaman & Nicobar Islands	13500	9	0.01
Andhra Pradesh	2466447	1655	1.36
Assam	23651	16	0.01
Bihar	193071	130	0.11
Chandigarh	41942	28	0.02
Chhattisgarh	347341	233	0.19
Delhi	302583	203	0.17
Goa	206791	139	0.11
Gujarat	883498	593	0.49
Haryana	64001	43	0.04
Himachal Pradesh	52420	35	0.03
Jammu & Kashmir	11991	8	0.01
Jharkhand	94859	64	0.05
Karnataka	9882	7	0.01
Kerala	41252	28	0.02
Madhya Pradesh	81871	55	0.05
Maharashtra	397269	267	0.22
Odisha	305625	205	0.17
Puducherry	150	0	0.00
Punjab	78018	52	0.04
Rajasthan	978398	657	0.54
Sikkim	868	1	0.00
Tamil Nadu	6689	4	0.00
Telangana	836118	561	0.46
Tripura	74876	50	0.04
Uttar Pradesh	847451	569	0.47
Uttarakhand	35379	24	0.02
West Bengal	20539	14	0.01
Total	**8416480**	**5,647**	**4.6**

SLNP programme has led to energy savings of 5.6 Million units and reduction of 4.6 Million tonnes of CO_2 emissions during FY 2018-19 on account of the implementations carried out during the FY 2015-19.

57 http://www.cea.nic.in/reports/others/thermal/tpece/cdm_co2/user_guide_ver13.pdf

Transport

CHAPTER 8

The automotive industry is one of the largest industries globally and has deep forward and backward linkages with the rest of the industries. It has a strong multiplier effect and is one of the major drivers of economic growth. With the gradual liberalization of the automotive sector in India since 1991, the number of manufacturing facilities has grown progressively. The Indian automotive industry produces a wide variety of vehicles: passenger cars, light, medium and heavy commercial vehicles, multi-utility vehicles such as jeeps, two wheelers that include scooters, motor-cycles and mopeds, three-wheelers, tractors and other agricultural equipment. The Indian automobile industry is dominated by Two Wheelers, which account for 60% of the total vehicles sold in the country[58]. In the passenger car segment, India is mainly a small car market.

Two-wheelers and passenger vehicles dominate the domestic Indian auto market. Passenger car sales are dominated by small and mid-size cars. Two-wheelers and passenger cars accounted for 80% and 13% of over 26.26 million vehicles sold in FY19, respectively. The market share by vehicle type and the total vehicle sale in India between FY13-FY19 is shown below[59]:

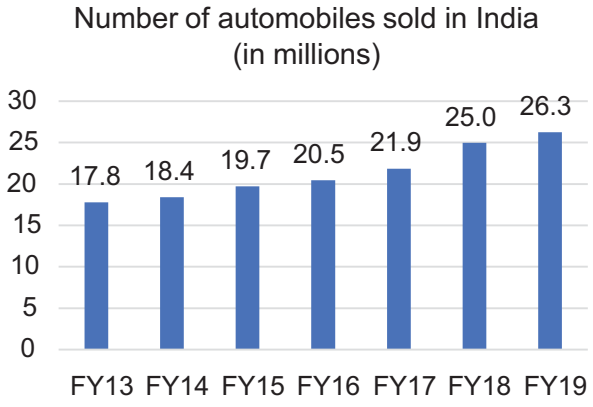


Figure 51 : Sales of Automobiles

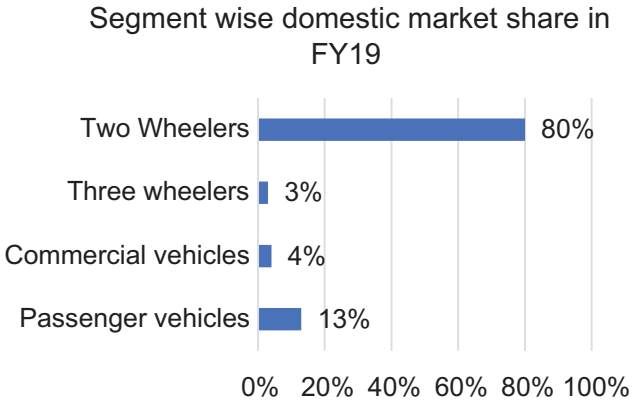


Figure 52 : Market share of different class of vehicles

58 https://www.ibef.org/download/automobiles-jan-2019.pdf
59 https://www.ibef.org/download/automobiles-jan-2019.pdf

The automotive manufacturing industry comprises the production of commercial vehicles, passenger cars, three & two-wheelers. Domestic automobile production increased at 8.4% CAGR between FY13-19 with 30.91 million vehicles manufactured in the country in FY19. The trend of automobile production in India is shown in Figure 53

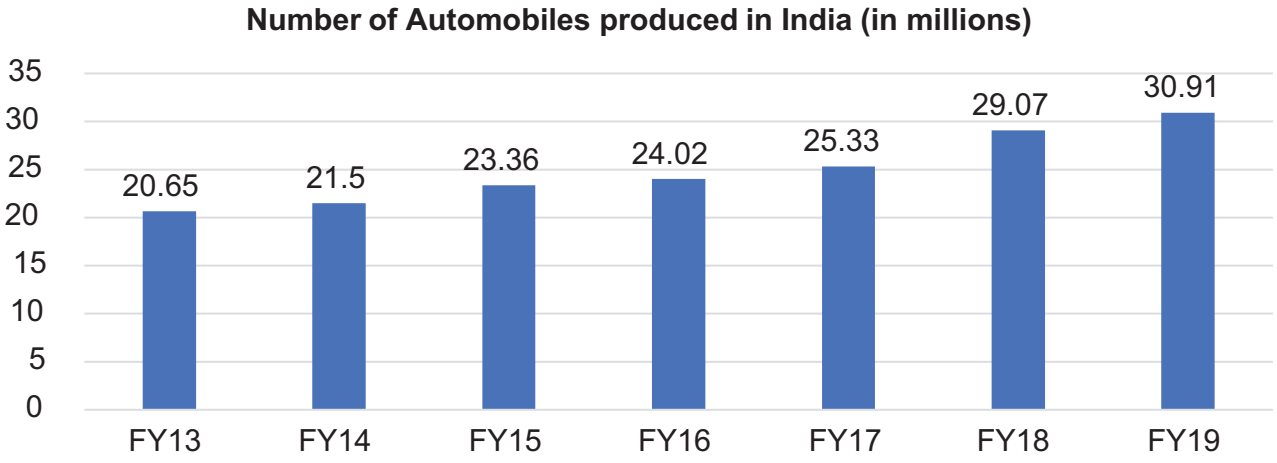


Figure 53: Production details of Automobiles

Over the past few years four specific regions in the country have become large auto manufacturing clusters, each present with a different set of players.

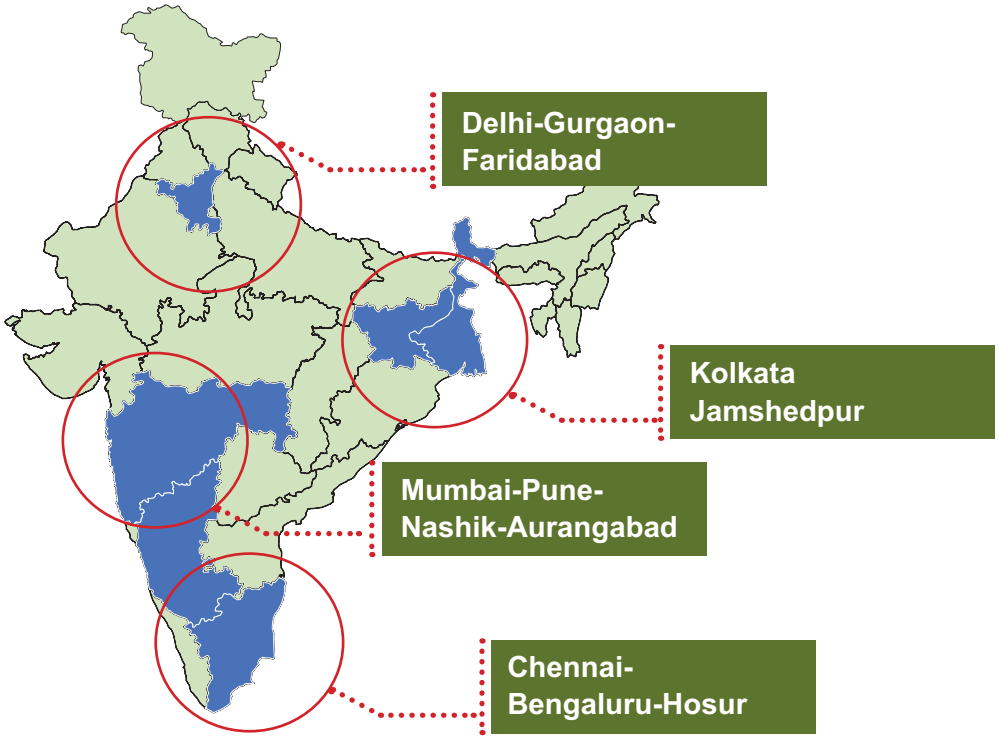


Figure 54: Major automobile manufacturing clusters in India

Table 62: Cluster wise leading companies

	List of companies
North	Ashok Leyland, Force Motors, Piaggio, Swaraj Mazda, Amtek Auto, Eicher, Honda SIEL Maruti Suzuki, Tata Motors, Bajaj Auto, Hero Group, Escorts, ICML, JCB, Yamaha, Mahindra, Suzuki Motorcycles
West	Ashok Leyland, Bajaj Auto, FIAT, GM, M&M, Eicher, Skoda, Bharat Forge, Tata Motors, Volkswagen, Renault Nissan, John Deere
East	Tata Motors, Hindustan Motors, Simpson & Co, International Auto Forgings, JMT, Exide
South	Ashok Leyland, Ford, M&M, Toyota Kirloskar, Volvo, Sundaram Fasteners, Enfield, Hyundai, BMW, Bosch, TVS Motor Company, Renault Nissan, TAFE

8.1 Vehicular pollution in India

Air pollution is one of the serious environmental concern of the urban Asian cities including India where majority of the population is exposed to poor air quality. The health-related problems such as respiratory diseases, risk of developing cancers and other serious ailments etc. due to poor air quality are known and well documented. Besides the health effects, air pollution also contributes to tremendous economic losses, especially in the sense of financial resources that are required for giving medical assistance to the affected people. The poor are often the most affected segment of the population as they do not have adequate measures to protect themselves from air pollution.

Most of the Indian Cities are also experiencing rapid urbanization and the majority of the country's population is expected to be living in cities within a span of next two decades. Since poor ambient air quality is largely an urban problem this will directly affect millions of the dwellers in the cities. A recent WHO database (2018) has identified several of India's top cities with some of the highest levels of air pollution. Kanpur, Faridabad, Gaya, Varanasi and Patna are the top five most polluted cities in the world[60]. In fact, according to Health of the Nation's States, household air pollution was responsible for 5% of the total disease burden in India in 2016, and outdoor air pollution was responsible for 6% of the burden[60].

The country has however taken several measures for the improvement of the air quality in cities. These include, promoting electric mobility, improvement in fuel quality, formulation of necessary legislation and enforcement of vehicle emission standards, improved traffic planning and management etc. The non-technical measures taken include, awareness raising regarding the possible economic and health impacts of air pollution and available measures for improving air quality, increasing use of cleaner fuels and purchase of vehicles with advance emission control devices, increasing institutional framework and capacity building for the monitoring of vehicle emissions.

This section covers the fuel savings as well as the emission savings from CAFE norms that have been notified in India since 1st April 2017 and electric vehicles sold under the implementation of the FAME India scheme by the Department of Heavy Industries. A brief description of the energy saving initiatives under Railways in India is also mentioned in the section, but the energy savings has been accounted under industries section as Railways has been incorporated under the PAT cycle.

60 https://www.statista.com/statistics/318023/two-wheeler-sales-in-india/

8.2 Savings under Corporate Average Fuel Economy (CAFE) implementation

In 2015, the government of India established corporate average fuel consumption standards for passenger cars taking effect as two-phase targets for FY 2017–2018 and for FY 2022–2023 onward. Subsequently, in August 2017, CAFÉ Norms were established for Heavy Duty Vehicles (HDV) and while in 2019 CAFÉ Norms were established for light and commercial vehicles.

The standard for a manufacturer is set in terms of gasoline-equivalent liters per 100 kilometers (L/100 km) based on vehicle curb weight. The actual fuel consumption for compliance is measured as grams of CO_2 emissions per kilometer (g/km) during vehicle type approval. The factors for converting consumption of different fuel types into gasoline-equivalent fuel consumption and for converting from gasoline-equivalent fuel consumption to CO_2 emissions are defined in the regulation.

The regulation provides super credits for battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and strong hybrid electric vehicles (HEVs). For the purpose of calculating the corporate average CO_2 performance, a manufacturer uses a volume derogation factor of 3 for BEVs, 2.5 for PHEVs, and 2 for HEVs. This means that a BEV counts as three vehicles, a PHEV as 2.5 vehicles, and an HEV as two vehicles in calculating fleet average CO_2 emissions. The fuel consumption of the electricity driving portion for BEVs and PHEVs is converted from electricity consumption based on an equation provided in the regulations.

Derogation factors for CO_2-reducing technologies aim to reward innovative technologies that produce real-world CO_2 savings beyond what is measured over a standardized test cycle during vehicle type approval. The compliance provisions allow manufacturers to use derogation factors for four CO_2-reducing technologies in calculating the corporate average CO_2 performance. The defined CO_2-reducing technologies include regenerative braking, start-stop systems, tire pressure monitoring systems, and 6-speed or more transmissions.

8.2.1 Methodology to calculate savings under CAFE norms

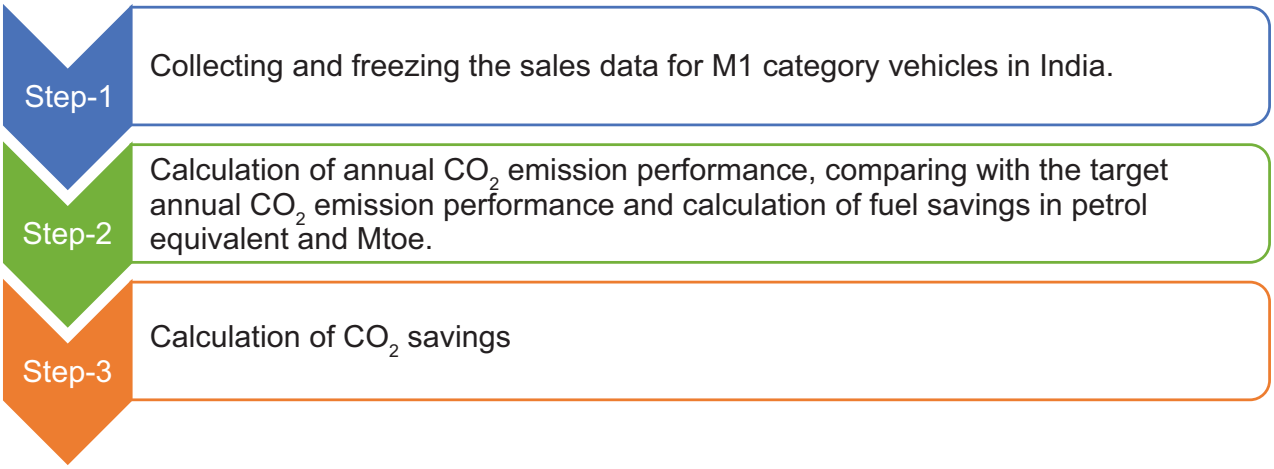


Figure 55: Methodology for saving calculation under CAFE norms

8.2.2 Energy and emission saving calculations

Step-1: Sales data for M1 category in 2017-18 and 2018-19

The data for total sales of this vehicle category was collected from the vahan dashboard[61] as well as data collected from ICAT. The sales data for these years is presented in (including mild and strong hybrids):

Table 63: M1 category sale in India in 2017-18 and 2018-19

2017	2018-19
3323754	3408712

Step-2: Calculation of annual CO_2 emission performance

The fuel wise annual CO_2 performance achieved is calculated by the formula mentioned below, as stated in amendment No.7 MoRTH/CMVR/ TAP-115/116: Issue No.4:

$$\text{Annual corporate average carbon dioxide emission performance} = \frac{\Sigma \left[\begin{array}{c} (\text{Manufactured volume} \times \text{Volume factor for super credit}) \\ \times (\text{manufacturer declared carbon dioxide} \times \text{carbon dioxide reducing technology}) \end{array} \right]}{\Sigma\ (\text{Manufactured volume} \times \text{Volume factor for super credit})}$$

The annual performance (in g/km) for 2017-18 and 2018-19 calculated is presented in Table 64

Table 64: Annual performance measures (in CO_2/km) for various fuel types

2017-18	2018-19
122.71	121.37

The target annual CO_2 emission performance for the duration 2017-18 to 2021-22 is calculated on the basis of the formula mentioned in S.O. 1072(E) and comes out as 129.3 g/km. The comparative CO_2 emission performance is presented in Table 65

Table 65: Comparison between target and performance achieved in 2017-18 and 2018-19

2017-18 (g/km)	Target achievement in 2017-18 (g/km)	2018-19 (g/km)	Target achievement in 2018-19 (g/km)
122.71	6.58	121.37	7.92

The actual fuel consumption in petrol equivalent is calculated by considering the fuel conversion factor of 0.04217 liters of petrol per 100 km, 10,000 km run of a passenger vehicle per year and the total number of registered vehicles (50% of the total sales for 2018-19 is considered for energy saving calculations as vehicles are registered during the course of one year) as collated from vahan portal and ICAT. The fuel savings in 2017-18 and 2018-19 in petrol equivalent and Mtoe is shown in Table 66

61 https://www.ibef.org/download/automobiles-jan-2019.pdf

Table 66: Fuel savings (in Mtoe)

Year	CO_2 emission savings
2017-18	0.42
2018-19	0.43
Cumulative 2017-19	0.85

Step-3: Calculation of CO_2 savings

The CO_2 savings is calculated from the achievement in CO_2 emissions in g/km and multiplying it with the total number of vehicles sold (50% of the total sales for 2018-19 is considered for CO_2 saving calculations as vehicles are registered during the course of one year) and assuming 10,000 km of vehicle run in one year. The CO_2 emission savings for 2017-18 and 2018-19 are mentioned in Table 67:

Table 67: CO_2 emission savings (in $MtCO_2$)

Year	CO_2 emission savings
2017-18	1.3
2018-19	1.35
Cumulative 2017-19	2.65

8.3 Accelerating E-mobility adoption in India

The thrust on electrification of India's fleet from all quarters is becoming profound, which is a clear indication of the fact that soon we will have a substantial number of electric vehicles in the country. However, the electric vehicle push is not new or sudden, India has been giving emphasis on electric vehicles for a long time. Despite all efforts, it was not that successful in the past. But with the recent push for e-vehicles by the government, the Indian auto industry is gearing up to make the electric vehicle mission 2030 a success.

Charging infrastructure is identified as the key to the uptake of EVs in India. In absence of policies to foster faster growth of charging infrastructure such as notifying EV charging as a service, consensus over the charging tariff, standards for EV chargers and innovative business models, the sale of EVs was largely stagnant in the past. A mere 1318 e-cars were added in FY 17-18, making the total EV stock reach 10,300 with a total market share of 0.10%. As per the 2018 data captured for public chargers, total publicly available chargers accounted for just 352 chargers, highlighting a need for rapid uptake and installation of accessible and available charging stations[62].

Given the nascent market, over the past few years, the national government has created momentum through several policies that encourage the adoption of electric mobility.

Major initiatives undertaken in the last few years to promote EV and EVSE in India are mentioned below:

FAME-I

The scheme was aimed to provide a major push for early adoption and market creation of both hybrid and electric technologies vehicles in the country. The thrust for the Government through this scheme was to allow hybrid and electric vehicles to become the first choice for the purchasers so that these vehicles can replace the conventional vehicles and thus reduce liquid fuel consumption in the country from the automobile sector. It was envisaged that early market creation through demand incentive, in-house technology development and domestic production will help industry reach a self-sufficient economy of scale in the long run by around the year 2020. The scheme planned to focus on:

- Technology development
- Demand creation
- Pilot projects
- Charging infrastructure

Individual budget had been allocated for

62 http://www.indiaenvironmentportal.org.in/files/file/Global_EV_Outlook_2019.pdf

Table 68: Component wise budget under FAME-I

S. No.	Component of the scheme	2015-2016 [USD million]	2016-2017 [USD million]
1	Technology platform	10.8	18.5
2	Demand incentives	23.9	52.3
3	Charging infrastructure	1.5	3.1
4	Pilot projects	3.1	7.7
5	IEC/Operations	0.7	0.7
Total		**40**	**82.4**
Grand Total [USD million]			**122.4**

every focus area keeping the highest budget for the demand incentives to lower down the EV prices in the market and push the faster adoption process. The total budget allocated was USD 122.4 million over the period of two years, USD 40 million for FY 2015-2016 and USD 82.4 million for FY 2016-2017.

FAME-II

The FAME-II scheme will act as a successor to the FAME-I scheme and would be implemented for a period of 3 years, eff. 1st April 2019 with a budget allocation of 10,000 Cr. The scheme is proposed to be implemented through the following verticals: Demand Incentives, Establishment of network of charging stations and administration of the scheme. The subsidies that have been provided under the scheme is presented in Table 69

Other highlights under the scheme are as follows:

- Electrification of Public Transport - The policy focuses on penetration of EV's in public transport, with the maximum demand incentive of 3545 Cr. Set aside for e-buses
- Under the FAME – II policy, subsidies have only been meted out for vehicles with advanced batteries, i.e. the policy effectively **covers only Li-ion battery operated vehicles** and does not cover Lead-Acid batteries
- Promoting localization in manufacturing/ assembling of EVs and related components
- Focus on advanced charging technologies and inter-linking of RE with EV charging

Table 69: Subsidies under FAME-II

Vehicle segment	No. of vehicles supported	Approx. size of battery	Total incentive (INR)	Max. ex-factory price to avail incentive
Electric 2W	10,00,000	2 kWh	20,000	1.5 lakhs
Electric 3W	5,00,000	5 kWh	50,000	5 lakhs
Electric 4W	35,000	15 kWh	1,50,000	15 lakhs
4W strong hybrid	20,000	1.3 kWh	13,000	15 lakhs
Electric Bus	7,090	250 kWh	50,00,000	2 Crores

8.3.1 Methodology to calculate fuel savings from adoption of EVs

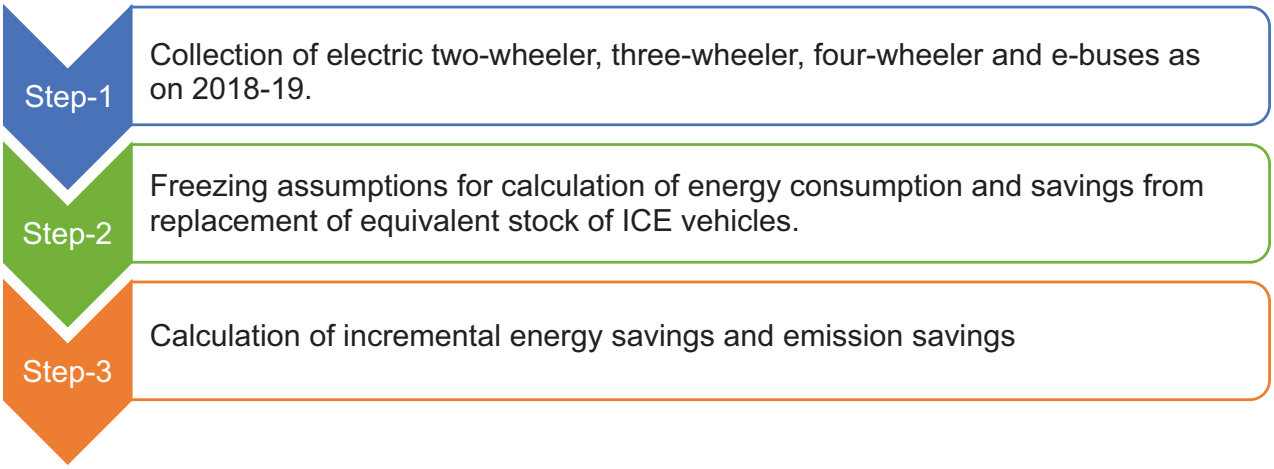


Figure 56: Methodology for fuel saving estimation due to EVs

8.3.2 Energy and emission saving calculations

Step-1: Collection of electric 2W, 3W, 4W and Buses data

Under FAME-I scheme 2.8 lakh hybrid and electric vehicles were supported under a total demand incentive disbursement of INR 359 crores. The number of electric vehicles (excluding hybrids) supported under the scheme as on 2018-19 is presented in Table 70

Table 70: Number of EVs supported under FAME-I (as on 2018-19)

Vehicle segment	Number of vehicles supported
e- 2-wheeler	1,70,000
e- 3-wheeler	2598*
e- 4-wheeler	12,447
e-Bus (6-8 mts)	400
e-Bus (8-10 mts)	
e-Bus (10-12 mts)	

**Though the number of electric three wheelers in India are more than a million, a vast majority of these three wheelers are assembled locally by unlicensed manufacturers. Thus, the numbers taken here are for electric three wheelers that claimed incentives under FAME-I.*

Step-2: Assumptions for various category of electric vehicles

Following are the assumptions that have been considered for deriving the energy savings and CO_2 emission savings for various category of EVs under FAME-I is presented in Table 71

Table 71: Assumptions for electric vehicles

Parameters	Electric 2W	Electric 3W	Electric 4W	Electric Buses
Range	50 km	80 km	110 km	200 km
Battery Capacity	2 kWh	7.5 kWh	15 kWh	250 kWh
Total Yearly run	10000 km	36500 km	30000 km	70000 km
CO_2 Emission factor				0.82 tCO_2/MWh

To compare the energy and emission reductions by adoption of various category of EVs, it is also necessary to calculate the equivalent energy consumption and CO_2 emissions from same number of ICE vehicles. The following are the assumptions that were considered for ICE category of vehicles, details are presented in Table 72

Table 72: Annual running (Kilo meter) for ICE vehicles

Parameters	2-wheeler	3-wheeler	4-wheeler	Buses
Mileage	**48 km/l**	**35 km/l**	**15 km/l**	**8 km/l**
Fuel type	**Petrol**	**Petrol**	**Petrol**	**Diesel**
Total Yearly run	**10000 km**	**36500 km**	**30000 km**	**70000 km**
CO_2 Emission factor[63]	**44 g/km**	**92 g/km**	**231 g/km**	**1056 g/km**

Step-3: Calculation of energy and emission savings

The energy savings and CO_2 savings were calculated by estimating differential energy consumption and CO_2 emissions, had the same amount of ICE vehicles been purchased instead of EVs. The overall energy and CO_2 emission savings for 2018-19 are given in Table 73

Table 73: Energy and CO_2 savings in 2018-19

Particulars	Savings in 2018-19
Energy savings in Mtoe (2018-19)	**0.04**
CO_2 emission savings in $MtCO_2$ (2018-19)	**0.07**

8.4 Energy efficiency in the Railway Sector

Indian Railways is an Indian state-owned enterprise, owned and operated by the Government of India governed by the Ministry of Railways. It is one of the world's largest railway networks comprising 1,23,542 km of track over a route length of 67,415 km and about 8500 stations. Due to the high energy consumption of the various Production Units and Workshops in the Indian Railways, the Bureau of Energy Efficiency, and Ministry of Power has identified Indian Railways as one of the designated consumers under the Perform Achieve and Trade (PAT) Scheme.

63 https://shaktifoundation.in/wp-content/uploads/2017/06/WRI-2015-India-Specific-Road-Transport-Emission-Factors.pdf

Indian Railways is divided into two categories i.e. Traction and Non-Traction. All traction zonal railways having the annual energy consumption for traction of 70,000 metric tonne of oil equivalent (Mtoe) per year and above are considered as DC and for non-traction system all production by name and above are considered as DC. In PAT Cycle II, 16 Zonal Railways and 6 production units are included[64].

The total electricity consumption in traction energy in Indian Railways over the years is presented in Figure 57.

Over the last few years, there has been an increase in the electricity consumption which can be attributed to the significant increase in the route electrification in the same period, as shown in Figure 58. To counter this increase, the Indian railways has taken several steps to

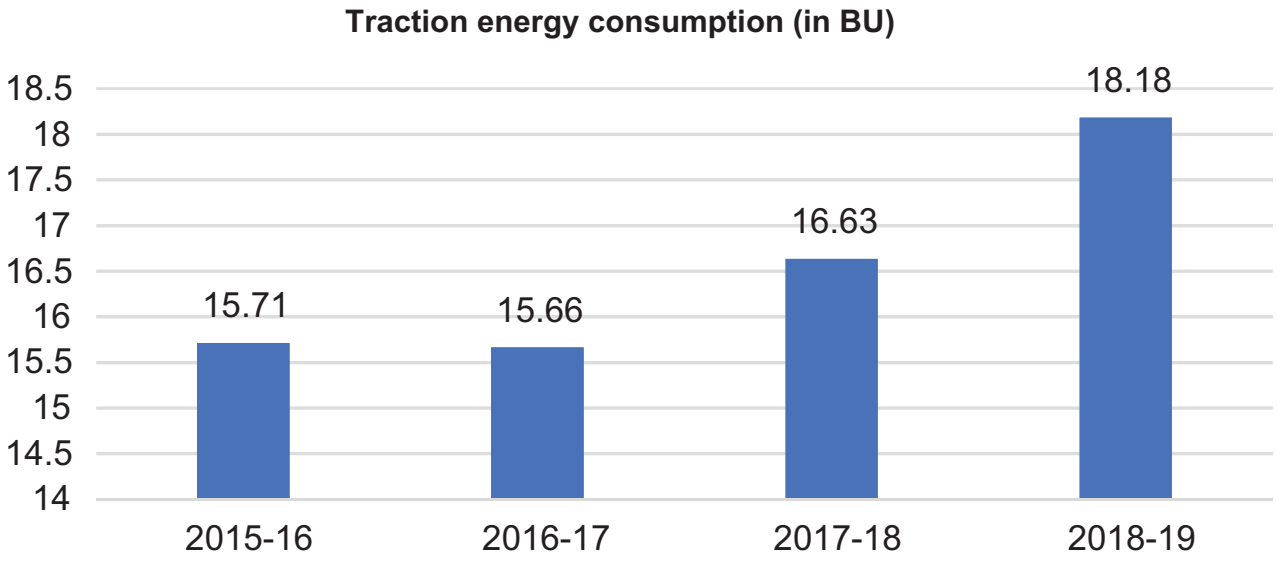


Figure 57: Traction energy consumption by Railways

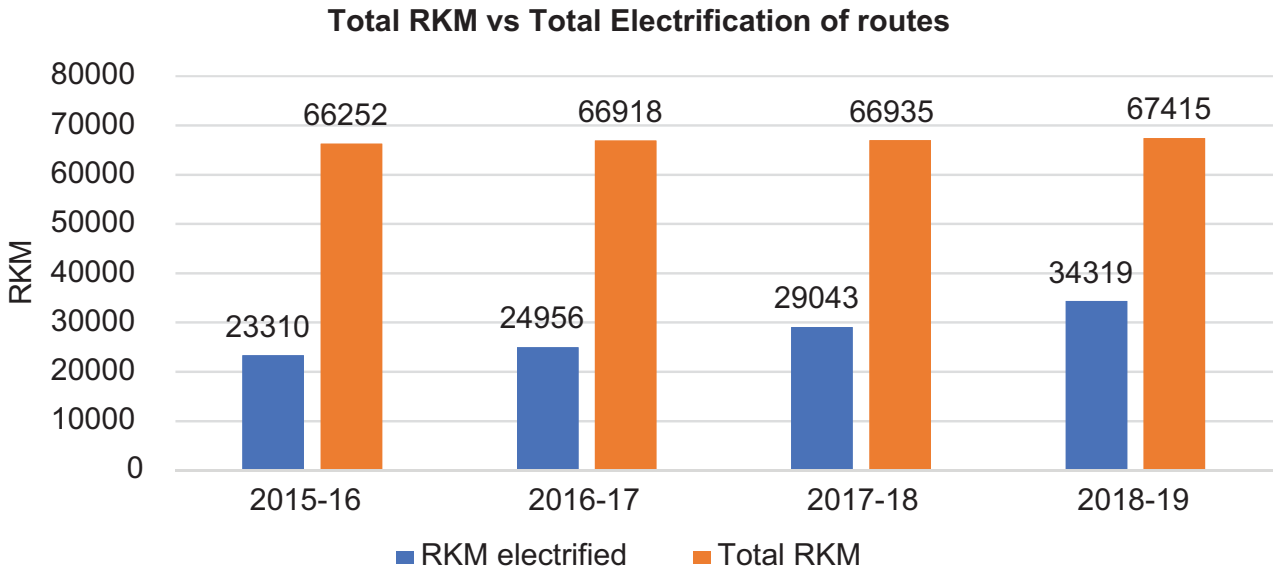


Figure 58: Route electrification in Indian Railways

64 http://www.indianrailways.gov.in/railwayboard/uploads/directorate/traffic_comm/RatesLetters/2017/Milind%20Deore_International_Conf_Railways_MD_27_10_2017(final).pdf

reduce the energy consumption in the traction segment. Some of these initiatives have been mentioned below:

Mission Electrification: It is one of the biggest initiatives taken by Indian Railways for switching over energy efficient mode of traction i.e. from diesel to electric. has planned to electrify major Broad-Gauge routes in mission mode by increasing yearly targets. As a direct result of this programme, the pace of electrification has enhanced multifold, going from 1646 RKM achieved in 2016-17 to 5276 RKM in 2018-19. It is envisaged that after 100% electrification, there will be a saving in diesel oil consumption to the tune of 2.8 Billion liters per annum and CO_2 emission reductions of 342 million tonnes per annum.

3-phase regenerative locomotives: The Indian Railways has decided that all new locomotives and EMUs will be manufactured with three phase technology having regenerative capability. It is envisaged that this measure will save 15% energy on locomotives and 30% in EMUs.

Change in Policy: The Indian railways in its endeavor to bring in new technologies into the system had stopped the production of conventional locomotives since 31st March 2016 while the production of diesel locomotives was stopped from 31st March 2019 onwards.

Ramp up production of Electric locomotives: The year 2018-19 saw the highest ever locomotive production, which included 625 electric locos and 4 diesel converted electric locos working as multi-units. It is important to note here that the conversion of diesel to electric locos was the first of its kind that was done by Indian Railways on 1st March 2018. The Railway Board has identified 108 diesel locomotives in total for electric conversion during mid-life rehabilitation.

HOG (Head-on-Generation) Trains: More and more trains are being taken on HOG system resulting in saving of diesel in power cars. All WAP-7 locomotives being produced by Indian Railways are fitted with Hotel Load Converters (around 550 locomotives). Over 500 trains have been taken on HOG scheme resulting in saving of over Rs 1100 Cr in operational costs. HOG power supply will do away with the requirement of diesel sets for feeding electric supply to coaches for train lighting and air conditioning thereby reducing carbon emissions, noise level and consumption of fossil fuels. Presently around 440 Mail/Express trains are running with HOG on Indian Railways. It is envisaged that once the entire process of HOG process is converted, it will result in carbon dioxide emission savings of 2 lakh tonnes annually.

Training of loco pilots: Regular counselling of Loco Pilots for resorting to maximum coasting and use of regenerative breaking. Continuous monitoring of regeneration is done in Crew Management System (CMS) for each Loco pilot. Electric loco idling in sheds and yards are kept to minimum. Regular counselling of Loco Pilots for switching 'OFF' blower in case yard detention is more than 15 minutes.

Non-traction energy

Non-Traction load has come down from 2.5 Billion Units in 2014-15 to 2.27 Billion Units in 2018-19 (an average decrease of 1.84% per year) despite increase in electric load (lifts & Escalators) and addition of railway assets on stations buildings such as air-conditioned waiting rooms, new platforms, etc. The non-traction energy consumption over the years is in presented in Figure 59.

The various measures that have been taken by the Indian Railways to achieve the significant decrease in energy consumption over the years are mentioned below:

100% Green Powered Stations: Indian Railways' go green and save electricity initiatives have proved to be immensely beneficial. 13 Railway stations & 18 other Railway buildings have been certified as Green Buildings by IGBC. Additionally, 52 other Railway installations have been certified with GreenCo Ratings and 50 buildings (including

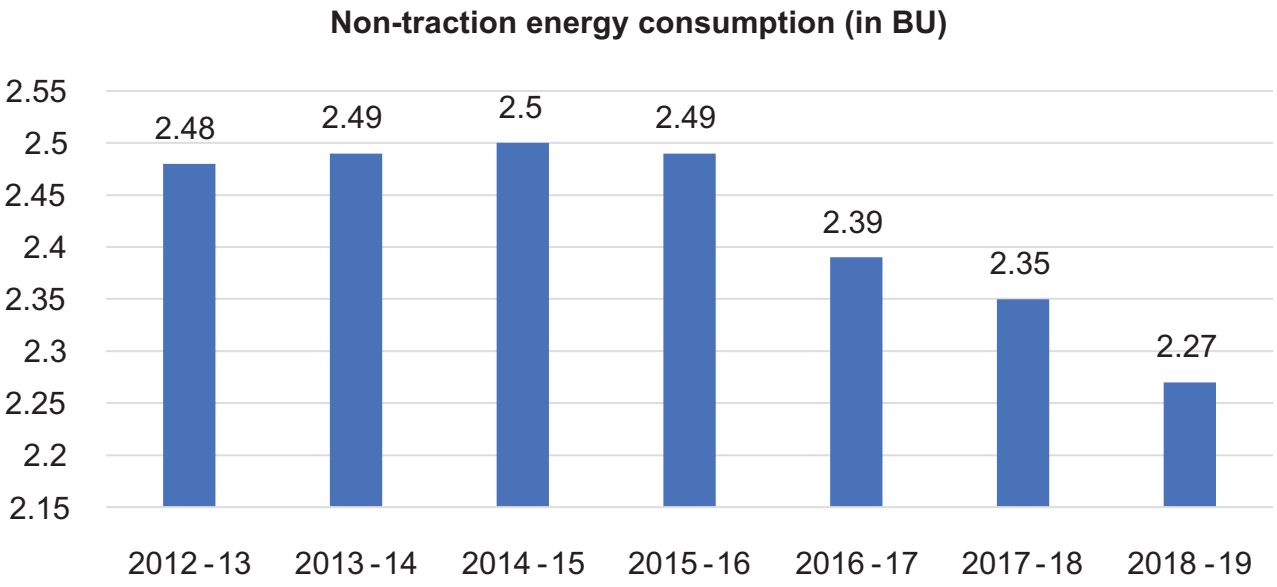


Figure 59: Non traction energy saving

4 Divisional Hospitals) have been given Star rating by BEE.

In addition to this, a directive has been issued by the Indian Railways to adhere to super ECBC compliance in new buildings as well as for redevelopment of existing station buildings.

100% LED initiative: Provision of 100% LED lighting has been completed on all the railway stations and service buildings under Indian Railways. In addition, all residential railway quarters are being provided with LED lights. Ultimately, 100% LED lighting will improve the non-traction energy scenario under Indian Railways and will reduce about 10% of total energy being utilized in non-traction. In addition, the Indian Railways is deploying 70:30 circuit for platform lighting at railway stations.

Renewable energy integration in Indian Railways

Indian Railways has plans to set up 1000 MW solar & 200MW wind power plant by 2020-21. 500 MW solar plants on roof tops of railway buildings through developer mode has been planned for meeting non-traction loads and 500 MW solar plants through land-based systems are planned to meet traction loads.

Some of the projects that have been set-up or are in the process of being commissioned under the 1000 MW solar target are as follows:

- 3 MW has already been set up at MCF, Raebareli.
- Railway is purchasing the renewable energy from 400 MW power from RUMS (Rewa Ultra Mega Solar), a JV of SECI and Govt. of MP.
- Railway is setting up 50 MW solar plant at its vacant railway land at Bhilai.
- 2 MW solar power plant being set up by REMCL at Diwana (near Panipat) for Northern Railway.
- 1.7 MW solar power plant being set up by BHEL at Bina for West Central Railway.

Some of the projects that have been set-up or are in the process of being commissioned under the 200 MW wind target are as follows:

- 10.5 MW capacity has already been set up at ICF, Chennai.
- 26 MW plant at Jaisalmer in Rajasthan.
- 10.5 MW plant installed in the state of Tamil Nadu.
- 50.4 MW plant installed at Sanglii district of Maharashtra.
- 6 MW plant installed at Sanglii district of Maharashtra

The energy savings and emission reductions in the sector have been accounted for under the PAT section of the report.

Agriculture

CHAPTER 9

Agriculture plays a vital role in India's economy. 54.6% of the total workforce is engaged in agricultural and allied sector activities (Census 2011) and accounts for 17.1% of the country's Gross Value Added (GVA) for the year 2017-18 (at current prices)[65]. Agriculture is an energy intensive sector and as per the energy statics published in 2019, the sector consumes 18% of the total electricity consumption in the country[66]. The electricity consumption in the sector over the last 8 years with % growth over the same period is presented in Figure 60.

AGRICULTURE SECTOR

Total pump sets energized in India – 21.3 million

Energy supplied (FY 2017-18) – 203 BU

Percentage of total energy supplied (FY 17-18) – 18%

As per CEA annual report of 2018-19 total 21.3 million pump sets are energized at present[67]. Most of the energized pump sets on agriculture sector are non-standard and locally made. In

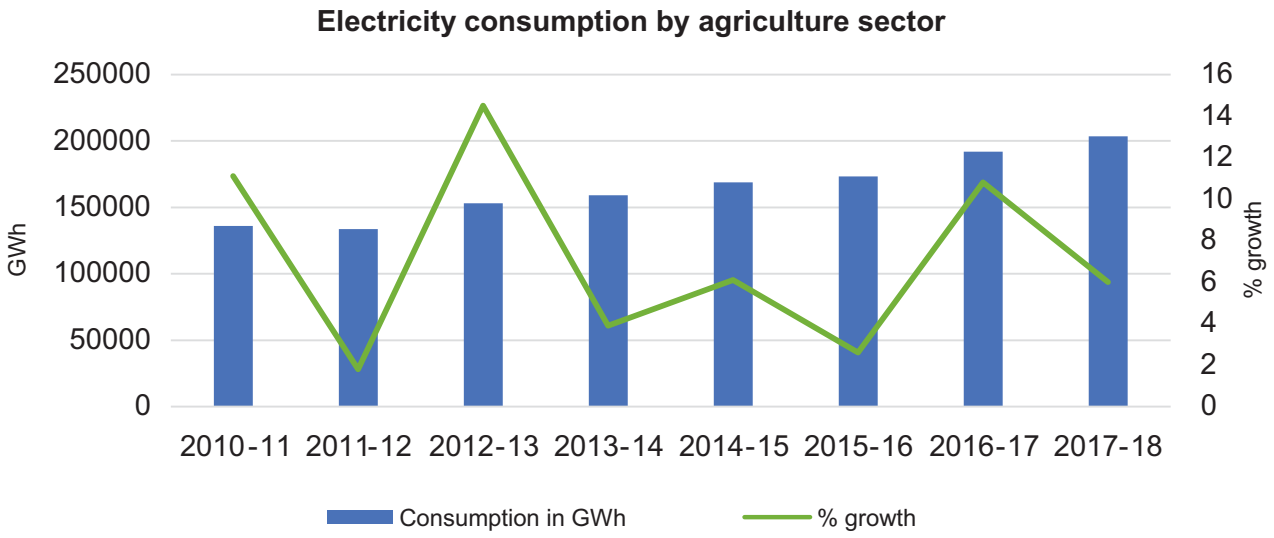


Figure 60: Energy consumption in agriculture sector

65 http://agricoop.nic.in/sites/default/files/AR_2018-19_Final_for_Print.pdf

66 Energy Statistics 2019 - MOSPI

67 http://www.cea.nic.in/reports/annual/annualreports/annual_report-2019.pdf

comparison to the commercially available BEE star rated energy efficient pump sets, the existing pumps are consuming more power for delivering similar quantity of water. Supply of electricity agricultural sector is mostly free or high subsidized across most of the states of India. Under this scenario, as a consumer, farmer has little or no motivation in making any serious effort for saving energy. This has resulted in a huge financial burden on the distribution utilities and has resulted in higher tariffs for industrial and commercial consumers.

Along with higher energy consumption, existing pump sets is indirectly leading to wastage of ground water, as currently there is little or no motivation for farmer to monitor the pump sets operation or regulate operating hours as per actual water demand of the crops under irrigation. Under these circumstances, agricultural demand side management is an attractive option for limiting wastage of water and energy in agriculture sector

9.1 AgDSM programme

AgDSM consists of methodologies and policies aimed at bringing a change in the power consumption patterns of consumers (farmers). The objective of the AgDSM programme is to reduce peak demand, and, ultimately, the total energy consumption of the agriculture sector. All project implemented under AgDSM in India have focused on replacement of existing inefficient agricultural pump sets with BEE star-rated energy efficient pump sets.

Under subsidized power supply scenario, farmer does not have any commercial benefit of installing energy efficient pumps, therefore in almost all AgDSM projects DISCOMs are paying for replacement of pump sets either by sharing energy savings (in ESCO mode) or through capital investment.

Before ongoing state level AgDSM projects at Andhra Pradesh and Uttar Pradesh, four pilot projects were undertaken in India at Maharashtra (1 Nos.), Karnataka (2 Nos.) and Andhra Pradesh (1 Nos.). Details regarding mentioned pilot projects is summarized in Table 74.

Benefits to various stakeholders under the programme

The AgDSM programme involves several stakeholders such as farmers (the main beneficiary), Discom (implementing agency/

Table 74: Pilot projects in AgDSM

Particulars	BEE – Solapur	EESL- Hubli	EESL – Mysore	EESL –Rajanagaram
No. of pumps replaced	2,209	590	1,337	973
Type of pumps replaced	• Submersible • Monoblock • Open well	• Submersible • Monoblock	• Submersible • Monoblock	• Submersible
Rating	3 to 20 hp	2 to 7.5 hp	2 to 7.5 hp	4 to 30 hp
Project implementation model	ESCO mode	ESCO mode	ESCO mode	ESCO mode
Energy sharing ratio – ESCO: DISCOM	85:15	95:5	90:10	85:15
Repayment Period (Years)	5	6	6	5
Repair and maintenance	Free for 5 years	Free for 5 years	Free for 6 years	Free for 5 years
Implementation period (months)	36	10	9	22
Percentage Energy savings (%)	25%	35.18% (2014) 33.3% (2015)	36.15% (2015)	33%

project owner) the state government and EESL. Benefit accrued by various stakeholders by implementation of AgDSM are presented in Figure 61

9.1.1 Recent efforts by BEE to promote AgDSM scheme

Over the last year, the Bureau of Energy Efficiency has taken various measures to promote the usage of energy efficient pumps

Farmers	State Government	DISCOM
• Free of cost BEE 5 star rated energy efficient submersible pump • Free R & M for 5 years • Ease of operation through smart control panel • Improved awareness regarding water conservation • Improved safety	• Reduction of subsidy burden • Reduction in CO_2 emission. • Conservation of state gound water resources due to prudent use by farmers. • Reduced energy intensity of state GDP and contribution in meeting INDC targets.	• Reduction in energy and peak demand • Improved financial health • Improved power system reliability • Reduction in CO_2 emissions

Figure 61: Benefits of the AgDSM programme

by spreading awareness about the programme and building strategic alliances with key institutions working in the field of agriculture. Given below are some of the major initiatives that were taken during the last year:

Revised framework towards mandating the use of BEE star labelled pump sets for new connections through SDAs

BEE has made significant efforts towards mandating the use of EE pumps in agriculture by involving state regulatory commissions. BEE is undertaking stakeholder consultation meetings and capacity building sessions for DISCOMs, SERCs, SDAs and manufacturers to mandate the EE pumps for new connections. In consequent to the efforts made by BEE, States govts. Of Haryana, Himanchal Pradesh, Puducherry, Punjab, Kerala, Odisha, Karnataka, Tamil Nadu, Maharashtra and Uttarakhand have made it mandatory to use star labeled Energy Efficient Pumps sets (EEPS) for all the new pump set connections.

Driving nationwide awareness programs for farmers to promote the adoption of EE pumps

BEE being the nodal agency of the country is focusing towards conducting large scale awareness programs for farmers to promote the adoption of EE pumps by them. BEE is exploring different kinds of outreach channels such as local print and electronic media (including television and local radio channels), village cultural events, Grameen sabhas or other panchayat initiated public events, etc.

Organizing technical training programs for pump technicians

Under AgDSM programme, BEE is organizing training programs for pump technicians who have a major role to play in replacing old inefficient pumps with BEE star rated pump sets. BEE is also issuing a certificate to these technicians post successful completion of the training program.

Collaboration with ICAR

An MoU has been signed between Bureau of Energy Efficiency (BEE) and Indian Council of Agricultural Research (ICAR) to conduct training and awareness programs for farmers to promote the use of Energy Efficient (EE) agricultural pump sets. This would create awareness among the farmers for using Energy Efficient pump sets and its operational practices so as to adopt energy and resource efficient approaches to reduce the cost of cultivation and to increase farmer's income in harmony with strategies of "Per drop more crop" and "Doubling Farmer's income". Till now around 150 training and awareness programs have been organized in different KVKs covering at least 4000 farmers and stakeholders.

The current status of the number of pumps installed in these two states is presented in Table 75.

Table 75: Cumulative pump-set installations under AGDSM

	2016-17	2017-18	2018-19
Number of pumps replaced under AgDSM	5109	23,127	63,615

9.1.2 Methodology adopted to calculate energy savings and CO_2 emission savings

There are total 63,615 BEE 5 star rated 5 HP pumps which were distributed till FY 2018-19 to replace inefficient pumps. For the purpose of energy saving calculations in 2018-19, 50% of the total number of installations in the year 2018-19 is considered since pumps are installed at different times during the year. The energy savings and CO_2 emission savings were calculated on account of these number of inefficient pumps that were replaced by the energy efficient pumps in the past few years. The methodology to calculate each is explained below:

- **Energy Savings**: This is calculated by considering the number of pumps installed and considering an overall efficiency factor of 30% to calculate the energy savings per pump. The number of hours the pump is used per day and number of days the pump is operational in a year is assumed to be 6 hours and 270 days respectively based on ground surveys carried out for AgDSM programme implementation in AP.
- **CO_2 emission savings**: In order to calculate the reduction in total CO_2 emission, conversion factor of CO_2 for electricity is considered (1 MWh = 0.82 t CO_2)

Based on results obtained, the impact under the AgDSM programme is discussed below.

9.1.3 Impact of the scheme

Prior to the FY 2018-19, total 23,127 BEE five star rated 5 HP pumps were installed across India. In the financial year 2018-19, there were total 40,488 number of inefficient 5 HP pumps that were replaced by 5 HP BEE five star rated pumps under AgDSM program, details are presented in Figure 62

On account of number of energy efficient pumps getting distributed over the past few years, the impact of the AgDSM scheme in terms of energy (electrical) saved across India in FY 2018-19 is 0.18 BU and reduction in emission of CO_2 is 0.148 Million Tonne.

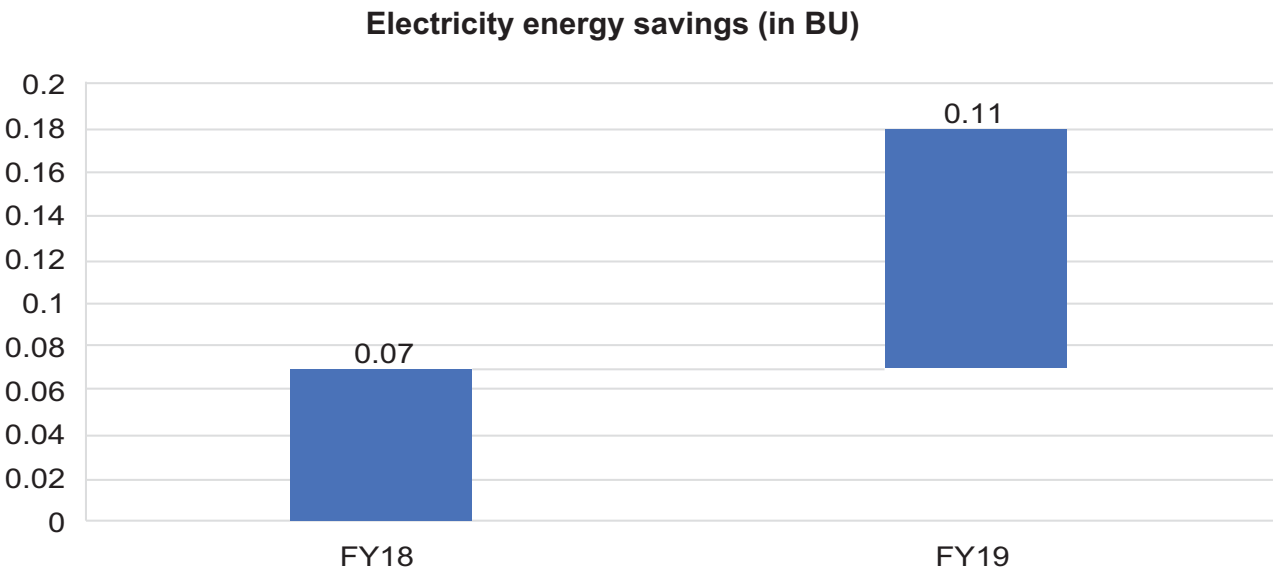


Figure 62: Energy saving from AgDSM

State Designated Agency

CHAPTER 10

Under the framework of Energy Conservation (EC) Act, a two-tier structure has been established for undertaking energy efficiency activities with Bureau of Energy Efficiency (BEE) at the Centre and State Designated Agencies (SDAs) as nodal agencies at the State level. In exercise of the powers conferred by section 15(d) of the Energy Conservation (EC) Act 2001, all the State Governments / UT Administrations have designated an agency as State Designated Agency (SDA) to coordinate, regulate and enforce the provisions of this Act within the State.

At present, there are total 36 SDAs in the country, out of which, 16 are Renewable Energy Development Agencies, 5 are State Government Power Departments, 7 are Electrical Inspectorates, 6 are Electricity Distribution Companies and 2 are Stand-Alone SDAs. Kerala and Andhra Pradesh are the two states, who have established Stand-Alone SDA. Remaining 34 States/UTs have assigned additional responsibility of facilitation and enforcement of the provisions of the EC Act at the State level to one of their existing agencies/ departments, wherein, the SDA shares key facilities / staff / budget with the parent department.

10.1 BEE support extended to SDAs

In order to build and strengthen the institutional, technical and financial capacities and capabilities of the SDAs for undertaking energy efficiency activities at the State level, BEE provides financial assistance to the SDAs under two major components cited as below.

- Providing financial assistance to the State Designated Agencies to coordinate, regulate and enforce efficient use of energy and its conservation.
- Contribution to State Energy Conservation Fund (SECF).

The activities covered under each of these components are as follows.

10.1.1 Providing financial assistance to the State Designated Agencies to coordinate, regulate and enforce efficient use of energy and its conservation

1. State Partnership for Energy Efficiency Demonstrations (SPEED)

    - Implementation of energy efficiency demonstration projects – These demonstration projects can be implemented by the SDAs in the areas of street lighting, water pumping, retrofitting of electrical appliances in buildings, and installation of smart-meters in municipalities.
    - Implementation of energy efficiency activities in Government schools – Replacement of existing conventional appliances with energy efficient appliances in Govt. schools is undertaken by SDAs under this head along with disseminating awareness

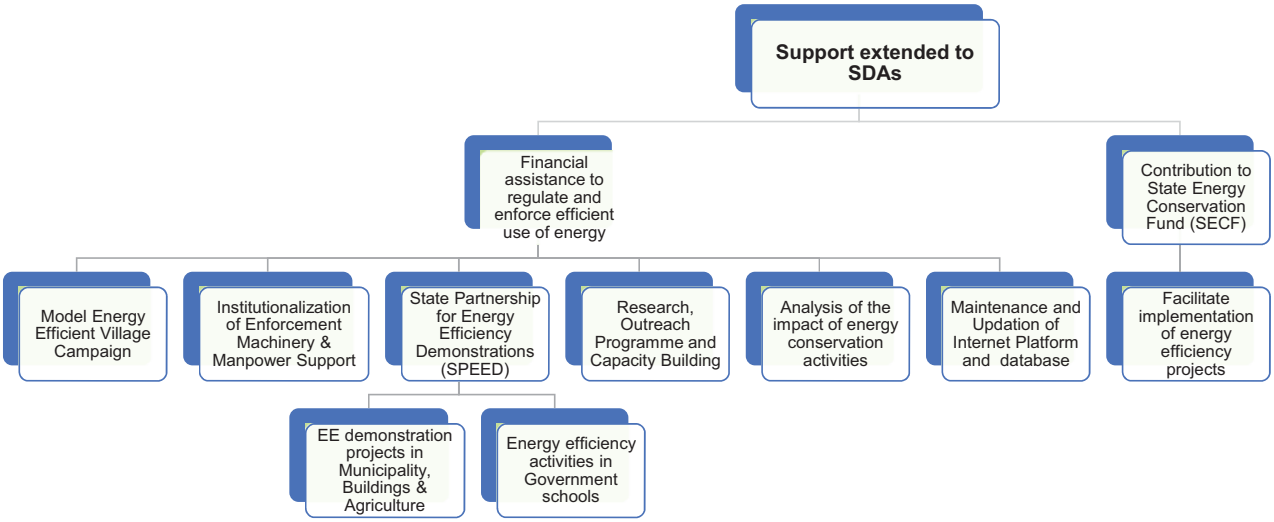


Figure 63: SDA Activities and initiatives

amongst school children by way of establishing energy clubs, organizing debates, quiz programs, etc.

2. Model Energy Efficient Village Campaign

3. Institutionalization of Enforcement Machinery at State level and Manpower Support to SDAs

4. State Energy Efficiency Research & Outreach Programme and Capacity Building

5. Analysis and survey of the impact of energy conservation activities by SDAs

6. Maintenance and Updating of Internet Platform and other database created

10.1.2 Contribution to State Energy Conservation Fund (SECF)

The SECF can facilitate to overcome the major barriers for implementation of energy efficiency projects. It is intended to be used as an instrument to facilitate implementation of energy efficiency projects through market transformation. The scheme is for contribution to all the State/UTs with a maximum ceiling of Rs. 4.00 crore for any State/UT provided in two installments of Rs. 2.00 crore each. The second installment of Rs. 2.00 crore under contribution to SECF is released only after the states have provided a matching contribution to the first installment of Rs. 2.00 crore provided by BEE. Till date, 31 states have constituted SECF out of which about 25 States have also provided matching contribution.

10.2 Andaman & Nicobar

SDA has identified three villages namely Harmindar Bay, Little Andaman; Dugong Creek, Little Andaman; and Strait Island, Middle Andaman under Model Energy Efficient Village Campaign for the implementation of Energy Efficient measures.

Implementation of 22,156 Nos. of LED streetlights under SLNP programme in rural areas of Andaman & Nicobar island is in process. Andaman & Nicobar administration has amended building code as per ECBC 2017. The amended code has been approved by BEE and has been circulated to various stakeholders for comments and inputs.

10.3 Arunachal Pradesh

Arunachal Pradesh Energy Development Agency (APEDA) has replaced all the conventional appliances in total 52 nos. of schools till date (2637 nos. of Fans, 3989

nos. of Bulbs and 738 nos. of Tube light), and further implementation in 48 schools is in process.

SDA has also replaced of 5 nos. of agricultural water pump sets with Energy Efficient water pump sets and replaced 34 nos. of conventional and inefficient motors across the state of Arunachal Pradesh. State has completed the amendment as per ECBC-2017. However, notification of amended ECBC is pending.

10.4 Andhra Pradesh

SDA identified two nos. of villages to be transformed as model energy efficient villages namely, Vinjarampadu village in Krishna district and Peddapodillu of Kurnool district. SDA has also replaced ordinary pump sets with energy efficient pump sets under Rural water supply scheme.

The State of Andhra Pradesh established a dedicated Cell for implementation of ECBC with support of ASCI. ECBC 2007 has been notified and made mandatory in AP. Draft Notification of ECBC 2017 has been submitted for approval to Municipal Administration.

10.5 Assam

SDA is in process of replacing conventional luminaries and fans with energy efficient luminaries and fans in 100 Govt. schools. SDA has completed the implementation in total 12 nos. of schools in the first phase of the project.

Government of Assam has amended ECBC as per the 2017 version. Assam specific ECBC has been submitted to the Government for approval. SDA has also drafted the “Assam Energy Conservation Policy – 2017” and sent to State Govt. for approval.

10.6 Bihar

SDA has carried out the replacement of existing inefficient lighting system and fans with energy efficient luminaries and fans in 18 nos. of Govt. schools. Till date, total 934 nos. of fans, 771 nos. of LED bulbs and 570 nos. of LED tube lights have been replaced in 18 nos. of schools.

SDA has implemented the model energy efficient village campaign in 10 nos. of villages by replacing existing conventional appliances with energy efficient ones. Bihar has amended the ECBC-2017 notification. The notification document of ECBC-2017 and cabinet note is submitted to Energy Department.

10.7 Chandigarh

SDA has installed 346 LED tube-lights and 3000 LED streetlights apart from undertaking various awareness programs. Chandigarh may amend and notify ECBC as per the local conditions and subsequently incorporate them in the building by-laws of Urban Local Bodies (ULBs).

10.8 Chhattisgarh

SDA has replaced about 2500 nos. of streetlights with LED street-lights in various districts, and has provided about 4500 nos. of LED lights (Bulbs, Tube lights & street-lights) to residents of 31 villages under model energy efficient village campaign.

The State of Chhattisgarh has amended the ECBC and the notification of ECBC-2017 is currently under process. Subsequently, incorporation of ECBC norms in building byelaws of Urban Local Bodies (ULBs) needs to be done.

10.9 Daman and Diu

SDA has replaced the 261 no. of street-lights with energy efficient LEDs. Daman & Diu Govt. has amended ECBC as per the local conditions. However, they are yet to notify ECBC and subsequently incorporate them in the municipal by-laws.

10.10 Delhi

Delhi Govt. has circulated the amended ECBC to various stakeholders for comments and inputs. The Govt. is yet to notify ECBC and subsequently incorporate them in the municipal by-laws.

Delhi SDA has identified 106 nos. of Govt. schools for formulation of energy clubs and subsequent uptake of energy conservation activities. SDA has also planned to implement energy efficiency measures in five Govt. hospitals within the territory of Delhi, as pilot project.

10.11 Goa

SDA has planned to renovate drinking water pumping system of the PHE / Water Supply Department by replacing inefficient old pumps with energy efficient ones. The State of Goa has amended the ECBC and the notification of ECBC is currently under process.

10.12 Gujarat

GEDA has undertaken the replacement of conventional luminaries and fans with energy efficient luminaries and fans in 133 Govt. schools across Gujarat. The State of Gujarat has amended the ECBC and the notification of ECBC is currently under process.

Gujarat Govt. has started the Smart GHAR III (Green Homes at Affordable Rate), an affordable housing project in Rajkot under the Pradhan Mantri Awas Yojana (PMAY). The project consists of 1176 units, all of which are 1 BHK units. Project is being implemented under the Indo-Swiss bilateral for building energy efficiency.

10.13 Haryana

Government of Haryana targeted two Vidhan Sabhas (Karnal & Khol Block of Rewari District) covering 500 nos. villages for implementation of Energy Efficiency Measures under LED village Campaign. Haryana Govt. has amended and notified ECBC 2007 as per the local conditions and subsequently issued directions for incorporation of the notified ECBC in the building by-laws of Urban Local Bodies.

10.14 Himachal Pradesh

The State of Himachal Pradesh has amended the ECBC. The draft Himachal Pradesh Energy Conservation Building Code (HPECBC) has

been approved by the Council of Ministers (CMM) to the Govt. of HP and will be notified shortly.

HP SDA is in process of replacing conventional luminaries and fans with energy efficient luminaries and fans in 100 Govt. schools across Himachal Pradesh.

10.15 Jammu & Kashmir

As on date, 79.54 lakhs LED bulbs have been distributed across the state under UJALA. Under national street lighting program, about 12 thousand conventional street lights have been replaced by LED street lights. Jammu & Kashmir has designated 3 agencies as the State Nodal Agency (SNA) to set up EV charging infrastructure in the state.

10.16 Jharkhand

Jharkhand SDA has undertaken retrofitting of existing inefficient appliances with energy efficient appliances at Project Bhawan, Dhurwa, Ranchi and Nepal House, Doranda.

JREDA has planned to implement energy efficiency demonstration projects in drinking water pumping systems, and administrative approval has been obtained. JREDA has planned to implement energy efficiency interventions at a cold storage unit at Ranchi, energy audit of which has already been completed.

10.17 Karnataka

SDA has initiated the implementation of the Energy Efficiency measures at 8 Govt. Hospitals under the demonstration project. Replacement of the existing less efficient water pumps with energy efficient BEE 4/5 star rated pumps at selected Govt. hospitals, is in process. SDA has implemented energy efficiency measures under LED Village Campaign in 10 villages.

The draft Code and Rules as per ECBC-2017 has been circulated by Energy department. Incorporation of directives pertaining to ECBC in the existing buildings was notified in Gazette and 21 buildings identified so far for making it ECBC compliant.

10.18 Kerala

Energy efficiency study for 15 Distribution Transformers is being carried out by the SDA. SDA has selected 2 nos. of villages for coverage under Model Energy Efficient Village Campaign. ECBC 2017 has been amended and submitted to Government of Kerala for concurrence. The Kerala Government has constituted a State Level Committee for enforcement of ECBC in the State of Kerala.

10.19 Lakshadweep

In order to stimulate demand for LED lighting in domestic lighting and street lighting sector, as on date, 1.0 lakh household LED bulbs have been distributed across the UT under UJALA. EESL has submitted a project proposal for replacement of 118 nos. of less efficient water pumps (0.75 hp to 7 hp) with energy efficient BEE star rated pumps including all accessories at Govt. Institutions at Kavaratti and Amini.

10.20 Madhya Pradesh

Madhya Pradesh SDA has completed replacement of all existing conventional luminaries and fans with energy efficient ones in more than 200 schools across 5 districts of Madhya Pradesh. Model Energy Efficient Village Campaign for converting the entire village into model energy efficient village, is underway in Kajlas, Badjhiri, Chandpur and Dobra.

The State of MP has amended the ECBC-2017 and the notification of ECBC-2017 is currently under process. MP SDA has distributed energy efficient appliances at concessional price in 8 districts across the state (100 villages in each district identified under Gram Swaraj Abhiyan).

10.21 Maharashtra

The State of Maharashtra has amended the ECBC and the notification of ECBC is currently under process. Subsequently, incorporation of the same in municipal bye laws needs to be done. Demonstration project replacing all energy in-efficient appliances by energy efficient appliances at Nagpur Municipal Corporation building has been undertaken by MEDA. MEDA has been replacing conventional lights and fans by LED lights and energy efficient fans in 100 Govt. schools across Maharashtra.

10.22 Manipur

In order to stimulate demand for LED lighting in domestic lighting and street lighting sector, as on date almost 3.0 lakhs household LED bulbs have been distributed across the state under UJALA program. Government of Manipur has amended ECBC as per the 2017 version. The same is yet to be notified.

10.23 Meghalaya

Government of Meghalaya has amended and notified the ECBC 2017 as per the local conditions and subsequently will incorporate them in the building bye-laws of Urban Local Bodies (ULBs). Meghalaya SDA has proposed to replace drinking water pumps of the PHE Department by replacing inefficient old pumps with BEE star rated energy efficient pumps. The proposal is submitted for approval. Replacement of existing conventional lighting by energy efficient LED luminaries at the Meghalaya Legislative Assembly is completed.

10.24 Mizoram

SDA has successfully replaced conventional appliances by 400 nos. of 9W LED bulbs, 200 nos. of 20W LED tube lights & 400 nos. of 50W celling fans in 100 schools in the state. SDA has also replaced 300 inefficient existing street-lights with 90-Watt LED street-lights at prominent places in 7 districts. SDA has successfully completed energy efficiency activities in three selected villages.

SDA has already amended the ECBC, however, notification of amended ECBC is pending. For undertaking the implementation of demonstration projects in Rural Drinking Water Pumping Systems, feasibility study has been conducted at four selected sites.

10.25 Nagaland

Nagaland SDA has implemented many demonstration projects on space heating and on replacement of conventional bulbs/ street-lights by LED bulbs and LED street-lights. The SDA has completed the replacement of conventional luminaries and fans with energy efficient luminaries and fans in 50 Govt. schools across Nagaland.

The Model Energy Efficient Village Campaign has been successfully completed in 11 villages. Amendment of ECBC has been completed by the state. However, notification of amended ECBC is pending.

10.26 Odisha

Odisha SDA has undertaken replacement of existing conventional luminaries and fans with energy efficient ones therein, as part of pilot project implementation in 5 Govt. hospitals within the State. Odisha SDA has completed replacement of all the existing conventional household bulbs and street-lights with LEDs in 4 no. of villages under North Eastern Electricity Supply Company of Odisha Limited (NESCO) .

SDA has replaced energy inefficient pumps with BEE star labelled pumps through Odisha Lift irrigation Corporation Ltd. Estimated energy saving of 15 MUs and capacity avoidance of 17 MW has been achieved by replacing 4316 nos. of lift irrigation pumps.

10.27 Puducherry

Renewable Energy Agency of Puducherry has replaced 1850 nos. of incandescent bulbs and 177 nos. of existing street-lights into energy efficient LED lights in four villages

namely Irulanchandai, Bahour Pet, Pudunagar and Kuruvinatham. Puducherry has already amended and notified the ECBC rules.

10.28 Punjab

PEDA has implemented Energy Efficiency project of revamping drinking water supply system in Patiala with installation of 19 nos. of Energy Efficient rural drinking water pumping stations. Implementation of Energy Efficiency measure in 117 govt Schools has also been completed. Amendment of ECBC Code and Rules as per 2017 version is in progress, and draft ECBC Rules are sent to stakeholder departments and public for their comments.

In order to stimulate demand for LED lighting in domestic lighting and street lighting sector, as on date, 14.05 lakh LED bulbs have been distributed across the state under UJALA program. Under Street Lighting National program, about 1 lakh conventional street-lights have been replaced with LED street lights.

10.29 Rajasthan

Rajasthan SDA is undertaking the replacement of conventional luminaries and fans with energy efficient luminaries and fans in 100 Govt. schools across the state. Government of Rajasthan has notified the ECBC. However, they are yet to incorporate the same in their building by-laws of Urban Local Bodies (ULBs).

10.30 Sikkim

Sikkim SDA has completed implementation of demonstration project in 50 Govt. schools by replacement of conventional luminaries and fans with LED luminaries and energy efficient fans. Sikkim SDA has successfully implemented “model energy efficient village campaign” of BEE in 330 households of Tingmo, Higdam, Lamaten, Mambru villages under South Sikkim by providing 2 LED tube-lights and 2 LED bulbs to each household.

10.31 Tamil Nadu

SDA has implemented the energy conservation measures at two government buildings and underway in 4 Collectorate Office Buildings (Chennai, Kanchipuram, Tiruvallur and Tirunelveli) is in process. Tamil Nadu government has amended code as per ECBC 2017. The amended code is with Energy Department for approval.

10.32 Telangana

Model Energy Efficient Village Campaign was implemented in Mahasamudram village, Peddakottapally Mandal, Nagarkurnool District and Gamya Naik Thanda, Kollapur Mandal, Nagarkurnool District. Implementation of the energy efficiency measures has been completed in the 27 no's SC/ST/BC/ Social Welfare Govt. Hostels covering 6 districts of Telangana State.

The state of Telangana has notified the ECBC as per the 2007 version and the same has also been incorporated in the building by-laws of Urban Local Bodies (ULBs). 30 nos. of buildings are already covered under ECBC. TSREDCO has also prepared State Energy Conservation action plan to strengthen Energy Conservation activities covering all the sectors.

10.33 Tripura

SDA Tripura has proposed to conduct Energy Audit of 'Drinking Water Pumping Systems' & replacement of the inefficient pumping systems at 'Agartala Municipal Council' area on pilot basis. SDA Tripura has identified 100 Nos. of Government school for carrying out energy efficiency measures in the school during FY 2018-19.

2500 nos. of 7-watt LED Bulbs & 120 nos. of 18-watt LED Street Lights have been distributed in 8 villages in Tripura under the LED Village Campaign of BEE. Govt. of Tripura has amended the code, same has been approved by BEE and the notification of ECBC-2017 is currently under process.

10.34 Uttar Pradesh

UPNEDA have replaced 9 nos. of existing conventional rural drinking water pumps with BEE star rated energy efficient pumps through UP Jal Nigam for demonstration purpose. UPNEDA has undertaken energy conservation measures in 500 nos. of Govt. schools under Madhyamik Shiksha Abhiyan by replacement of existing conventional luminaries and fans with energy efficient ones therein.

UPNEDA have undertaken replacement of all lights by LED lights, ceiling fans by BEE 5 star rated fans and ACs by BEE 5 star rated ACs etc. and installation of occupancy sensors in Uttar Pradesh Secretariat Building to make it Model Energy Efficient Building. Dedicated website for UP SDA has also been developed-www.upsavesenergy.com

SDA has also signed MoU with Petroleum Conservation Research Association (PCRA) for conducting awareness workshops for agricultural sector for farmers with focus on electric and diesel pumps.

10.35 Uttarakhand

UREDA has undertaken the replacement of conventional luminaries and fans with energy efficient luminaries and fans in 100 Govt. schools across the state. UREDA has also completed the replacement of 577 nos. of street lights with 74W energy efficient LED street lights at Nagar Nigam Haldwani-Kathgodam, Nainital and 2484 nos. of 12W LED bulbs in village Panchayat, Bahadarabad, Haridwar under Model Energy Efficient Village Campaign:

Government of Uttarakhand has amended and notified the ECBC. However, incorporation of the same in building bye-laws of Urban Local Bodies (ULBs) is yet to be done.

10.36 West Bengal

WBSDA has implemented the energy conservation measures in 100 nos. of govt. schools by replacement of existing conventional appliances with energy efficient ones. SDA has implemented "Model Energy Efficient Village Campaign" in 8 villages across the state for converting these villages into model energy efficient villages.

Conclusion

CHAPTER 11

Energy has always been recognized as one of the most important inputs to determine the economic growth of a country. A myriad of schemes has been undertaken by various institutes in the country that directly affect the energy consumption pattern in the country. There are 14 energy efficiency programmes/ schemes that are currently active and supporting the country to achieve India's Nationally Determined Contribution (NDC) targets.

The tentative findings of the report reflect that the adoption of energy efficiency schemes/ programs presented in Table 76 has led to the overall thermal energy savings in the order of 12.0 Mtoe, while overall electricity savings are to the tune of 136.374 BU. Overall, these energy savings translated into monetary savings of worth INR 89,122 crores and contributed in reducing 151.741 Million Tonnes of CO_2 emission.

Table 76: Summary of energy savings (2018-19)[68]

Name of the scheme / programme		Energy Savings		Total Savings (Mtoe)	Emission Reduction ($MtCO_2$)	Monetary Savings (INR Crore)
		Thermal (Mtoe)	Electrical (BU)			
PAT Scheme	Demand side sector	5.901	7.064	6.509	25.529	14391
	Supply side sectors - TPP, DISCOMs & Refineries	5.192	23.215	7.189	36.371	20014
MSMEs	BEE-SME Programme	0.001		0.001	0.004	2
	BEE-UNIDO-GEF Programme	0.009		0.009	0.047	16
	BEE-WB-GEF Programme	0.012		0.012	0.073	22
Standards and labeling Programme			55.693	4.790	45.668	27846
UJALA Programme**			44.645	3.839	36.609	22323
ECBC – Commercial buildings programme			0.040	0.003	0.033	20
BEE Star rating buildings*			0.083	0.007	0.068	41
Building energy efficiency programme*			0.110	0.009	0.090	55
Other Green Building Programmes			0.070	0.006	0.057	35
MuDSM (Street Lighting Programme)			5.647	0.486	4.631	2824
AgDSM* (Star Rated Pumps)			0.18	0.015	0.148	90
Corporate Average Fuel Economy (CAFE)		0.848		0.848	2.650	1560
FAME-I Scheme		0.038		0.038	0.070	70
Total		**12.000**	**136.374**	**23.728**	**151.741**	**89,122**

68 *Saving of AgDSM, BEEP, Star rating building is primarily on account of the retrofitting of the energy efficient BEE star labeled appliances. As saving of the Appliances is accounted in S&L programme thus saving indicated under these heads are not included in total (to avoid double counting). **Saving other than UJALA LED deployment programme not considered

Highlights from each scheme / programme in FY 2018-19:

Industry Sector

PAT Scheme[69]

Interventions in large industries, DISCOMs, Railways, & Buildings under PAT Scheme has led to total energy savings of 13.697 Mtoe (Thermal energy savings of 11.093 Mtoe and 30.279 BU of the electrical energy savings) under PAT cycle II, III, and IV. Energy savings for various PAT cycles is presented in Table 77.

Table 77: Total Energy saving Achieved from PAT cycle, II, III, & IV

PAT Cycle	Total Energy Savings Achieved		
	Thermal (Mtoe)	Electrical (BU)	Total (Mtoe)
PAT II	10.306	29.572	12.849
PAT III	0.595	0.504	0.638
PAT IV	0.193	0.202	0.210
Total	11.093	30.279	13.697

MSME Sector

BEE-SME program was focused in four clusters (Ludhiana, Indore, Varanasi and Pali) during FY 18-19. Energy efficiency and technology upgradation interventions carried out by BEE have led to savings of 1166 toe and emission reduction of 3954 tonnes of carbon dioxide annually.

BEE-UNIDO program was operational in 12 clusters during FY 18-19. Under the program, several energy efficiency and renewable energy initiatives have led to energy savings of over 8,519 toe and has contributed to reduction of 46,512 tonnes of carbon dioxide emissions annually.

Interventions by SIDBI and BEE under the World Bank-GEF project are instrumental in promoting energy efficiency in 25 clusters across India. The interventions carried out during the Phase - II (2015-17) and Phase - III (2017-19) have led to energy savings of 0.0122 million toe and has prevented 72,585 tonnes of carbon dioxide emissions annually.

Standards and Labeling

BEE initiated the Standards and Labeling (S&L) scheme for appliances and equipment in the year 2006, starting with voluntary appliances. During FY 18-19, there are 10 Mandatory appliances and 13 voluntary appliances. This scheme has led to savings of 55.7 BU of energy annually and remains the largest contributor to electrical energy savings. Color television, Room Air conditioner, and Refrigerator contribute to the maximum share of energy savings, among the labeled appliances. This programme has led to a reduction of 46 Mn tonnes of carbon dioxide emissions annually.

69 Energy saving of PAT Cycle – II is consolidated data for 535 DCs. For PAT Cycle III, it is assumed that 2/3 of the target savings would have been implemented till 2018-19. Further it is also assumed that only 90% of the notified industries for PAT cycle III will contribute to energy savings (balance 10% may have closed down or their energy consumption may have fallen below PAT threshold level prior to M&V phase). Similarly, for PAT Cycle -IV it is assumed that 1/3 of the target savings would have been implemented, and 90% of the notified industries will contribute to energy savings during 2018-19. These assumptions are based on trends observed in previous PAT cycles.

Table 78: Energy Savings in FY 18-19 for appliances sold during FY 2015-19[70]

Appliance	Savings (MU) due to sales of appliance in Financial Year				Total Savings (MU) in FY: 2018-19
	2015-16	2016-17	2017-18	2018-19[71]	
Mandatory Appliances					
LED LAMPS	-	28	65	-	93
Distribution Transformer	315.4	263	403	302	1283.4
Stationary Type Water Heater	299	410	472	344	1525
TFL	725	636	570	236	2167
Room AC (Variable Speed)	-	447	1461	593	2509
Frost Free Refrigerator	1428	1473	1967	1329	6197
Room AC (Fixed Speed)	3293	3364	3329	457	10443
Color Television	1463	1032	3806	2466	8767
Direct Cool Refrigerator	3568	4059	4459	3003	15089
Voluntary Appliances					
Submersible Pump Set	739	1310	1921	1481	5451
Open well Submersible Pump Set	287	368	426	371	1452
Computer	3.5	6	0	0	9.5
Monoset Pump	30.7	43	46	30	149.7
Ceiling Fan	104.3	162	191	106	563.3
Total Savings (BU)	**12.3**	**13.6**	**19.1**	**10.7**	**55.7**

Buildings

ECBC

Energy Conservation Building Codes - ECBC 2017 for new commercial building construction in India is estimated to lead to a 50% reduction in electricity use by 2030. Till FY 2018-19, 117 buildings have been registered under ECBC, of which, 23 buildings are completed and are ECBC compliant. 83 buildings are in design stage. The 23 constructed and ECBC compliant buildings with total area of 4.7 Million square feet have led to energy savings of 40 MU.

BEE Star Rating for Buildings

Under the BEE star rating scheme, existing buildings are being labeled as per their actual Energy Performance Indices (EPI) on a scale of 1 to 5 stars. The sets of standard EPI bandwidths developed to rate buildings under this scheme for different climatic zones indicate the range of variations. Till FY 2018-19, 261 buildings have been labeled under the programme. During FY 15-19, 24 Offices, 14 BPOs, 3 Hospitals, and one shopping mall have been certified with star label leading to energy savings of 82.5 MU.

Building Energy Efficiency Programme (BEEP)

EESL is implementing BEE star rated appliances to promote the energy efficiency in public buildings under Buildings Energy Efficiency Programme (BEEP), which was launched in May 2017 by the Indian Government. Till FY 2018-19, 6545 commercial buildings have been covered under this programme. Type

70 Energy saving estimated from LED is not included in total, these savings are reflected in UJALA program from 2018-19 onwards

71 Based on quarterly sales and respective operating hours of appliances

of commercial buildings covered under the programme includes Central Govt. Buildings, District Courts, PWD Buildings and Railway Stations. This programme has led to energy savings of above 110 MU during FY 2018-19.

Other Green Building Programs

There are 3 major Green Building Rating Systems in India, viz. IGBC, LEED and GRIHA. Energy Efficiency is a major component of these rating systems.

GRIHA: Till FY 2018-19, 1733 projects have been registered and 422 projects have been completed under GRIHA. 13 buildings with built up area of 0.9 million sqm have been completed under GRIHA rating during FY 18-19. These implementations resulted in energy savings of 69.9 MU.

LEED: Till date there are more than 2,900 registered and certified commercial projects participating in LEED, totaling more than 1.39 billion square feet. During the FY 15-19 total of 1478 buildings have been certified under the programme, having an area of 50 million square meters.

IGBC: Till 2019 more than 5,723 Green Building projects with a footprint of over 7.09 Billion sq. Ft are registered with the Indian Green Building Council (IGBC). Out of these, 1,932 Green Building projects are certified and fully functional in India.

UJALA

EESL, under UJALA programme, is promoting energy efficiency through LED lamps, Energy efficient tube lights and energy efficient fans. EESL has sold 34.7 Crore LED lamps during the FY 2015-19. This programme has saved over 44.65 BU and has led to avoidance of 37 million tonnes of carbon dioxide emissions annually.

SLNP

Street Lighting National Programme (SLNP) is being implemented in 28 States/UTs, to replace the conventional street-lights with BEE

Table 79: Energy savings from UJALA programme[72]

Year	Energy savings (MU)			
	LED lamps	LED Tube lights	EE Fans	Total
FY 15-16	10,867			10,867
FY 16-17	15,883	55	53	15,938
FY 17-18	10,195	153	99	10,348
FY 18-19	7,436	57	55	7,493
Total	**44,381**	**264**	**207**	**44,646**

Table 80: Energy savings from Street Lighting National Programme

Financial Year	Number of Installations	Number of States	Annual energy saving MU in FY 2018-19
2015-16	5,00,000	6	336
2016-17	13,92,587	21	934
2017-18	35,10,683	28	2356
2018-19	30,13,210	24	2022
Total	**84,16,480**	**28**	**5647**

72 Energy Savings due to fans is considered under S&L programme

star rated energy efficient street-lights with no upfront cost to the ULBs. Working on an ESCO based model, EESL will recover the cost from the savings generated by the replacement of street-lights. This programme has saved over 5.65 BU and has led to avoidance of 4.6 Mn tonnes of carbon dioxide emissions annually.

Agriculture

BEE has made significant efforts towards mandating the use of EE pumps in agriculture by involving state regulatory commissions. Under AgDSM programme, BEE is organizing training programs for pump technicians who have a major role to play in replacing old inefficient pumps with BEE star rated pump sets. BEE and ICAR has signed an MoU to conduct training and awareness programs for farmers to promote the use of EE agricultural pump sets

Under AgDSM programme EESL has been retrofitting BEE star rated pump sets in Andhra Pradesh, Karnataka, and Uttar Pradesh, during FY17-19. A total of 63,615 energy efficient star rated pump sets have been installed, which has led to energy savings of 0.11 BU and avoidance of 0.09 Mn tonnes of carbon dioxide emissions.

Transport

Corporate Average Fuel Economy (CAFE)

Several initiatives in improving the fuel efficiency norms for vehicles had been carried out in recent years. In 2015, the government of India established corporate average fuel consumption standards for passenger cars taking effect as two-phase targets for FY 2017–2018 and for FY 2022–2023 onward. In August 2017, CAFÉ Norms were established for Heavy Duty Vehicles (HDV), and in 2019 these Norms were established for light commercial vehicles.

The standard for a manufacturer is set in terms of gasoline-equivalent liters per 100 kilometers (L/100 km) based on vehicle curb weight. This intervention has led to saving of 0.848 Mtoe during FY18-19.

Faster Adoption and Manufacturing of Electric Vehicles (FAME)

FAME I and FAME II have been developed to promote electric vehicles (EV) and EV charging infrastructure towards cleaner road transport. This program has led to energy savings of 0.06 Mtoe and 0.04 Mn tonnes of carbon dioxide emission reductions during FY18-19.

BEE is also supporting various projects to promote EV charging infrastructure across the country. These initiatives aim to provide impetus for Indian e-vehicle manufacturers, charging infrastructure companies, service providers, etc. to gain efficiencies of scale and drive down costs in the electric mobility ecosystem.

11.1 Impact of various energy efficiency measures undertaken during 2018-19

Energy consumption across all the sectors of the economy has increased in the past few years and with growing economy & rapid urbanization, it is expected to increase further in the coming years. Total energy consumption of India is estimated as 581.6 Mtoe and the total primary energy supply stands at 879.23 Mtoe during FY 18-19[73]

Energy Savings (in 'Demand Side' Sectors)

The energy efficiency schemes at national as well as state level carried out by BEE and other agencies has led to the reduction of 16.54 Mtoe in the demand side energy consumption, amounting to 2.84% of the energy demand (581.6 Mtoe) during 2018-19. A comparison of

Table 81: Sector wise energy savings vis-à-vis energy consumption in demand-side sectors

Sector	Energy Consumption in FY 2018-19 (Mtoe)	Energy[74] savings in FY 2018-19 (Mtoe)	% Savings[75]
Industry (Excluding TPP, DISCOMs, and Refineries)[76]	324.10	6.33	1.95%
Domestic (S&L and UJALA)	52.85	7.91	14.97%
Commercial Buildings (Including buildings under PAT)	8.78	0.12	1.38%
Agriculture (Star Rated Pumps)	19.36	0.61	3.13%
Transport (Including Railways)	55.68	1.08	1.94%
Others (Including Municipal)	120.84	0.49	0.40%
Total	**581.60**	**16.54**	**2.84%**

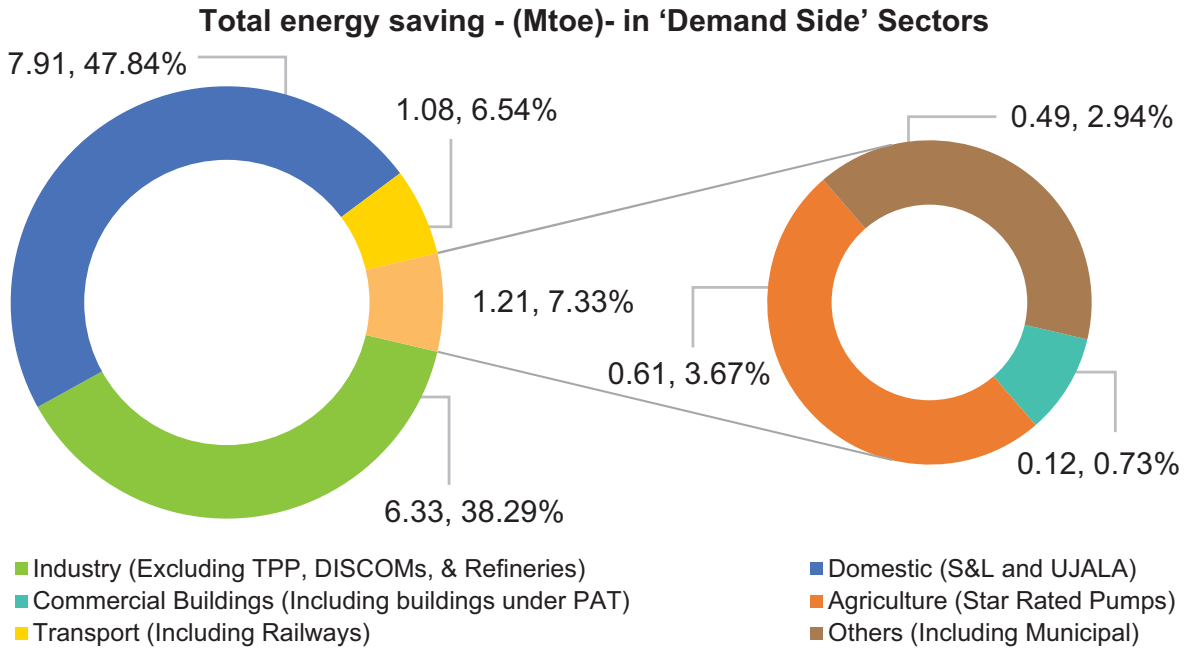


Figure 64: Share of Energy Savings across sectors of the economy

73 5% escalation is considered over the data reported by MoSPI for FY 2017-18 (for both Demand and Supply)

74 Total energy including thermal and electrical energy

75 W.r.t. total energy consumption in respective sector during 2018-19

76 Energy Savings from TPP, Refineries & DISCOMs is not considered here, as these are 'supply side' sectors of the economy

the energy savings across various sectors of the economy vis-à-vis energy consumption is presented in Table 82.

Industry sector has contributed to 38.29% of the total energy savings while domestic sector has contributed to 47.84% of the total savings achieved during FY 18-19. While, remaining sectors contributed to around 14% of total energy savings for 2018-19.

Electrical Energy Savings (in 'Demand Side' Sectors)

Adoption of energy efficiency schemes/ programmes as considered for this study has reduced the overall electricity consumption by 113.159 BU. This has led to the reduction of 9.4% of the electrical energy requirement (1204 TWh)[77] across various sectors of the economy in 18–19.

Table 82: Sector wise electrical energy savings (BU) vis-à-vis consumption in demand-side sectors

Sector	Electrical Energy Consumption (BU)	Electrical Energy Savings 2018-19 (BU)	% Savings[78]
Industry (Excluding TPP, DISCOMs, & Refineries)[79]	499.3	6.34	1.27%
Domestic (S&L and UJALA)	291.4	92.00	31.57%
Commercial Buildings (Including buildings under PAT)	102.4	1.41	1.37%
Agriculture (Star Rated Pumps)	217.6	7.05	3.24%
Transport (Including Railways)	15.3	0.71	4.62%
Others (Including Municipal)	77.8	5.65	7.26%
Total	**1204.00**	**113.159**	**9.40%**

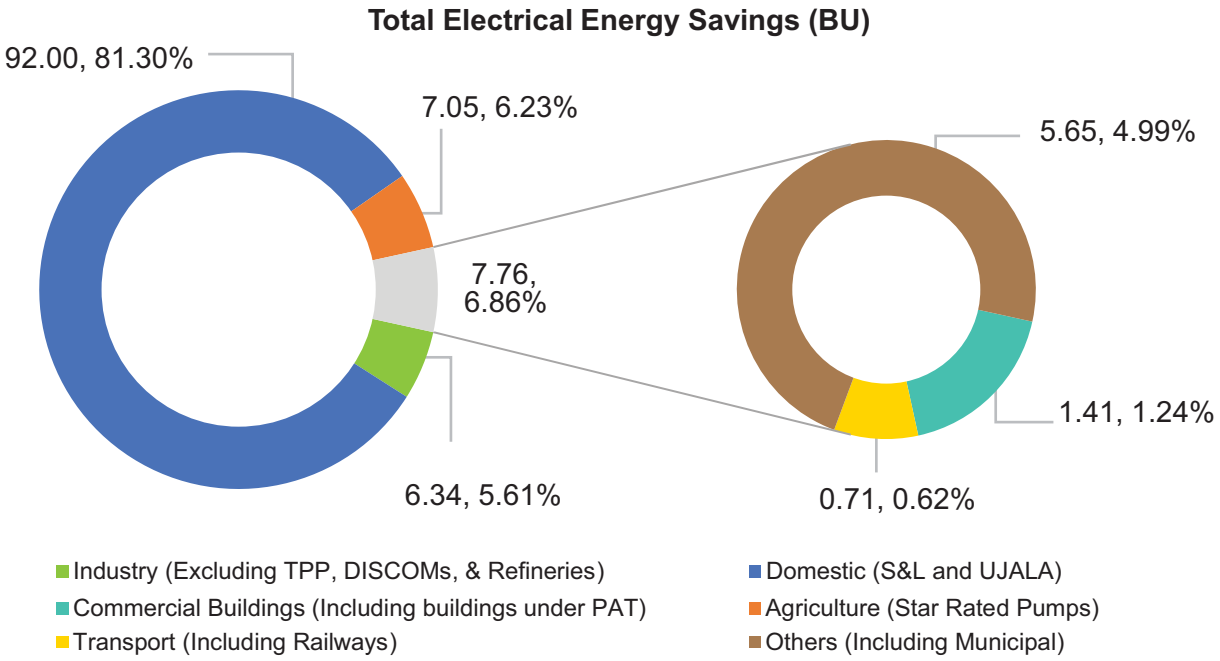


Figure 65: Share of Electrical Energy Savings across sectors of the economy

77 1204 TWh is calculated by inflating the energy consumption values of 2017-18 by CAGR of 6.51 (2016-17 to 2017-18) as reported in MoSPI 2019 statistics. (Table 6.9: Consumption of Electricity by Sectors in India)

78 W.r.t. total energy consumption in respective sector during 2018-19

79 Electrical savings from DISCOMs, & Refineries are considered for supply side and not considered here

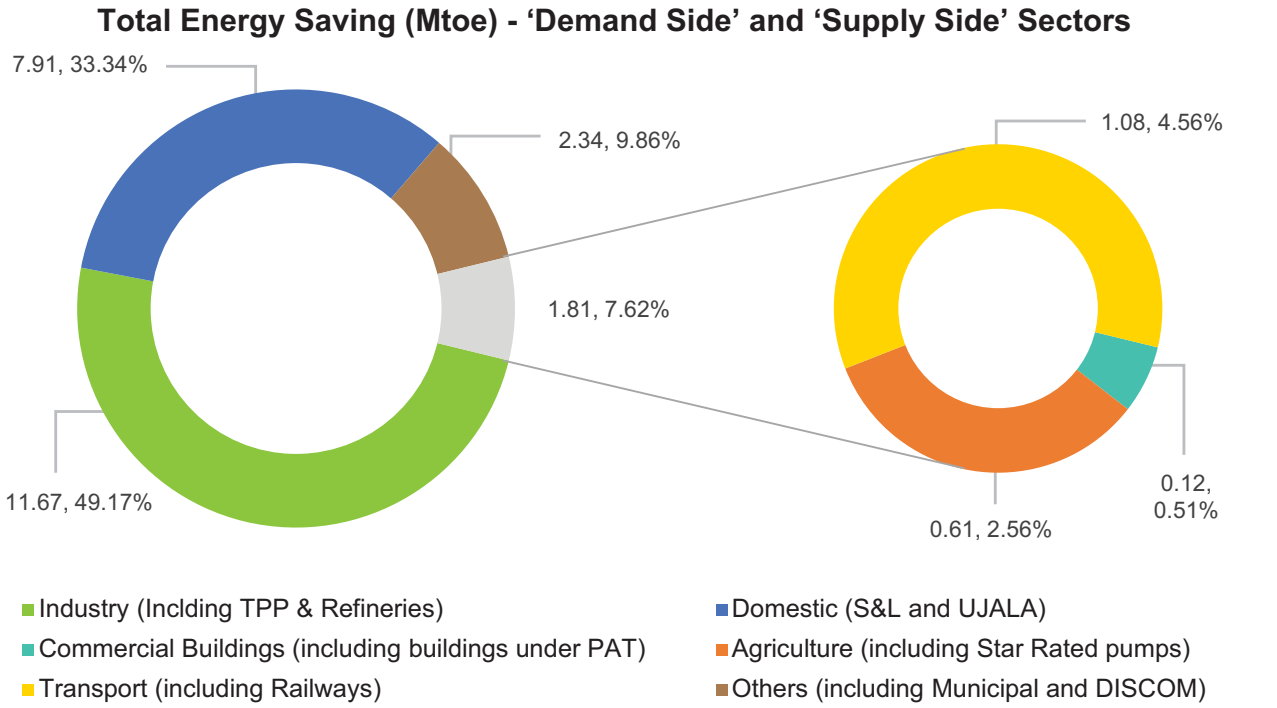


Figure 66: Share of Energy Savings across Sectors of the Economy (Including Supply Side)

Domestic sector has the highest contribution (81.3%) in the total electrical energy savings from all energy efficiency interventions carried out during FY 2018-19.

Total Energy Savings (Including Supply Side)

Similarly, Energy savings at the supply side has been achieved in the order of 23.728 Mtoe (inclusive of demand side energy savings). These energy savings amount to 2.69% of the total primary energy supply (879.23 Mtoe) during 2018-19.

11.1.1 Way Forward

With the GDP expected to grow at around 6%, the gap between energy supply and energy demand can be fulfilled by enhancing the efficiency of energy usage. Advances in technological excellence, engineering and capability will further help these demand sectors to achieve the global benchmark in energy efficiency and steadily reduce the energy intensity.

With this understanding, the Bureau of Energy efficiency has developed a National Strategy Plan Titled Unlocking National Energy Efficiency Potential (UNNATEE). As per the report, India's energy saving potential is estimated to be 86.9 Mtoe in case of a "moderate" implementation of EE programs and 129 Mtoe in case of an "ambitious" implementation of EE programs by year 2031 which stands at 15% reduction in energy demand as compared to BAU approach to energy savings are presented in Table 83

Table 83: Energy Savings Potential till 2031 in various scenarios

Sector	Energy Savings Potential by year 2031 w.r.t baseline year as 2016-17	
	Moderate Scenario (in Mtoe)	Ambitious Scenario (in Mtoe)
Agriculture	5.7	9.9
Commercial	4.9	6.4
Domestic	12.1	15.1
Municipal	0.1	1.5
Industrial	47.5	72.3
Transport	15.8	23.8
Total	**86.9**	**129**

The current policy and program implementation landscape of the country shapes the energy consumption of the demand sectors. Therefore, consolidated values of energy savings achieved for all energy efficiency programmes/schemes that are currently active and supporting the country to achieve NDC targets are compared with energy savings target for various demand sectors and presented in Table 84

Table 84: Comparison with UNNATEE

Sector	Energy Savings Potential[80] w.r.t baseline year, 2016-17 (Mtoe) till 2031	Pro-rata[81] Energy Savings Targets (Mtoe) for two years (2017-19)	Total Savings (Mtoe) for Last two Years (2017-19)	Achievement as compared to the target energy savings (Mtoe)
	(A)	(B)=(A)*14.3%	(C)	(D)=(C)-(B)
Agriculture	5.7	0.82	0.69	(0.13)
Commercial	4.9	0.70	0.22	(0.48)
Domestic	12.1	1.73	4.11	2.38
Municipal	0.1	0.01	0.49	0.48
Industrial	47.5	6.79	12.5	5.71
Transport	15.8	2.26	1.09	(1.17)
Total	**86.9**	**12.43**	**19.1**	**6.66**

This shows current schemes/programs are largely successful in achieving significant energy savings across various sectors viz. Industry, building (domestic and commercial), municipal, agriculture, and transport. However, it is possible that the future landscape would be driven by disruptive technologies and economic mega-trends such as smart cities, e-mobility etc. which are changing the dynamics of energy sector.

Activities to operationalize the National Strategic Plan on Energy Efficiency would not only focus on available technology to make such improvements but would also include relatively new technologies such as E-mobility, fuel cell vehicles (FCVs), integration of renewables & storage, net zero buildings, district cooling, smart meters, internet of things, active appliance feedback, blockchain technologies etc. for decarbonizing various sectors of the economy.

80 Moderate scenario

81 Energy Savings targets are for 14 years from 2017 to 2031. Pro-rata savings are considered for two years (2/14)%= 14.3%

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