सत्यमेव जयते
Government of India

IMPACT OF ENERGY EFFICIENCY MEASURES

FOR THE YEAR 2019-20

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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 enactment 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 the initiating National Mission for Enhanced Energy Efficiency (NMEEE).

Rolling out several schemes to conserve energy is one aspect but assessing their impact on ground help to understand their actual effectiveness. Therefore, an impact assessment of all the schemes related to energy efficiency is required. In financial year 2016-17, BEE had conducted first, third -party assessment of annual energy savings of its own set of schemes for the period 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 various energy efficiency schemes, Government of India directed BEE to **conduct a study comparing the actual energy consumption in particular year with the estimated energy consumption had the current energy efficiency measures were not been undertaken i.e. counterfactual.**

In compliance to this direction, BEE hired the services of an expert agency to conduct this study for the financial year 2019-20. The overall objective of this study was 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 2019-20.

The objective of this study is to assess the overall impact of all the energy efficiency schemes at national as well as state level for the financial year 2019-20 and compare it with a situation where the same were not been implemented. This study focused 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 Programme, GEF – World Bank Programme, Agriculture Demand Side Management Programme, and Municipal Demand Side Management Programme.

I hope this document will provide valuable information to the policy makers. I invite inputs from various stakeholders, to make this exercise more effective and meaningful in coming years.

March 2021
New Delhi

(Abhay Bakre)
Director General
Bureau of Energy Efficiency

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
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	Unlocking National Energy Efficiency Potential
UT	Union Territories
VLT	Visible Light Transmittance
W	Watt
WBP	Whole Building Performance
Yr	Year

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Executive Summary

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

India has remained progressive and one of the front runners to achieve its energy efficiency potential, through innovative programmes such as PAT scheme, Standard & Labeling, UJALA scheme, Energy Conservation Building Code, Electric Vehicle Mission and Smart Metering etc. However, the rhythm and momentum of this energy transition has been marginally impeded by the COVID-19 pandemic during the last quarter of FY19-20.

At country level, there is still an immense potential to be realized from large scale implementation of energy efficiency interventions in the various demand sectors like industry, agriculture, transport, municipal, domestic & commercial lighting and appliances and Micro, Small and Medium Enterprises. This should help to at least limit the energy imports and perpetual headlong rush towards new production capacities which still require heavy investment and significant financing.

The coronavirus pandemic has also taught a lesson to the world that globalization is important but being self-reliant is also necessary. The Government of India is implementing reforms towards a secure, sustainable and affordable energy system to power a robust economic

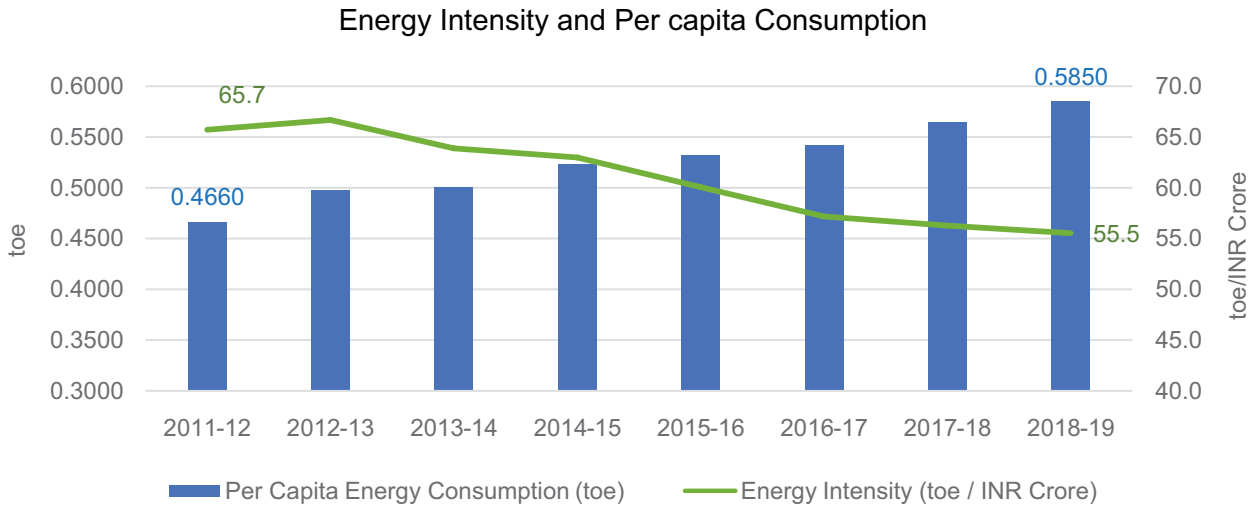


Figure 1: Energy intensity and Per capita Consumption trend

growth. Government of India has notified broad policies and regulations for promotion of energy efficiency in India.

Bureau of Energy Efficiency (BEE) has been engaged in several initiatives to design and implement energy efficiency programs, as well as there are complimenting programs by other agencies, a direct consequence of which can be observed in the declining trend of India's energy intensity.

During the years 2011-12 to 2018-19, India's energy intensity decreased from 65.5 toe per INR crore to 55.5 toe per INR crore Figure 1[1], this decline is largely attributed to the deployment of energy efficiency programmes among other factors.

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

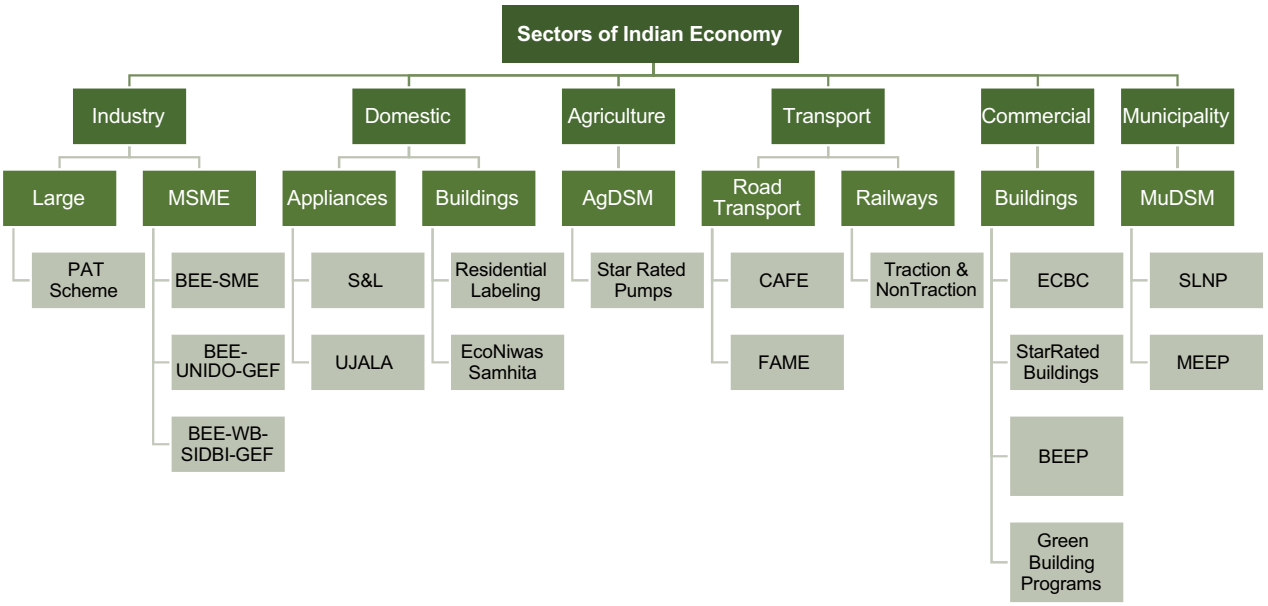


Figure 2: Energy Efficiency Schemes in India

1 Energy Statistics, 2020. Here we considered 1 toe = 41,840.00 MJ

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 2019-20 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 of CO_2 emissions during FY 2019-20. In order to assess the impact, agency has carried out the following tasks:

- Review of all the 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 as mentioned in figure 2.

Estimated Energy Savings for 2019-20

The adoption of energy efficiency schemes/ programmes has led to the overall energy savings of 28.06 Mtoe for the year 2019-20. Savings from various schemes and interventions are presented in Table 1.

Table 1: Summary of energy savings (2018-19)[2]

Name of the scheme / programme		Energy Savings Thermal (Mtoe)	Energy Savings Electrical (BU)	Total Savings (Mtoe)	Emission Reduction ($MtCO_2$)	Monetary Savings (INR Crore)
PAT Scheme	Demand side sector	7.193	8.176	7.896	35.939	18142
	Supply side sectors - TPP, DISCOMs & Refineries	7.121	29.772	9.681	51.015	30967
MSMEs	BEE-SME Programme	0.001		0.001	0.004	2
	BEE-UNIDO-GEF Programme	0.011		0.011	0.047	19
	BEE-WB-GEF Programme	0.012		0.012	0.073	22
Standards and labeling Programme		0.008	65.009	5.599	53.307	39020
UJALA Programme**			35.047	3.014	28.739	21028
ECBC – Commercial buildings programme			0.116	0.010	0.095	69
BEE Star rating buildings			0.179	0.015	0.146	107
Building energy efficiency programme			0.212	0.018	0.174	127
Other Green Building Programmes			0.070	0.006	0.057	42
MuDSM (Street Lighting Programme)			6.841	0.588	5.610	4105
AgDSM (Star Rated Pumps)			0.180	0.015	0.148	108
Corporate Average Fuel Economy (CAFE)		1.200		1.200	2.650	2208
FAME Scheme		0.042		0.042	0.077	77
Total		**15.59**	**145.03**	**28.06**	**177.60**	**115,702**

2 Savings 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).

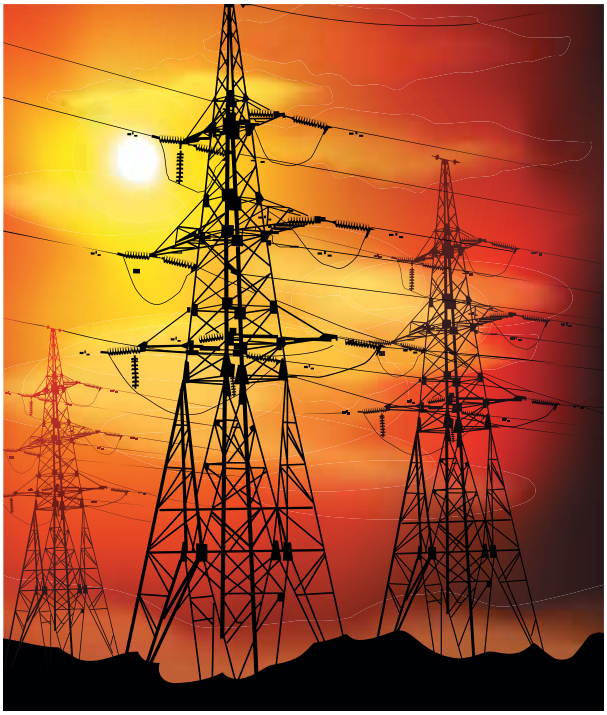
**Savings from LEDs under UJALA programme is considered here, LED industry has sold approximate 126 crore LEDs apart from UJALA till Jan 2020. Sales of these LEDs led to reduction of approximately 133 Mn tonne of CO_2.

The 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 15.59 Mtoe, while overall electricity savings are to the tune of 145.03 BU. Overall, these energy savings translated into monetary savings of worth INR 115,702 crores. The equivalent reduction in CO_2 emissions is around 177.6 Million Tonnes annually.

PAT scheme contributed to 62.64% of the total energy savings, while S&L and UJALA accounted for 30.53% of the total energy saving from all major interventions carried out during the FY19-20. Share of various schemes in the total Energy savings is presented in Figure 3.

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 18.38 Mtoe in the demand side energy consumption, amounting to 3.14% of the energy demand (585 Mtoe[3]) during the 2019-20. Similarly, energy savings at the supply side has been



achieved in the order of 28.06 Mtoe (inclusive of demand side energy savings). These energy savings amount to 3.03% of the total primary energy supply (926 Mtoe[3]) during 2019-20.

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

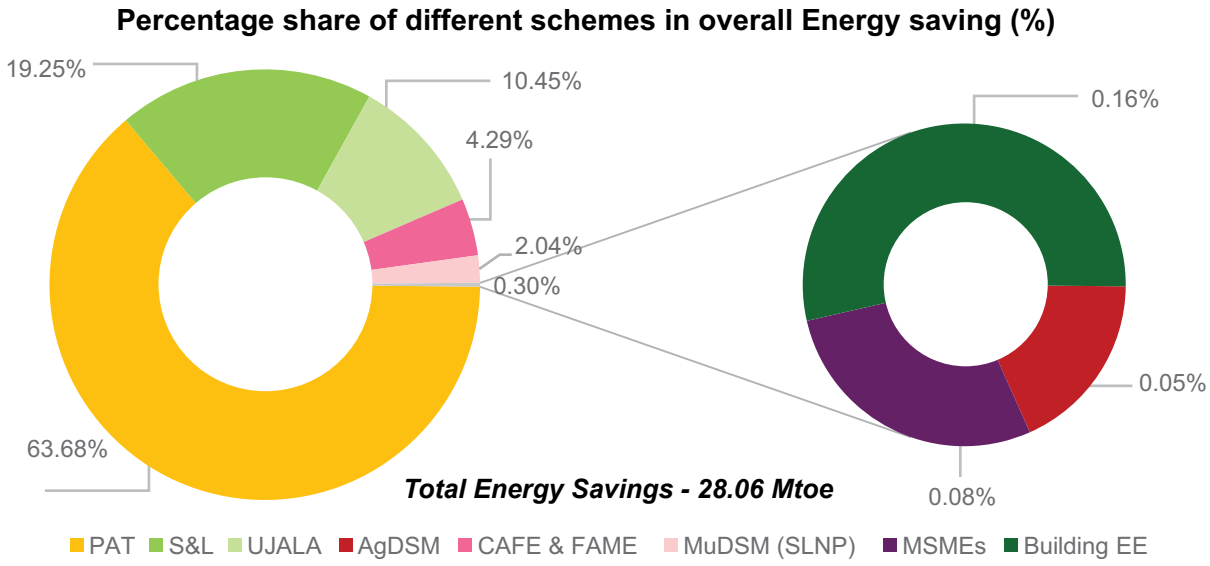


Figure 3: Total energy savings (Mtoe) by Scheme / Programme (2019-20)

3 This is considered with assumption of 2.73% increase YoY on energy values of 2019 taken form MoSPI report.

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)	Estimated monetary savings (INR crore)
Industry[4]	14.202	9.068	14.98	62.35	31,573
Domestic[5]	0.008	89.803	7.73	73.62	53,896
Commercial Buildings[6]	0.000	1.723	0.15	1.41	1,034
Transport (including Railways)		8.714	0.75	7.15	5,230
Others (including Municipal and DISCOM)	1.377	0.707	1.44	4.34	2,958
Agriculture (including Star Rated pumps)		35.015	3.01	28.71	21,010
Total	**15.59**	**145.03**	**28.06**	**177.6**	**115,702**

Industry sector has the highest contribution with share of 53.39% in total energy savings while domestic sector contributed to 27.55% of total savings achieved during FY 19-20.

Various energy efficiency interventions carried out in industry sector contributed to 35.1% and schemes under domestic sector contributed to 41.5% of the total emission reductions.

Emission reductions from the various schemes is presented in Figure 4

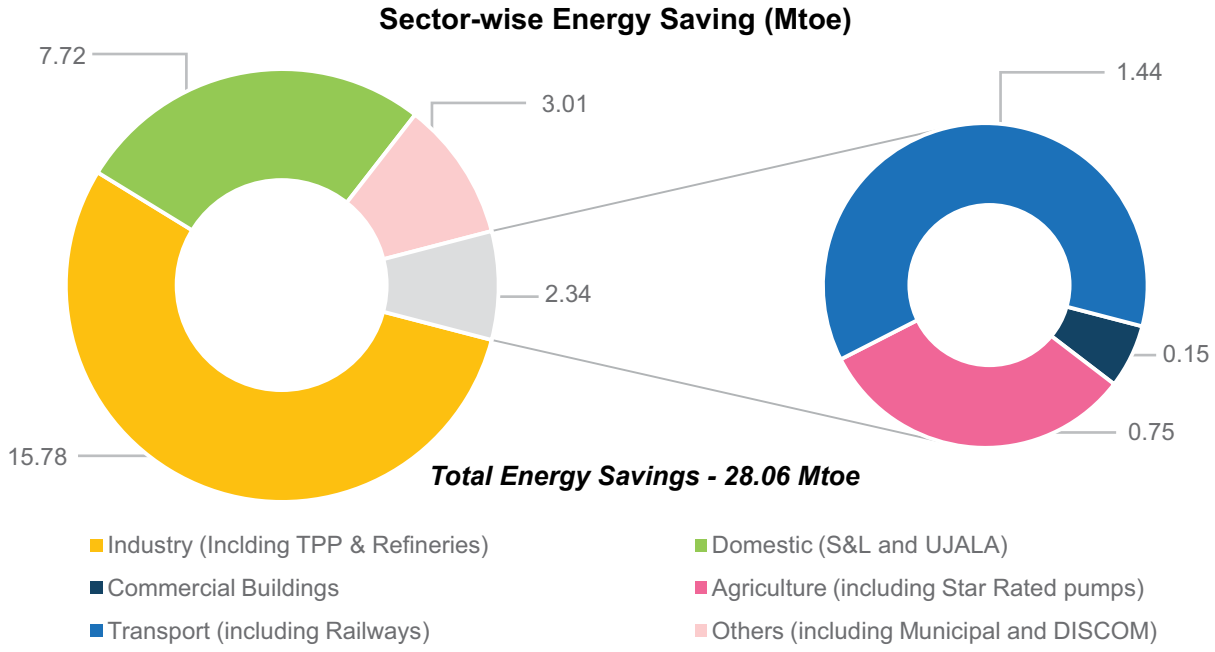


Figure 4: Total Energy Savings by Economic Sectors (2019-20)

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

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

6 Including saving from DTs

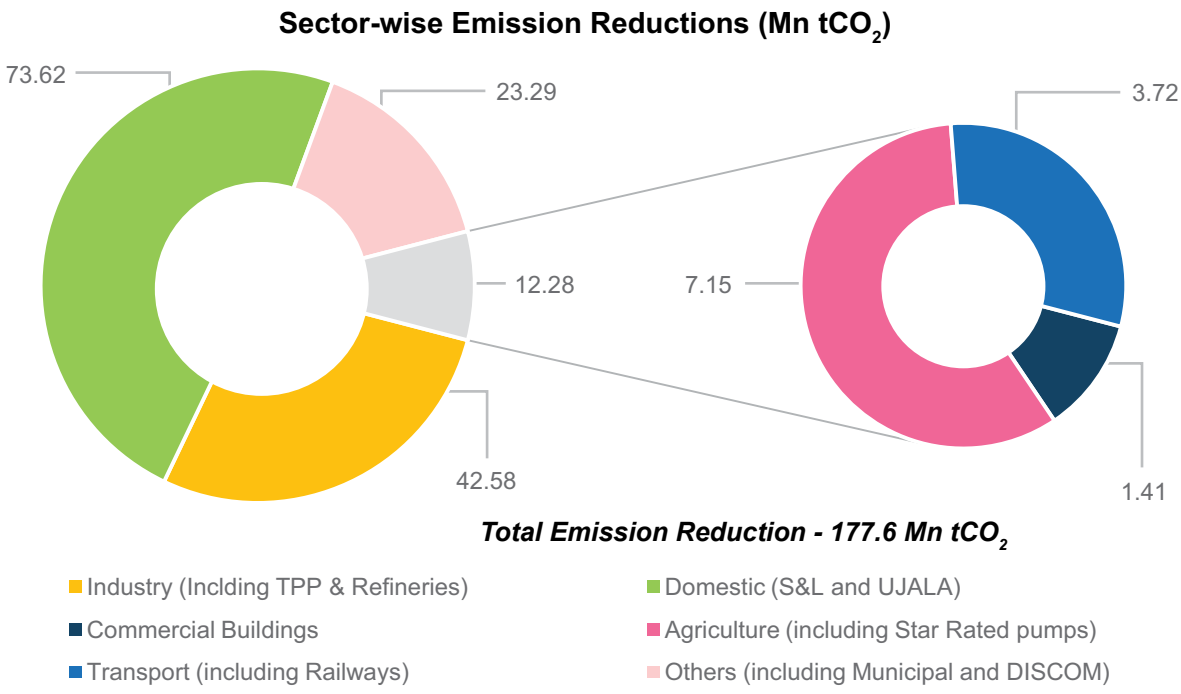


Figure 5: CO_2 Emission Reductions by Economic Sectors (2019-20)

Impact of various Energy Efficiency Interventions in India

Based on the energy savings data provided in the previous section, it is evident that all these schemes/programmes, were 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

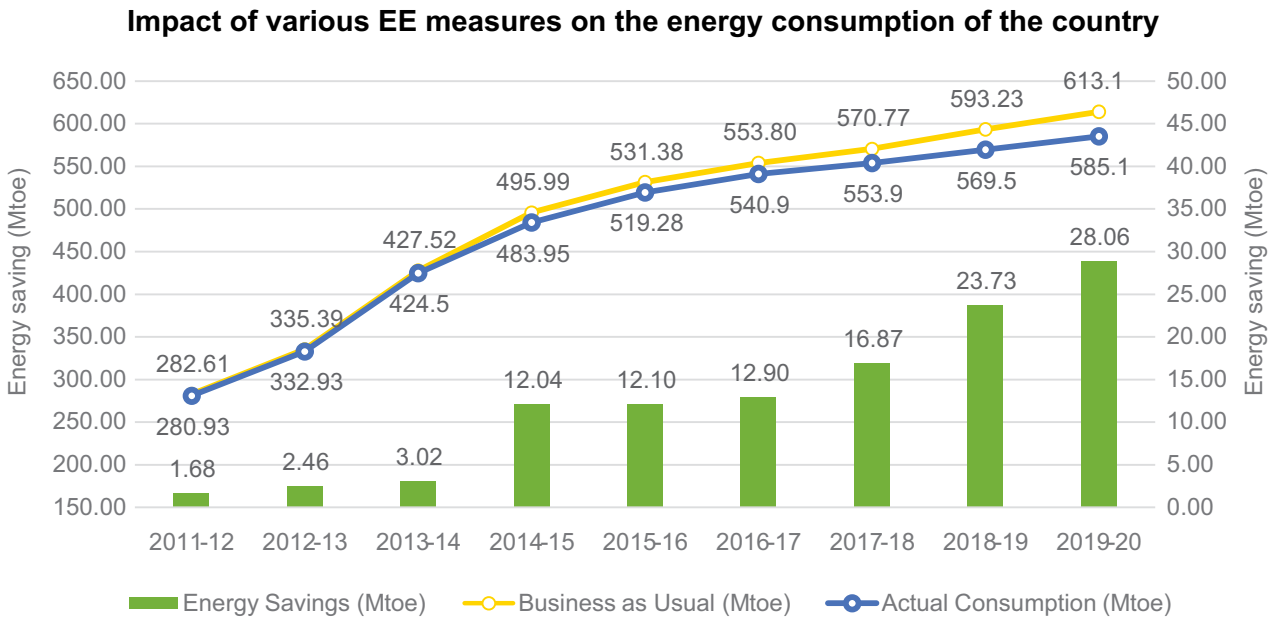


Figure 6: Impact of various EE measures (Mtoe)

to 2019-20 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.

Way forward

The Government of India has made impressive progress in recent years in increasing citizens' access to electricity and clean cooking. Looking ahead, the government has laid out an ambitious vision to bring secure, affordable and sustainable energy to all its citizens.

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 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. The consolidated values of energy savings achieved for all these schemes during last 3 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

Table 3: Comparison with UNNATEE

Sector	Energy Savings Potential[7] w.r.t baseline year, 2016-17 (Mtoe) till 2031	Pro-rata[8] Energy Savings Targets (Mtoe) for three years (2017-20)	Total Savings (Mtoe) for Last three Years (2017-20)	Achievement as compared to the target energy savings (Mtoe)
	(A)	(B)=(A)*21.4%	(C)	(D)=(C)-(B)
Agriculture	5.7	1.22	0.75	(0.47)
Commercial	4.9	1.05	0.15	(0.90)
Domestic	12.1	2.60	7.73	5.14
Municipal	0.1	0.02	3.01	2.99
Industrial	47.5	10.19	14.98	4.79
Transport	15.8	3.39	1.44	(1.95)
Total	**86.9**	**18.47**	**28.06**	**9.59**

and commercial), municipal, agriculture, and transport. However, in 2020, the coronavirus pandemic has exacerbated many of the existing challenges the energy sector faces to its financial and physical resilience.

India has suffered the devastating impacts of Covid-19, raising health, economic and social challenges. However, as the Indian economy is coming back to pre-Covid levels, the resilience of the power sector has become critical. It is this crisis and the government's response that could create the strongest momentum for energy efficiency reforms in coming years.

It is possible that the future landscape would be driven by disruptive technologies due to change in behavior post Covid such as remote production, process automations, economic mega-trends such as industry 4.0, e-mobility which will change the dynamics of energy sector.

BEE's National Strategic Plan on Energy Efficiency includes these 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.

Energy saving through adoption of new technologies, increasing the scope of the wide gamut of energy related programs and sensitizing the consumers towards the importance of saving energy in their day-to-day lives would go a long way in making India energy secure, self-reliant and resource efficient.

7 Moderate scenario

8 Energy Savings targets are for 14 years from 2017 to 2031. Pro-rata savings are considered for two years (3/14)%= 21.4%

CHAPTER 1

Introduction

India is becoming more self-reliant in the area of effective energy transition. The increase in demand and high volatility in prices of coal, gas & oil has led India to adopt two-pronged approach for enhancing its energy security by increasing its focus on improving energy intensity and also enhancing the share of renewable energy[9] sources in energy supply.

This two-pronged 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.

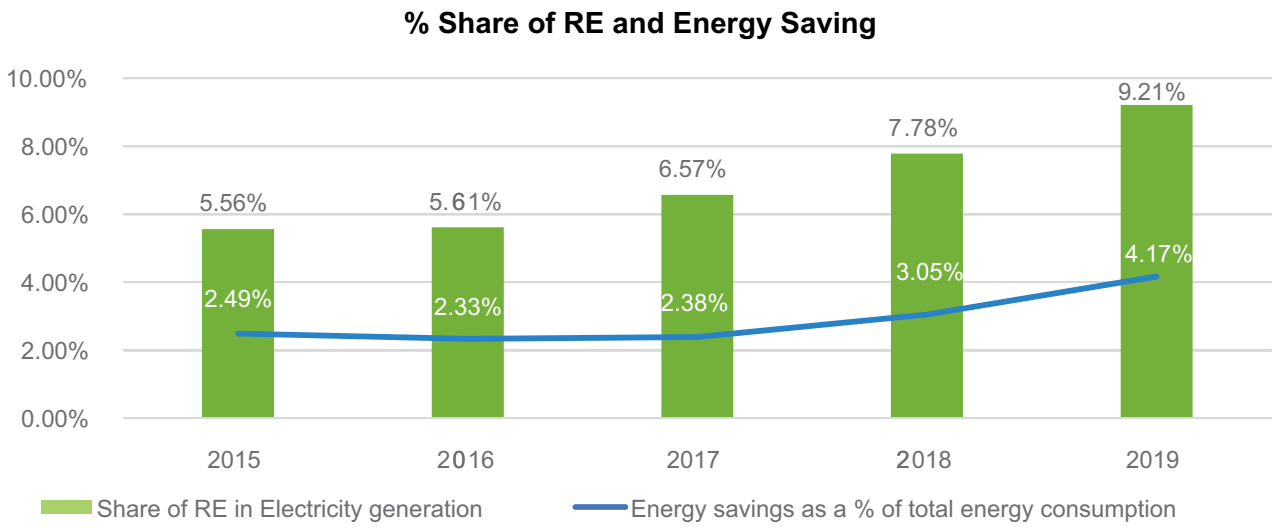


Figure 7: Energy Saving as % of total Energy consumption and Share of RE in Electricity generation

9 Energy Statistics Reports from 2015 to 2019 published by MoSPI

The diverse challenges facing the energy security today cannot be addressed by a single government, industry, company or other institution alone. In order to achieve its energy vision, several ministries and different energy sector stakeholders are working in tandem for building a strong foundation for the same.

The direction that national and state policies take, and the rigor and effectiveness with which they are implemented, plays a critical role in India's energy outlook. 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 BEE and then initiating the National Mission for Enhanced Energy Efficiency (NMEEE), all aided by consistent improvements in the quality of Indian energy data.

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 such as Performance Achieve and Trade (PAT) scheme, ECBC for residential & commercial sector, Standards & Labeling programme for appliances, and conducive policies for clean transport (EVs) etc.

On the occasion of 19th foundation day, BEE has expanded the coverage of S&L programme by including two new appliances (total 26) under voluntary regime i.e. energy efficient "Deep Freezers" and "Light Commercial Air Conditioners (LCAC)".

During the event, Urja Dakshata Information Tool (UDIT) (www.udit.beeindia.gov.in), was also launched to facilitate a database on energy efficiency, a user-friendly platform that explains the energy efficiency landscape of India across industry, municipal, appliances, building, transport and agriculture sectors.

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 2019-20.

Though it is difficult to estimate the impact of energy savings from the indirect effect of some

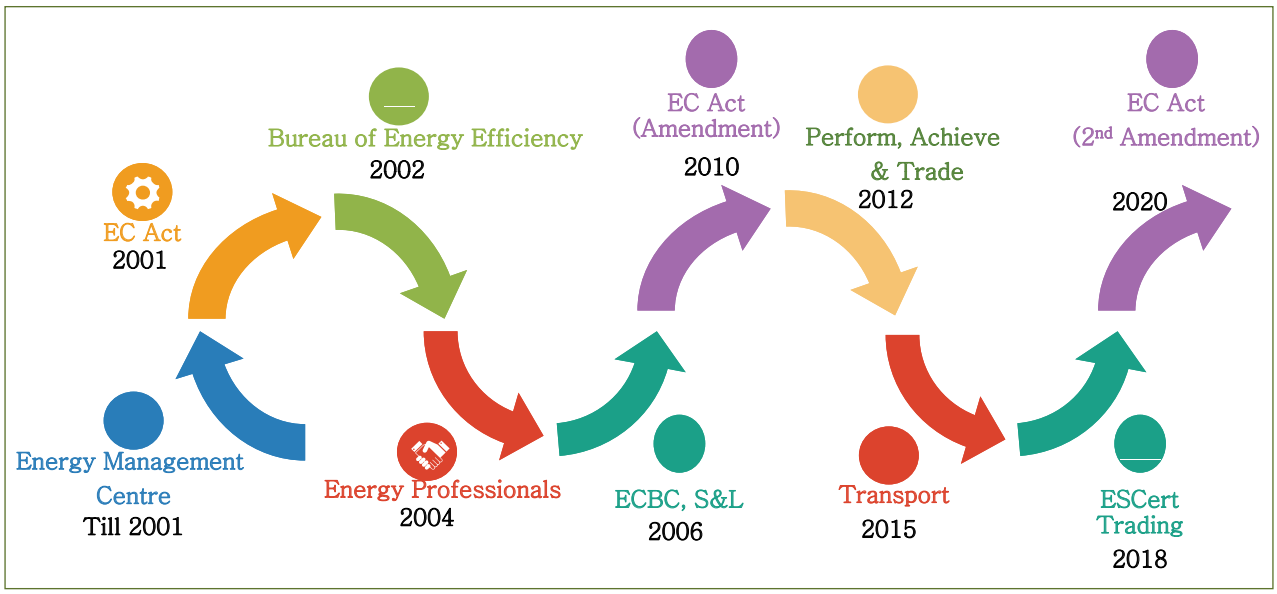


Figure 8: Chronograph of EE policies and programs in India

Table 4: Status of major EE schemes and programmes

Sector/ Sub-sector	Schemes/ Programs	Status as on FY 2019-20
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, 542 DCs out of total 621 DCs were analyzed for M&V. • PAT Cycle-III added 116 more DCs out of these M&V of 90 DCs have been completed. • PAT Cycle IV, V & VI added 109, 110 and 117 DCs respectively, which makes the total number of DCs till PAT Cycle VI = 1073.
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 23 MSME clusters including - Hand tools, Ceramics, Dairy, Foundry, Brass. • 599 small scale energy efficient projects implemented in the clusters as on 31st March 2020.
	GEF – World Bank – BEE Programme	• Project implemented the EE measures across 25 Clusters.
Domestic- Lighting & appliances	Standards & Labeling (S&L)	• Total 26 appliances in this programme covered on 31st March 2020. • 10 appliances under Mandatory regime. • 16 appliances under voluntary regime.
	UJALA	• 27.4 Crore LED lamps were distributed during 2016-20. • 75.9 lakhs LED tube-lights and 23.4 EE fans were also distributed under UJALA programme during 2016-20.
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.
Commercial- Buildings	**ECBC– Commercial Building**	• As on 31st March 2020, technical assistance has been extended to 284 buildings by ECBC cell and 365 buildings have been supported by ULB's. • 54 buildings completed as ECBC compliant by March 2020.
	BEE – Star Rating Programme	• Offices, Hospitals, Shopping malls and BPOs are part of this programme. • 264 existing commercial buildings across India have adopted BEE Star ratings 31st March 2020.
	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)	• 74,399 (5 HP) pumps along with smart control panels have been installed as on 31st March 2020.

Sector/ Sub-sector	Schemes/ Programs	Status as on FY 2019-20
Municipality- Lighting & Appliances	MuDSM- (SLNP)	• Over 101.9 lakhs LED street-lights were replaced under SLNP across 28 States & UTs during 2016-20.
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 (LCV).
	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 lakhs vehicles were supported. • Upgradation of Public EV charging infrastructure for faster adoption of EV. • FAME II was launched in 2019, 17393 EV were supported in FAME II as on 31st March 2020. • 2636 Public EV charging stations have been sanctioned under FAME II and 811 LOA's were issued as on 31st March 2020. • EESL, REIL, NTPC and other local state governments are supporting the development of Public EV charging infrastructure under FAME II.
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.

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 2019-20 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, ICAT, 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 2019-20. 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
MoMSME	EESL -UNIDO -GEF 5
CEA	Electricity generation data
Ministry of Railways	EE initiatives in Traction and Non-traction system

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

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[10]
Cost/toe = INR 18,402
Cost/kWh[11] = INR 6.00
Net energy (Total)[12] consumption in 2019-20 = 585 Mtoe
Net energy supply in 2019-20 = 926 Mtoe
Electricity (Total)[13] consumption in 2019-20= 1186.9 TWh
Emission factor for LPG[14] – 63.1 tonne of CO_2/ TJ

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

11 https://pfcindia.com/Home/VS/29 (PFC report 2018-19)

12 This is considered with assumption of 2.73% increase YoY on energy values of 2019 taken form MoSPI report.

13 This is considered with assumption of 2.48% increase YoY on energy values of 2019 taken form MoSPI report.

14 http://www.ghgplatform-india.org/data-and-emissions/electricity-and-energy/Worksheet_Others%20sector_%20V%2015.07.2016%20GHG%20platform%20India.xlsx and https://www.ceew.in/sites/default/files/GHGPI_Industry_Sector_State_Level_Methodology.pdf

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 2019-20. Chapter 10 covers various initiatives undertaken in states by SDAs and other agencies. Finally, chapter 11 concludes along with the way forward.

CHAPTER 2

Industries

India under the Paris Agreement has pledged to improve the emissions intensity of its GDP by 33 - 35 % by 2030 (as compared to 2005 baseline). Achieving these ambitious emissions reduction targets needs inclusive efforts by industrial consumers, which also happen to be the largest consumers of primary energy in India (56% energy demand).

Needless to say, Industrial consumers will also be the front-enders when it comes to sharing the targets, either through regulations, or in context of global pressure and even voluntarily. The rising quantum of energy consumed by the industrial consumers signifies the immense potential for energy conservation across industrial sector.

BEE 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 under "moderate" implementation of EE programs by year 2031. As per this report, industrial sector will contribute an estimated 60% of the estimated energy savings potential.

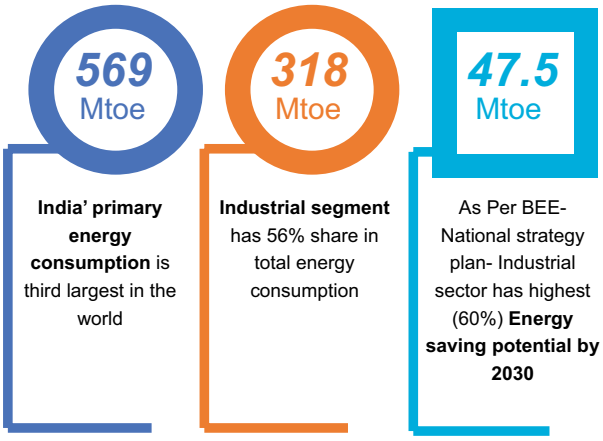


Figure 9: Energy Consumption Scenario

Bureau of Energy Efficiency (BEE) has notified broad policies for promotion of Energy Efficiency (EE) in India. Industrial segment is one of the focus sectors of the BEE to enhance 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.

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

EE in industrial sector has gained significant momentum with policy focus coming-in through schemes like Perform, Achieve and Trade (PAT). While, energy efficiency in the MSME sector has remained on the programme agenda of several institutions, including BEE, World Bank, UNIDO and UNDP etc. for a significant time now.

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 10:

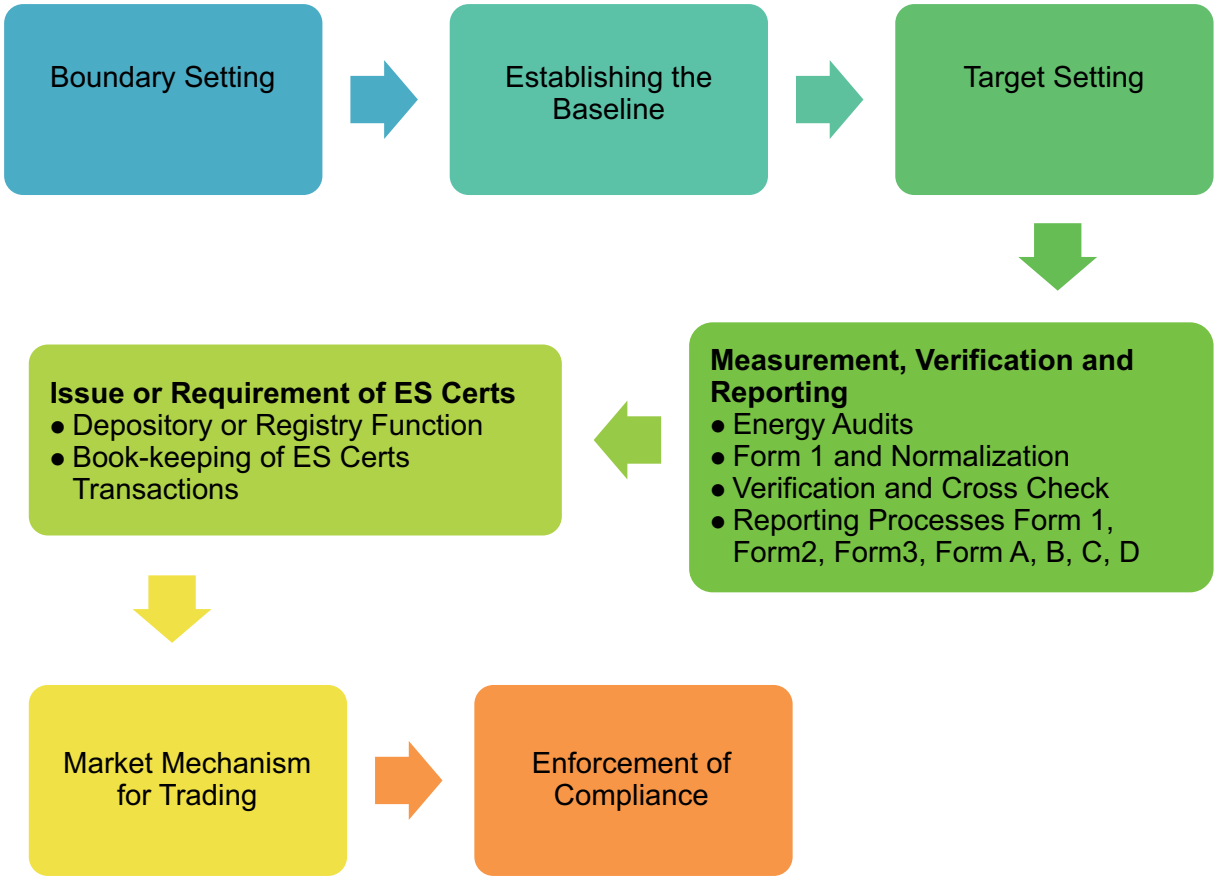


Figure 10: Design of the PAT framework

Table 7: PAT Stakeholders and responsibilities

Responsibility	Stakeholder	Responsibility	Stakeholder
Policy Maker & Administrator	Ministry of Power (MoP)	**Nodal Agency**	Bureau of Energy Efficiency
Implementer	Designated consumer (DC)	**State Administrator**	State Designated Agency
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 8) 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

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**

of sectors and deepening among existing sectors, 173 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 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 sixth cycle, covering 13 Sectors and 1073 DCs with estimated energy saving of around 28 Mtoe till PAT Cycle–VI. These industries would

Table 9: PAT details till Cycle VI

Sector / No. of DCs	Till PAT Cycle II	PAT Cycle-III	PAT Cycle-IV	PAT Cycle-V	PAT Cycle-VI	Total DCs
Thermal Power Plant	154	37	17	17	-	225
Iron & Steel	71	29	35	23	5	163
Cement	111	14	1	12	37	175
Aluminium	12	1	-	1	-	14
Fertilizer	37	-	-	-	-	37
Paper & Pulp	29	1	2	8	2	42
Textile	99	34	7	16	7	163
Chlor- Alkali	24	-	2	2	-	28
Refinery	18	-	-	-	2	20
Railways	22	-	-	-	-	22
DISCOMs	44	-	-	-	-	44
Petrochemical	-	-	8	-	-	8
Buildings	-	-	37	31	64	132
Total	**621**	**116**	**109**	**110**	**117**	**1073**

be among the top 1100 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.

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.

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.

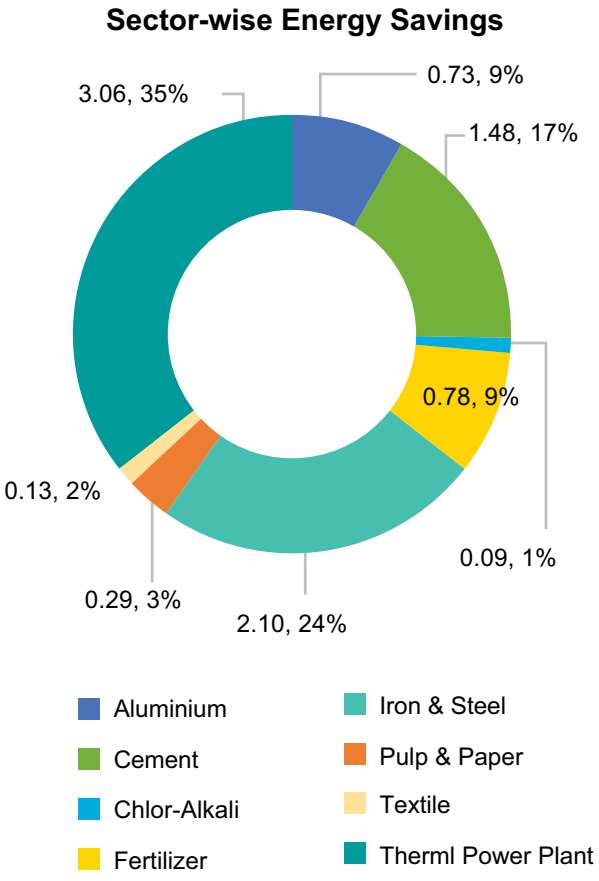


Figure 11: PAT Cycle I – Sector-wise Energy Savings

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**

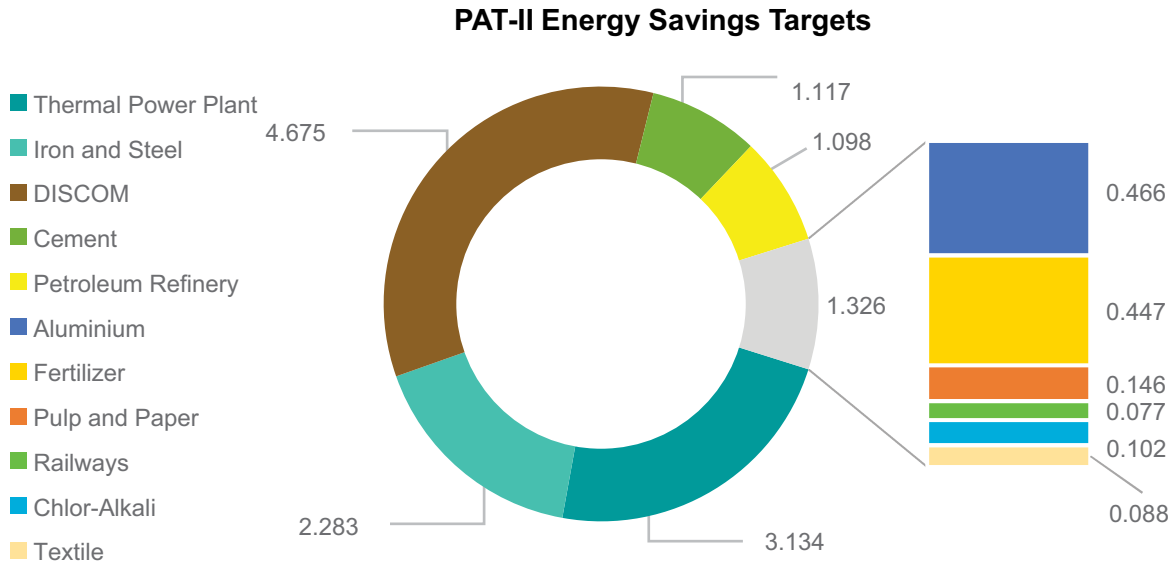
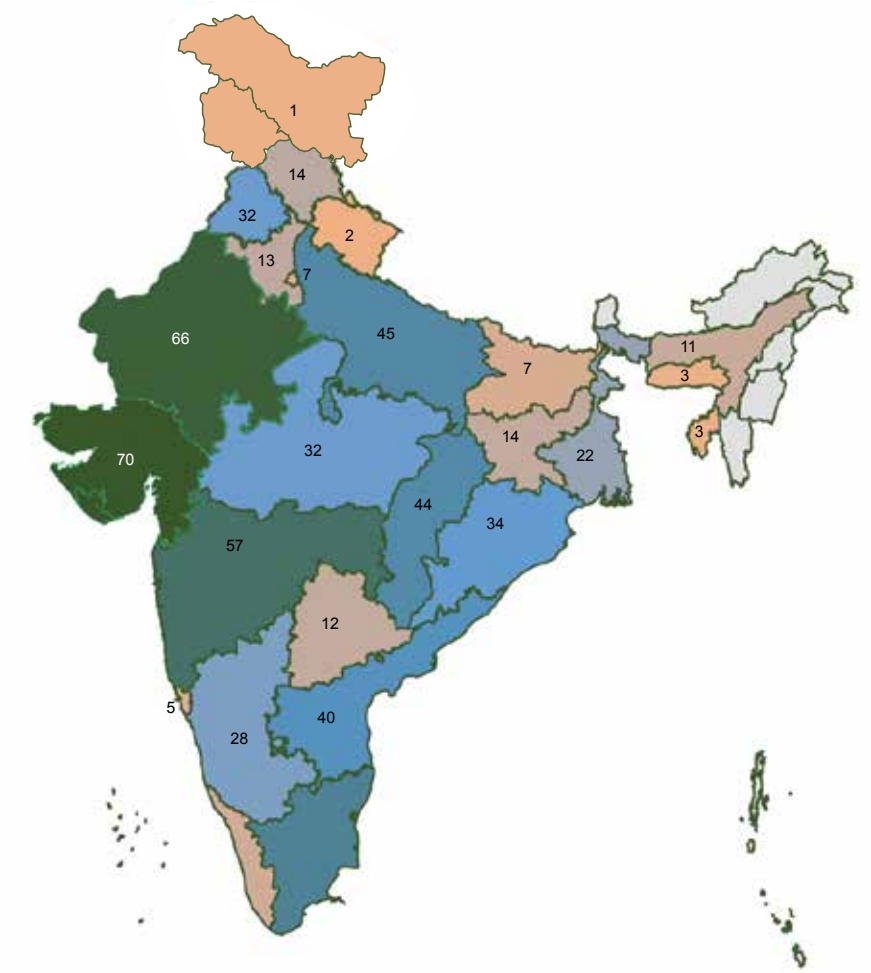


Figure 12: PAT Cycle II Energy Savings Targets

State wise number of DCs



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 13: 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

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

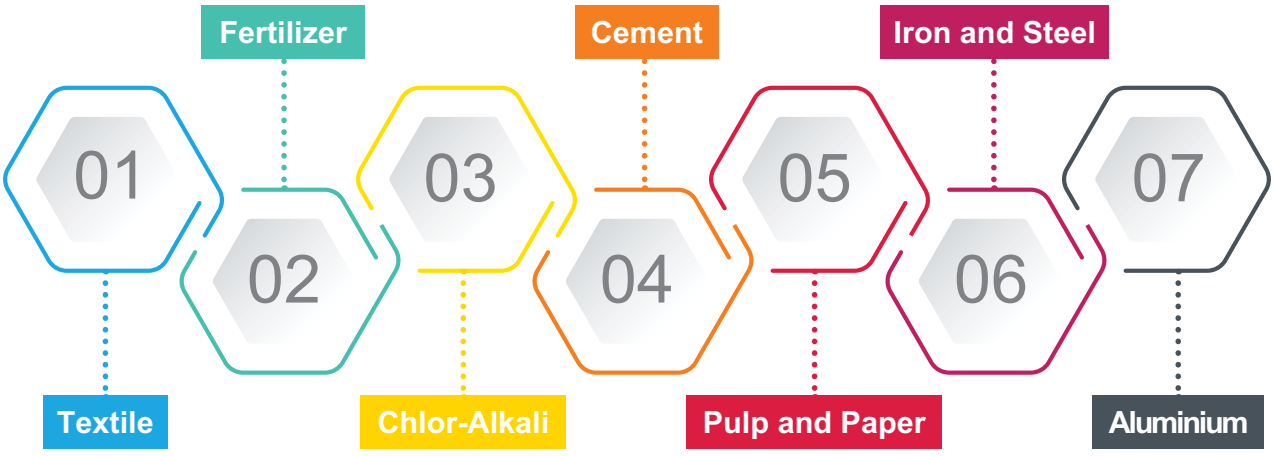
Sector	Total DC	Total Finalized DCs after M&V	Closed[15]	Below Threshold	M&V Not Done
Aluminium	12	11	1		0
Cement	111	99	9	3	
Chlor-Alkali	24	24			
Fertilizer	37	36		1	
Iron and Steel	71	67	1	1	2
Pulp and Paper	29	24	2		2
Textile	99	85		6	8
Thermal Power Plant	154	118	18	18	
Petroleum Refinery	18	17			1
Railways	22	22			
DISCOM	44	39		1	5
Grand Total	**621**	**542**	**31**	**30**	**18**

In order to calculate the savings under the PAT scheme, the 542 DCs of PAT Cycle-II and their M&V data (Assessment year 2018-19) have been considered.

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:



15 Includes 7 Cement plants, which are on hold for M&V process

- 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: $\Sigma ES = ES_{Plant\ 1} + ES_{Plant\ 2} + ES_{Plant\ 3} + ES_{Plant\ 4}$ +----------+ $ES_{Plant\ N}$

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: $\Sigma ES = ES_{Zone\ 1} + ES_{Zone\ 2} + ES_{Zone\ 3} + ES_{Zone\ 4}$ +----------+ $ES_{Zone\ N}$

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: $\Sigma ES = ES_{Production\ Unit\ 1} + ES_{Production\ Unit\ 2} + ES_{Production\ Unit\ 3}$ + ----------+ $ES_{Production\ Unit\ N}$

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: $\Sigma ES = ES_{Plant\ 1} + ES_{Plant\ 2} + ES_{Plant\ 3} + ES_{Plant\ 4}$ +----------+ $ES_{Plant\ N}$

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 542 DCs. The total energy savings for PAT cycle II totals to 14.08 Mtoe (based on baseline year production data of FY 2014-15). The share of energy saved by each sector is presented in Table 13.

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		11	1.226	8.7%	48.24%
Cement		99	1.559	11.1%	
Chlor-Alkali		24	0.133	0.9%	
Fertilizer		36	0.383	2.7%	
Iron and Steel		67	2.845	20.2%	
Pulp and Paper		24	0.315	2.2%	
Textile		85	0.135	1.0%	
Railways		22	0.196	1.4%	
	Thermal Power Plant	118	3.435	24.4%	51.76%
	Petroleum Refinery	17	1.43	10.2%	
	DISCOM	39	2.423	17.2%	
Grand Total		**542**	**14.08**		

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 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 6.793 Mtoe while the total energy savings for the supply side sectors amounts to 7.288 Mtoe for FY 2018-19, saving due to these interventions will be carried forward to FY 2019-20.

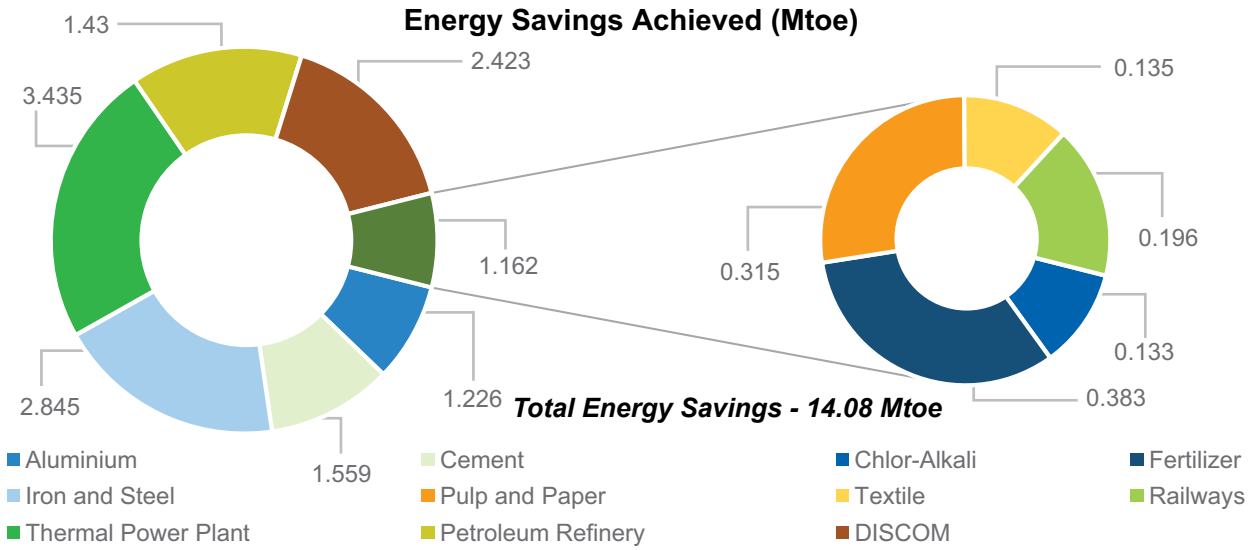


Figure 14: PAT Cycle II Energy Savings Achieved

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

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.

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

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	1.226	2.01	39%
Cement	1.559	2.07	25%
Chlor-Alkali	0.133	0.20	34%
Fertilizer	0.383	0.45	15%
Iron and Steel	2.845	4.12	31%
Pulp and Paper	0.315	0.38	17%
Textile	0.135	0.15	10%
Thermal Power Plant	3.435	4.71	27%

PAT Sectors	Energy Savings Achieved based on BY production (Mtoe)	Energy Savings Achieved based on AY production (Mtoe)	% Increase in Energy Savings
Petroleum Refinery	1.43	1.74	18%
Railways	0.196	0.24	18%
DISCOM	2.423	2.61	7%
Total	**14.08**	18.68	25%

production (i.e. 2018-19), for comparison and calibration purposes.

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.

Energy Savings- Target Vs Achieved

Data in below table shows that PAT II has overachieved its energy saving targets by almost more than 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	11	0.46	1.226	167%
Cement	99	1.05	1.559	48%
Chlor-Alkali	24	0.1	0.133	33%
Fertilizer	36	0.44	0.383	(13%)
Iron and Steel	67	2.27	2.845	25%
Pulp and Paper	24	0.12	0.315	163%
Textile	85	0.08	0.135	69%
Thermal Power Plant	22	2.85	3.435	21%
Petroleum Refinery	118	0.96	1.430	49%
Railways	17	0.08	0.196	145%
DISCOM	39	3.73	2.423	(35%)
Grand Total	**542**	**12.13**	**14.08**	**16%**

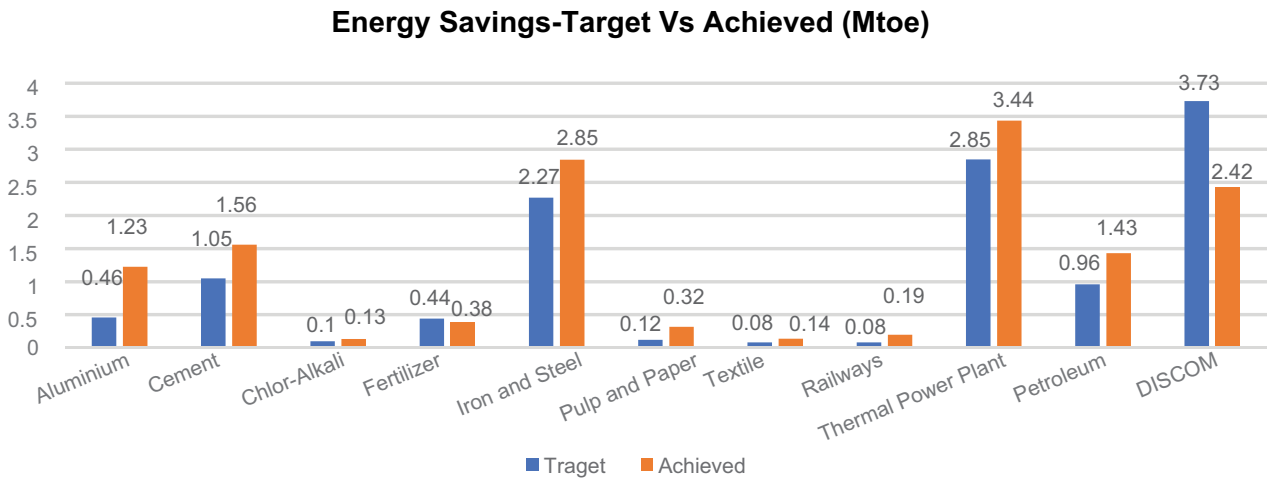


Figure 15: Energy Savings - Target Vs Achieved

2.1.3.3.1. Estimation of Fuel- wise energy savings:

In order to calculate the fuel-wise energy savings, a list and 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.

Post that conversion factor of 860 kcal/kWh is considered for calculation of electrical energy savings. Thermal and electrical energy savings for each PAT sectors provided in Table 17

The analysed data of sector under the consumption side demonstrates the total thermal energy savings of 6.217 Mtoe and

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%

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		11	1.214	0.143
Cement		99	1.529	0.363
Chlor-Alkali		24	0.120	0.155
Fertilizer		36	0.375	0.089
Iron and Steel		67	2.475	4.301
Pulp and Paper		24	0.268	0.549
Textile		85	0.102	0.388
Railways		22	0.135	0.707
	Thermal Power Plant	118	3.435	0.000
	Petroleum Refinery	17	1.293	1.598
	DISCOM	39	0.000	28.174
Grand Total		**542**	**10.945**	**36.466**

electrical energy savings of 6.694 BU. While the sector under the supply side demonstrates the total thermal energy savings of 4.728 Mtoe and electrical energy savings of 29.772 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 16. Post that following assumptions were taken for calorific values, density of respective fuels and CO_2 conversion factors as presented in Table 18.

Overall, the energy savings of 10.945 Mtoe and 36.466 BU under PAT Cycle II has resulted in reduction of 71.47 $MtCO_2$. Emission reduction due to PAT Cycle II is presented in Table 19.

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

Gross Calorific Values	kcal/kg	kcal/kWh
Coal	4500	
Oil	10050	
Gas	9500	
LPG[16]	11900	
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	
LPG[17]	2.89	
Electricity		0.82

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	11	5.24	7.3%
Cement	99	7.58	10.6%
Chlor-Alkali	24	0.59	0.8%
Fertilizer	36	0.71	1.0%
Iron and Steel	67	12.74	17.8%
Pulp and Paper	24	1.59	2.2%
Textile	85	0.75	1.1%
Thermal Power Plant	22	14.90	20.8%
Petroleum Refinery	118	2.64	3.7%
Railways	17	1.62	2.3%
DISCOM	39	23.10	32.3%
Total	**542**	**71.47**	

16 https://www.hindustanpetroleum.com/AboutLPG#:~:text=Properties%20of%20LPG,-LPG%20is%20twice&text=LPG%20can%20be%20compressed%20at,in%20high%20efficiency%20heat%20output.

17 https://www.ipcc-nggip.iges.or.jp/public/gp/bgp/2_1_CO2_Stationary_Combustion.pdf- pro rata to 11900 kcal/kg

Summary:

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

Table 20: PAT Cycle II emission and energy saving summary

Parameters	Values
No. M&V Analyzed PAT DCs	542
Total Energy Savings achieved under PAT II	14.08 Mtoe
Overall reduction in CO_2 emission	71.47 $MtCO_2$
Energy (thermal) saved at consumption side	6.217 Mtoe
Energy (thermal) saved at supply side	4.728 Mtoe
Energy (electrical) saved at consumption side	6.694 BU
Energy (electrical) saved at supply side	29.772 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 35 Mtoe. These 116 Designated Consumers from six sectors have been given target to reduce 1.06 Mtoe, details of the target energy saving for 116 DC is presented in Table 21.

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	23.86	0.406
Iron & Steel	29	7.65	0.457
Cement	14	1.74	0.094
Aluminium	1	1.02	0.061
Paper & Pulp	1	0.06	0.003
Textile	34	0.67	0.040
Total	**116**	**35.0**	**1.06**

2.1.4.1. Methodology adopted to calculate the savings

Monitoring & Verification of the units under PAT cycle III is being carried out and production data of the baseline year (2015-16) has been taken into consideration for calculating 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 = $SEC_{2015-16}$
- Step II: Obtain the Estimated SEC target for the year 2019-20= SEC_{target}
- Step III: $SEC_{2015-16}$ - 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 = $ES_{Plant\ 1}$= ($SEC_{2015-16}$ - SEC_{target}) x $Production_{2015-16}$
- Step V: ΣES = $ES_{Plant\ 1}$ + $ES_{Plant\ 2}$+ $ES_{Plant\ 3}$ + $ES_{Plant\ 4}$ +----------+ $ES_{Plant\ N}$

2.1.4.1. Impact of PAT Cycle III

M&V Data for 90 DCs under PAT cycle III is being analyzed and as per preliminary assessment it has been estimated that this will result into energy savings of 3.496 Mtoe (based on baseline year production data of FY 2015-16). The share of energy saved by each sector is presented in Table 22

The sectors mentioned in above table is further divided as demand side sectors and supply side sectors with respect to energy. The analysed data of demand side sectors demonstrates the

Table 22: PAT Cycle III Energy Savings Achieved

PAT Sector (Demand Side)	PAT Sector (Supply Side)	Number of DCs Notified in PAT	Number of PAT DCs analyzed for M&V	Energy Savings Achieved (Mtoe)	% Share of Savings (Sector-wise)	% Share of Savings (Demand & Supply wise)
Aluminium		1	1	0.089	2.5%	31.55%
Cement		14	12	0.163	4.7%	
Iron and Steel		29	14	0.735	21.0%	
Pulp and Paper		1	1	0.009	0.3%	
Textile		34	30	0.107	3.1%	
	Thermal Power Plant	37	32	2.393	68.4%	68.45%
Grand Total		**116**	**90**	**3.496**		

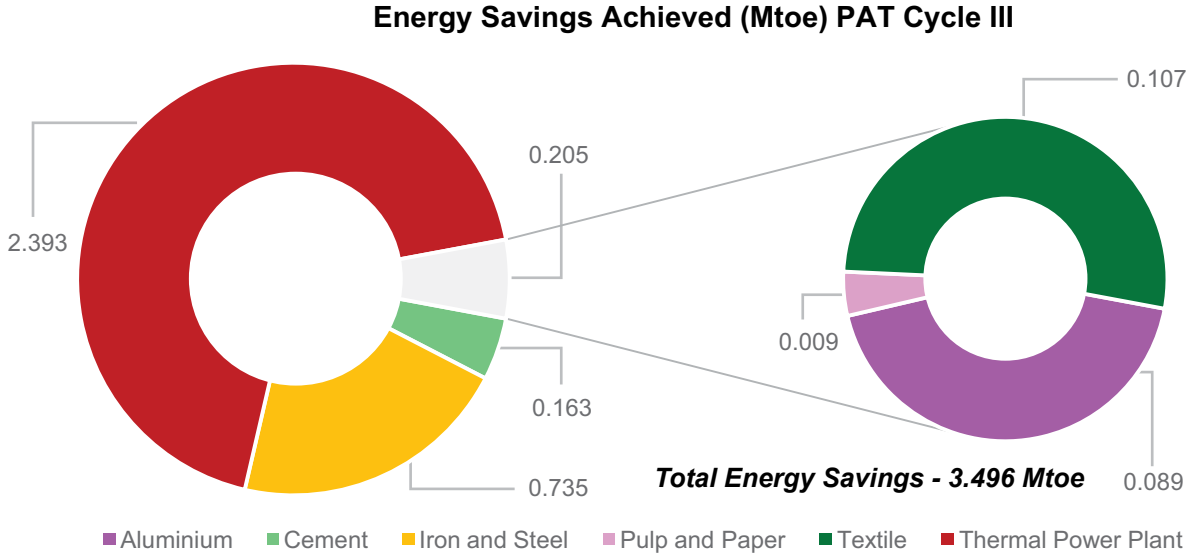


Figure 16: PAT Cycle III Energy Savings Achieved

total energy savings of 1.103 Mtoe while the total energy savings for the supply side sectors amounts to 2.393 Mtoe for FY 2019-20.

2.1.4.2.1. Estimation of Fuel- wise energy savings:

In order to calculate the fuel-wise energy savings, a list and 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 is used for estimation of thermal and electrical saving, details are presented in Table 23.

The analysed data of sector under the consumption side demonstrates the total thermal energy savings of 0.975 Mtoe and electrical energy savings of 1.483 BU. While the sector under the supply side demonstrates the total thermal energy savings of 2.393.

2.1.4.2.2. 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 16. Post that following assumptions were taken for calorific values, density of respective fuels and CO_2 conversion factors as presented in previous section in Table 18 are used for evaluation of the emission reduction. Overall, energy savings of 3.368 Mtoe and 1.483 BU under PAT Cycle III has resulted in reduction of 2.865 $MtCO_2$. CO_2 emission reductions due to PAT Cycle III is presented in Table 24.

Table 23: 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		1	0.880	0.010
Cement		12	0.160	0.038
Iron and Steel		14	0.639	1.111
Pulp and Paper		1	0.008	0.016
Textile		30	0.081	0.308
	Thermal Power Plant	32	2.393	0.0
Grand Total		**90**	**3.368**	**1.483**

Table 24: Share (Value) of reduction in CO_2 emission by each sector

Sector	No. of DCs	Emission Reduction ($MtCO_2$)	% Share in Total reduction
Aluminium	1	0.4	2.5%
Cement	12	0.8	5.1%
Iron and Steel	14	3.3	21.3%
Pulp and Paper	1	0.05	0.3%
Textile	30	0.6	3.9%
Thermal Power Plant	32	10.4	67.0%
Total	**90**	**15.4**	

Table 25: PAT Cycle III emission and energy saving summary

Parameters	Values
No. of M&V Analyzed PAT DCs	90
Total Energy Savings achieved under PAT III	3.496 Mtoe
Overall reduction in CO_2 emission	15.48 $MtCO_2$
Energy (thermal) saved at consumption side	0.975 Mtoe
Energy (thermal) saved at supply side	2.393 Mtoe
Energy (electrical) saved at consumption side	1.483 BU
Energy (electrical) saved at supply side	0 BU

Summary:

Under the PAT scheme III, overall summary of energy (thermal & electrical) savings, and corresponding reduction in CO_2 emissions are is presented in Table 25.

2.1.5. Summary of PAT Cycle II & III

Interventions in large industries, Thermal Plants, DISCOMs, Railways, & Buildings under PAT Scheme has led to total saving of 17.577 Mtoe (Thermal energy saving of 14.313 Mtoe and 37.949 BU of the electrical energy saving) under PAT cycle II,III. Sector wise energy saving is presented in Table 26.

Table 26: Total Energy saving Achieved from PAT cycle II, III

PAT Cycle	Total Energy Savings Achieved		
	Thermal (Mtoe)	Electrical (BU)	Total (Mtoe)
PAT II	10.945	36.466	14.08
PAT III[18]	3.368	1.483	3.496
Total	**14.313**	**37.949**	**17.577**

18 Evaluation is done on basis of M&V data reported by 90 DCs to BEE

CHAPTER 3

MSME Sector

The Industrial segment has been contributing to the bulk of the energy consumption (56%) in the India (at 318 Mtoe)[19]. Among this large share, Micro, Small and Medium Enterprise (MSME) sector contributes about 20-25%[20] of overall industrial energy consumption, estimated at 70 Mtoe. This immense quantum of energy consumed by the MSME sector signifies the immense potential for energy conservation across the sector.

3.1. MSME Sector (as the backbone of the Indian industrial economy)

MSMEs have been accepted as engines of economic growth to promote and accelerate equitable development. The major advantage of this sector is its enormous employment potential at significantly low capital involvement.

Today, the sector produces a wide range of products, from simple consumer goods to high-precision, sophisticated finished products. It has emerged as a major supplier of mass consumption goods as well as a producer of auto components, plastic goods, electrical equipment and pharmaceuticals. An impetus to the sector is likely to have a multiplier impact on economic growth. The definition for MSME sector is recently revised and bill was passed in parliament to enact this criterion.

The MSME is an important sector of the Indian economy comprising several energy intensive industries, such as foundry, forging, textile, ceramics, refractory, glass, dairy, etc. The industries in the MSME sector generally exist as clusters across different geographical locations of the country.

These MSME clusters exhibit a number of commonalities, such as technology use, production capacities, operating practices, etc. With the use of conventional technologies and poor operating practices, it offers a significant potential for energy saving through technology upgradation and adoption of best operating practices (BOPs) in the production processes.

Table 27: MSMEs upper limit on investment in core plant, machinery and turnover (in INR Crores)

Category	Investment	Turnover
Micro	< 1 Cr	< 5 Cr
Small	< 10 Cr	< 50 Cr
Medium	< 50 Cr	< 250 Cr

19 https://pib.gov.in/PressReleasePage.aspx?PRID=1628925

20 https://beeindia.gov.in/sites/default/files/UNNATEE_report_11.04.19.pdf

As per BEE's UNNATEE (Unlocking National Energy Efficiency Potential) report, industrial sector including MSMEs, will contribute an estimated 60% the of the energy savings. Energy consumption of the Indian MSME sector is estimated to increase to 500% in the next decade (by year 2031) and to realize the energy saving potential at MSMEs, an investment of ~12.3 Bn USD is required in next 14 years as per UNNATEE report.

3.1.1. Programmatic interventions in the energy efficiency domain

To tap the above-mentioned energy efficiency potential, Indian govt. has undertaken several policies, strategies and programs targeted at promoting energy efficiency in the MSME sector at the national level. In its endeavour to accelerate uptake of energy efficiency in the MSME sector, BEE had initiated an SME programme during the year 2009 with an objective to improve the energy performance of MSME sector.

Energy Efficiency in the MSME sector has also remained on the programme agenda of several institutes and development agencies, including World Bank, UNIDO, UNDP, JICA and GiZ etc. for a significant time now. Some of the commercial banks have also been providing concessional energy efficiency loans to MSMEs under different Government schemes and bilateral lines of credits.

While these programmatic interventions have made an impact, there is a long way to go before majority of MSMEs voluntarily increase their uptake of energy efficiency interventions. Across these MSMEs, there are various proven as well as emerging innovations in Energy Efficient technologies including LED lighting, Waste heat recovery solutions, efficient Permanent Magnet Motors, PLC based system and Super-Efficient ACs, Fans.

Although programmatic interventions have demonstrated the effectiveness of the energy efficient technologies, the large-scale deployment of energy-efficient technologies in MSMEs has been limited.

Across these MSMEs, there are various proven as well as emerging innovations in Energy

Table 28: BEE Programmatic Interventions

Programmatic Interventions	Achievements
BEE – SME Program National Program for EE in SMEs	• Technology gap assessment study in 35 energy intensive clusters • Preparation of 375 Technology specific bankable DPRs • Energy efficient technologies demo projects in 21 units of 4 selected clusters • More than 100 Capacity building cum Knowledge dissemination programme were organized • Identification of more than 70 local service providers for supplies of EE technologies in 5 clusters • Created Knowledge Management Portal "SIDHIEE" which hosts fifty videos of multimedia tutorials for MSMEs for adoption of EE technologies • Energy mapping of MSME clusters on pan India basis covering 10 sectors and 50 MSME clusters
GEF-World Bank BEE SIDBI Project Financing Energy Efficiency at MSMEs	• Program footprint to 25 MSME clusters till third phase. • Reached out to 5000 MSME units through Capacity Building Workshops, and B2B Exhibitions

Programmatic Interventions	Achievements
GEF-World Bank BEE SIDBI Project Financing Energy Efficiency at MSMEs	• EE Implementations in more than 1250 MSME units • Resulted in emission reductions of 1.9 $MTCO_2$ • Support to more than 45 MSMEs for implementation of Energy Management System (EnMS) ISO 50001 • Key Performance Indicators (KPI) and EE Benchmarks for MSMEs in various sectors • Around 200 participants from 20 MSME clusters have participated in ISO 50001 training workshops • Estimated EE saving potential of INR 900 lakh was identified from implementation of ISO50001 and EnMS
GEF UNIDO BEE Program- Promoting EE and Renewable Energy in Selected MSME Clusters	• Operational in 23 MSME clusters in India • More than 599 small scale energy efficient projects • Annual energy reduction of about 11452 toe • Cumulative of 1MWp of solar was installed in 18 MSME ceramics units in Thangarh cluster • EMC centers have been established for ceramic cluster in Morbi and Dairy cluster in state of Kerala.
BEE, SDC Sameeeksha Project 'Scaling up Energy Efficiency in Small Enterprises'	• Cluster profile reports for 108 energy intensive MSME clusters • MSME Energy Map providing insights of energy intensive clusters

Efficient technologies including Waste heat recovery solutions, servo motors, induction furnaces, CNC machines, VFD installed plastics moulding machines, and efficient Permanent Magnet Motors for air compressors.

Apart from these, use of emerging technologies such as automated data acquisition and analysis, Artificial Intelligence, Internet of Things (IoT) and Industry 4.0 is slowly gaining visibility as a means of improving efficiency, productivity and cost effectiveness.

Energy savings through adoption of innovative technologies, increasing the scope of energy related policies with inclusion of financing schemes and sensitizing the MSMEs towards the importance of energy efficiency in their day-to-day operations would go a long way in making MSME sector self-reliant and energy efficient.

3.2. 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.

During FY 2015-16 to FY 2018-19, under SME programme various initiatives as described 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. During the project 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 saving considering the improvement in the specific energy consumption due to the interventions.

Energy Saving = (Specific Energy consumption $_{Baseline}$ – Specific Energy Consumption $_{Post\ EE\ Interventions}$) Annual Production*

A summary of energy savings and emission reductions in FY 2019-20, due to interventions carried out during FY16-20 is tabulated in Table 29 and presented in Figure 17.

Table 29: Energy saving from BEE SME programme FY 19-20

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**

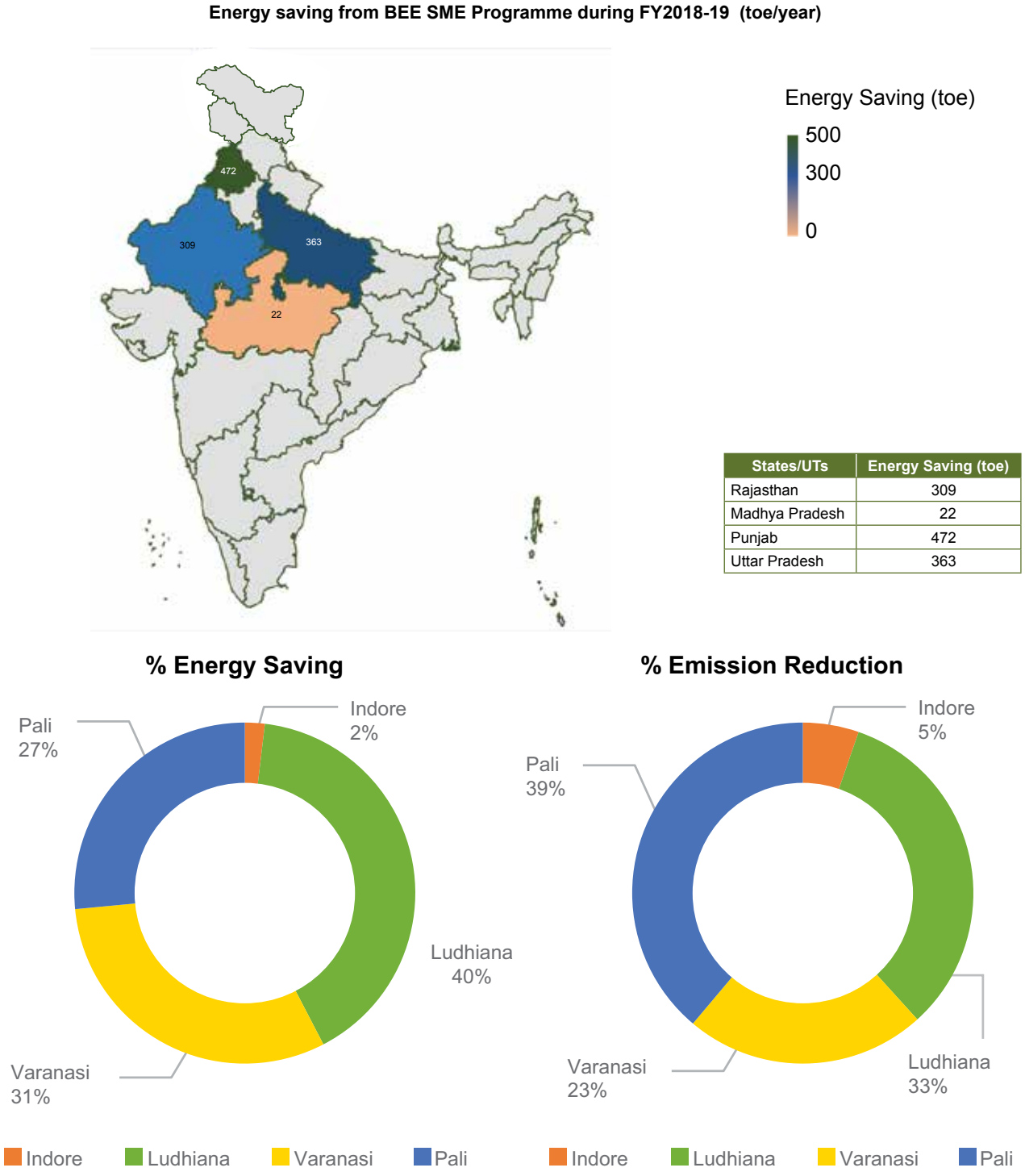


Figure 17: Energy and emission reduction across the four clusters

Development and Launch of knowledge portal for SMEs

A knowledge management portal - *Simplified Digital Hands-on Information on Energy Efficiency in MSMEs (SIDHIEE)* has been developed by Bureau of Energy Efficiency which hosts variety of knowledge resources like case studies, best operating practices, details of latest energy efficient technologies etc. 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.

Promoting Energy Efficiency and Technology Upgradation in SMEs through ESCO

BEE has institutionalized Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE), which provides a partial coverage of risk involved in extending loans for Energy Efficiency 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 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 energy efficiency investments at MSMEs in 4 ECO-Cities across India, wherein a pipeline for loans benefitting from PRGFEE is expected to be created.

Dissemination of EE technologies and Awareness:

- More than 60 Capacity building cum Knowledge dissemination programme were organised in SME clusters for dissemination of available energy efficient technologies in SME sectors. National Summit on Energy Efficiency in SMEs was also organized in consultation with leading stakeholders for further scaling up the project for transformational results.

- Identification of Local Service Providers and Suppliers: About 70 local service providers were identified for offering services and supplies of various technologies in 5 clusters for ensuring the replication of the identified technologies in the clusters.

Energy and Resource mapping of SME sector

BEE is presently conducting an energy and resource mapping study in the most energy intensive MSME sectors in the country. Study is presently being carried out in nine energy intensive sectors (Forging, Foundry, Bricks, Chemicals, Dairy, Glass and refractory, Pharma, Steel) in 45 MSME clusters across the country. Main objectives of the study are

- Evaluate the present specific energy consumption of the different MSME clusters for nine sectors

- Evaluate the extent of EE improvement potential across these sectors

- Estimation of energy efficiency improvement, energy saving potential for each sector.

Key expected outcome of the study will include – preparing of roadmap for these sectors to make them energy & resource efficient. Study will also prepare list of policy level recommendations required for faster adoption of the energy efficiency measures in these sectors.

3.3. "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 clusters during 2011-2015, this programme was extended to 25 clusters across India during phase-II and phase-III of the project. Under the programme over 1250 IDGPRs were prepared and hand-holding support were provided to MSME industries.

There was a measure of skepticism and lack of trust towards energy efficiency in the project

clusters during the initial stages of the project. In stark contrast to this initial environment, the project has achieved over INR 330 crores worth of EE investments, which resulted in lifetime emission reductions of 2 million tons of CO_2.

Under this program, technical assistance provided to energy intensive MSMEs in below mentioned clusters and sectors to meet Project Development Indicators. Phase-wise details of the clusters are presented in Table 30.

Table 30: Phase wise coverage of MSME Clusters under BEE-WB-GEF Programme

Cluster	Phase and Year
Pune	Phase-I (2011-2015)
Ankleshwar	
Tirunelveli	
Kolhapur	
Faridabad	
Ludhiana - Jalandhar	Phase-II (2015-17)
Dehradun	
Thane, Mumbai	
Delhi, NCR	
Varanasi	
Kundli, Panipat, Rai, Sonipat	Phase-III (2017-2019)
Ludhiana, Jalandhar, Chandigarh	
Rajkot, Morbi, Thangarh	
Coimbatore, Erode, Virudhachalam, Tirupur	
Surat, Vapi, Valsad	

As Phase -II and Phase III clusters saw implementations during 2016-19 hence are considered for calculating energy savings for impact assessment study of FY19-20.

Methodology for estimation of energy savings

Energy Saving = (Specific Energy consumption $_{Baseline}$ – Specific Energy Consumption $_{Post\ EE\ Interventions}$) Annual Production*[21]

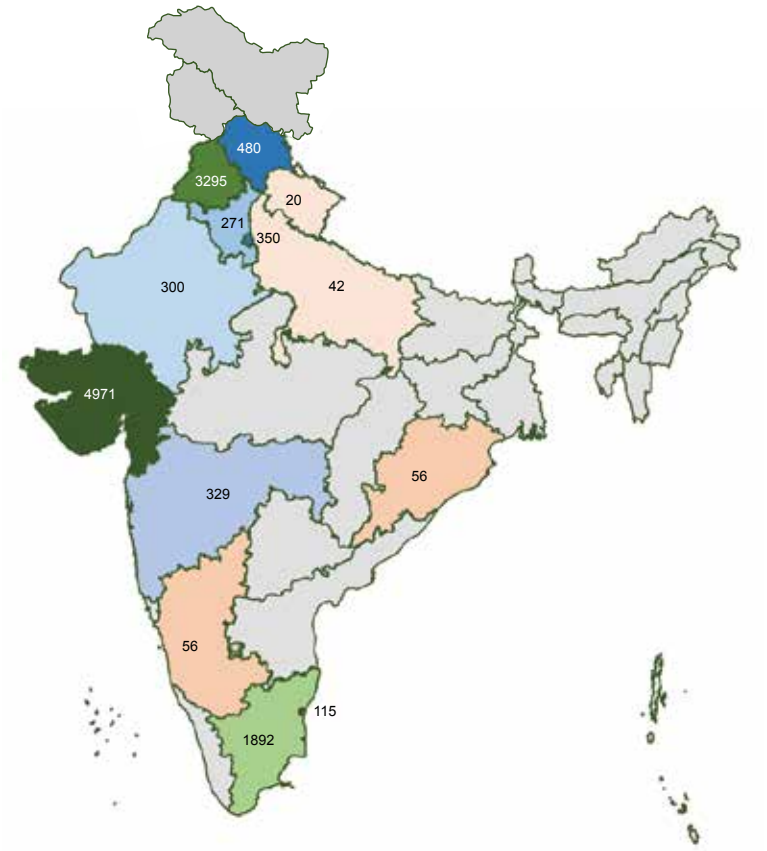
The WB-GEF project has also created a revolving fund to promote the financing of energy efficiency projects in MSME sectors. The fund is being used to provide financing at concessional interest rates to MSMEs for the implementation of energy efficiency interventions. Till date over 630+ industries have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

Interventions carried out under the project has led to total energy savings of 12,178 tonne of oil equivalent[22] during FY 2019-20 (due to interventions carreid out during 2016-19) across 13 states and union territories. A summary of the energy savings across different states is presented in Figure 18.

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

22 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 (2016-19), Phase I of the project is not considered in energy savings

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 18: Energy saving (tonne of oil equivalent) BEE-WB-GEF-SIDBI during FY 19-20

SIDBI has been supporting implementation of EE projects under PRSF scheme. SIDBI has supported different MSMEs with implementation of 1,076 Lakh Rupees of EE projects, which has resulted in saving of 3.14 Mn units of electrical energy during 2019-20.

Awareness and Capacity Building activities

Building Capacity and Awareness to MSMEs and Programme knowledge management were the two major components of the Financing Energy Efficiency at MSMEs project implemented by BEE. This intervention has been significantly successful in creating awareness and outreach on resource efficiency among MSMEs.

Within a short span of time, the project was successful in reaching out a large number of MSMEs and related stakeholders such as industry associations, technology and service providers, etc. directly through workshops, B2B exhibitions, training programs, certification events, etc. At the same time, social media channels have been deployed to reach out to greater MSME audience to create buzz around significance of energy efficiency and upcoming events in respective industrial clusters.

Component 1: Activities to Build Capacity and Awareness

Awareness Generation and Capacity Building Workshops

The objective of awareness and capacity building programmes was to raise awareness on benefits & potential of enhancing EE, and

also to share information about the most appropriate / relevant resource efficient technologies for the industries in the clusters, along with the best industrial practices from similar type of industries in India.

A series of awareness generation and capacity building workshops organized in both old and new clusters under all three phases of the project. More than 2500 MSMEs who attended these workshops understood various resource efficient and cleaner production measures available to them and had an interactive session with technology suppliers that are otherwise located far away from these clusters.

Certification programmes for old and new clusters were organized to foster greater understanding and cooperation within MSMEs in the clusters, besides motivating them to strive for achieving higher energy efficiency in their organizations. Project team conducted 14 certification programmes covering the old and the new clusters during the course of the assignment. This resulted in creation of an atmosphere of positivity and enthusiasm, among both MSMEs that were felicitated and others, to share their experience with and understand the next level of energy efficient technologies through direct interaction with technology suppliers.

During these events, various industrial associations, lauded BEE's initiative to recognize the achievements of member industries, and encouraged the MSMEs to take part in more numbers in similar initiatives and make their factories competitive with other national and global players.

Training programmes were organized where specialized trainers explained on best practices and energy efficiency measures relevant to the respective clusters. Several of these programmes included field visits for a first hand demonstration and understanding of the efficient practices and technologies.

The events were conducted at a stage when MSMEs were undertaking implementations of improvement measures, and the programmes complemented the ongoing implementation drive by training operators on aspects relevant to EE implementations.

B2B EE Technology Vendor interface with MSMEs

CleanTech Exhibitions and B2B Forums have been organized at Chandigarh, Surat, Rajkot, Tiruppur and Ludhiana. More than 150 stalls of energy efficient technology and service providers were on display for MSMEs from all over India. MSMEs appreciated the one-of-its kind event that provided access to several relevant EE technology vendors under one roof. The technology/ service providers were also successful in generating business leads from the visitors.. Details of the B2B is presented in Table 31.

Table 31: Details of CleanTech B2B events

Location	Technology Exhibitors	MSME visitors
Chandigarh	35	> 150
Rajkot	27	>140
Surat	29	>80
Tirupur	32	>100
Ludhiana	33	>250

Component 2: Design and Implementation

Design and Implementation of EnMS (ISO 50001) at MSMEs

The objective of this assignment was to assist selected MSME units in establishing, documenting and implementing an Energy Management System (EnMS) as per IS/ISO 50001 standard. The activity was targeted to assist around 50 MSME units located at different clusters including Pune, Kolhapur,

Faridabad, Ankleshwar, Ludhiana, Thane, Varanasi, Coimbatore, Thangarh, Morbi, Vapi and Delhi NCR. Details of the programme is presented in Table 32.

Table 32: Details of ISO 50001 programme for MSMEs

Impact Area	Values
Number of MSME sectors covered	18
Number of MSME clusters covered	20
Number of Participants attended the campaign	200
Number of units shortlisted for implementation	50
Estimated Energy saving (INRLakh)	900

This was a unique attempt in the Indian MSME sector, whereby energy management systems were implemented at MSMEs thus inculcating a culture of regular monitoring and measurement of energy performance at these MSMEs. The implementations also resulted in a number of energy-saving measures being identified in-house by the implementing MSMEs, thus providing a further boost to the core project objectives of generating tangible energy and resources efficiency outcomes. The culture thus inculcated also contributes towards sustaining the benefits and effectiveness of the various EE and resource efficiency measures implemented in these units and MSME clusters. Following are the key impact areas,

20 Clusters and 18 different MSME sectors are covered under the project through awareness cum Workshop sessions. The awareness cum workshop sessions was organized at 13 different locations.

More than 200 Number of participants have attended awareness cum workshop sessions organized at different locations. During this workshop awareness about the project, ISO 50001 and Energy Efficiency were given to participants.

Component 3: Knowledge management

12 Nos. documentaries on cluster level success stories were prepared at various stages during project implementation in clusters. These films captured the change in the perception of various stakeholders towards EE and Success stories from beneficiary units in the clusters. Captive audio-visual media in the form of documentaries have emerged as an excellent medium for capturing and showcasing successful case studies and best practices. Summary of the multimedia prepared during phase I and Phase III are presented in Table 33.

Newsletters, Case Studies and Posters

E-newsletters containing key updates and project achievements were circulated regularly through direct mailers. It was conceptualized to raise involvement and participation through regular communication and updates. Thus, monthly issues have been circulated widely among the various stakeholders in the project clusters and beyond.

Posters were developed as a medium to generate awareness at various levels of

Table 33: List of Multimedia prepared under the project activities

Phase I	Phase III
Energy Efficiency options in Forging Furnaces	Oxygen and Flue Gas control in reheating furnaces
Energy Efficiency options in Foundry Industries	Waste Heat Recovery from Dye Effluent in textiles sector
Energy Efficiency options in Chemical Industries	Thermal Insulation Paints
Energy Efficiency options in Air Compressor Systems	WHR options in Furnaces
Energy Efficiency options in Diesel Generator Sets	Energy Efficiency through in Brick Kiln
Benefits of RVD Technology in Chemical Industry	Micro Turbines

MSME stakeholders ranging from Industry Associations, MSME units, plant operators, etc. Posters were focused on best EE practices and Energy Efficient Processes, mostly those that were less prevalent in some clusters or innovative in nature, thus needing to be popularized through multiple media.

Case study brochures were developed to spread awareness about the energy efficiency implementations in the clusters that were achieved under the project. The objective was to effectively showcase the benefits of these energy efficiency implementations with a view to promote wide spread replication.

Collectively, the development and wide circulation of these knowledge resources among stakeholders in project clusters and beyond has been effective in creating and sustaining a consistent buzz, generating enthusiasm, and top-of-mind awareness around the project implementation activities and successes being achieved. This has contributed to an enabling environment in project clusters and beyond, that support implementation activities.

Sector specific Energy Efficiency Benchmarking

The objective of this initiative was to develop sector specific energy efficiency benchmarks, which helped MSMEs in establishing their current performance level, areas for improvement, prioritize them and ways & means to improve their performance. This included identification of sector specific benchmarking related to:

- Key Performance Indicators (KPIs) related to energy; important parameters to monitor,
- Benchmarks for EE performance (National and International); Potential for EE improvement,
- Identification of applicable EE Technologies and Best Industrial practices

The proposed project activity focused on two MSME sectors including Ceramics (Tiles) and Forging (Hot Forging).

Knowledge Management Portal – indiasavesenergy.com

Under the project, a wealth of useful information was generated which was intended to be consistently made available to energy and resource efficiency stakeholders working in the project clusters and beyond via the knowledge portal. The portal contains information on energy efficient technologies, best industrial practices and success stories that may find interest among these people and to get benefited.

Dedicated section, providing contacts of technology suppliers, energy efficiency financing schemes, energy efficiency case studies for replication, sector based good practice manuals, AV documentaries covering success stories, project e-newsletters and many more knowledge repositories were introduced. Awareness about the portal has been consistently growing and MSMEs are day-by-day becoming more familiar with it.

3.4. "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 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:

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 23 MSME clusters in India from five sectors, respectively: *Brass* (Jamnagar); *Ceramics* (Khurja, Thangadh and Morbi, Himmatnagar, Virudhachlam); *Dairy* (Gujarat, Sikkim and Kerala, Tamil Nadu, Odisha, Madhya Pradesh, Andhra Pradesh & Telangana, Haryana, Maharashtra, Punjab); *Foundry* (Howrah, Ahmedabad, Belgaum, Coimbatore and Indore); and hand tools

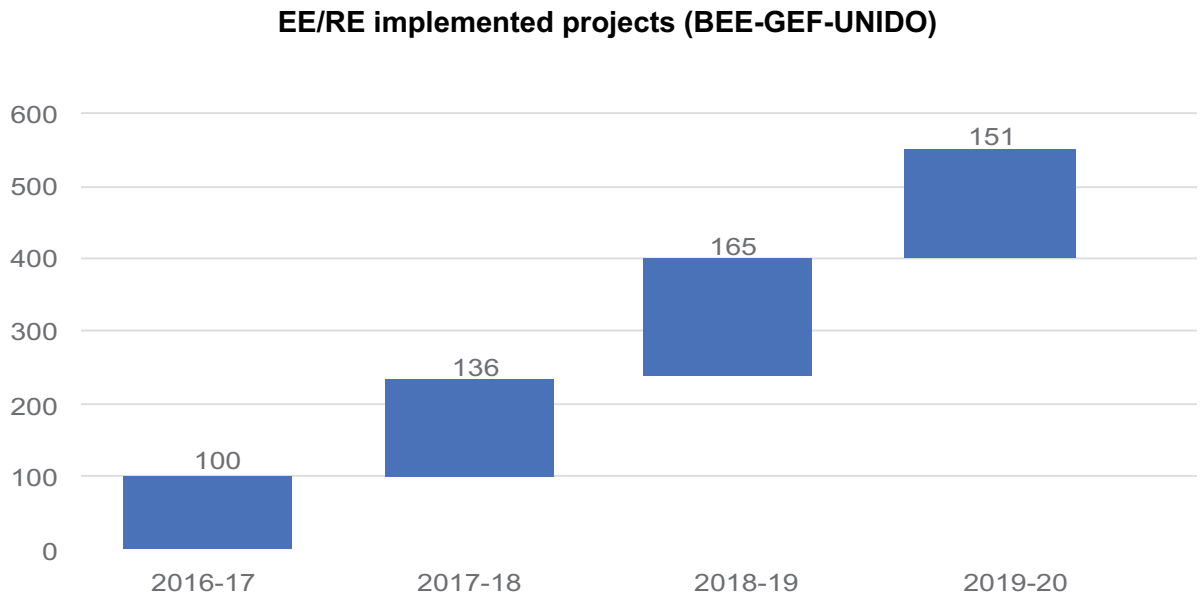


Figure 19: Numbers of EE/RE projects implemented under the project

(Jalandhar and Nagaur). Mixd Clusters in Indore (10 foundry, 20 Auto component, 30 Ready made garment, 15 pharma, 25 food processing units), Sikkim (15 Pharma, 5 Beverage, 5 food processing units).

Methodology for estimation of the saving

Energy Saving = (Specific Energy consumption $_{Baseline}$ – Specific Energy Consumption $_{Post\ EE\ Interventions}$) Annual Production*[23]

Various energy efficiency interventions have been carried out during FY16-20, that has resutled in energy saving during the FY19-20. Summary of the energy saving interventions is tabluted in Table 34.

Apart from the above EE implementations, cumulative of 1MWp of solar was installed in 18 MSME ceramics units in Thangarh cluster. Two EMC centers have been established in for ceramic cluster in Morbi and Dairy cluster in state of Kerala. Also under initiative, 'Energy Clinics' was organized in Coimbatore cluster to discuss "BOP and EE in Induction Furnace & Cupola Furnace for foundries. One international study tour for dairy sector was also organized under the pregame.

3.5. "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 MSMEs in India' in cooperation with the Ministry of MSME, Government of India and Energy Efficiency Services Limited (EESL).

EESL is implementing this project in 10 MSME clusters (Surat, Ankaleswar, Jorhat, Vellore, Jalandhar & Batala, Varanashi, Sundargarh,

Table 34: Summary of the energy saving from BEE-UNIDO programme (FY 2016-20)

Cluster	Sector	Number of EE projects	Investment (Lakh Rupees)	Energy Savings (tonne of oil equivalent)[24]	CO_2 Reduction (tonne of CO_2/ year)
Belgaum	Foundry	89	484		3865
Coimbatore	Foundry	60	267	259	2448
Gujarat	Dairy	110	5221	6154	31858
Indore	Foundry	20	52	130	821
Jalandhar	Hand Tool	58	119	247	1892
Jamnagar	Brass	38	270	113	667
Kerala	Dairy	19	210	232	1441
Khurja	Ceramic	9	28	383	1495
Morbi	Ceramic	14	49	564	1739
Nagaur	Hand tool	57	15	30	295
Thangadh	Ceramic	78	1403	1916	10098
Total		**552**	**8118**	**10556**	**56619**

23 Baseline audits defines the present energy consumption and operational hours, Proposed energy consumption based on guaranteed energy saving by 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 34

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 2019-20.

EESL has signed MoUs with 4 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.

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

2. Replacement of Existing Dryer LSU Dryer *(Vellore – Rice cluster)*

3. Implementation of Withering automation system, FRP fans and EE natural gas burners *(Assam Tea cluster)*

4. Replacement of conventional metal heating with Induction metal heating machines *(Punjab – Forging 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. Under the projct activites, EESL has supported over 700 units in identification of 24 replicable energy efficiency technologies for the selected sector/clusters out of which 2 technologies have been successfully demonstrated with a visible saving of 15 to 35% based on technology and the sector during 2019-20. So far, 20 ESCO contracts have been placed with a deployment of about 50 equipment in various MSME units. The project has also successfully scaled up two projects in Surat textile and Assam tea cluster which has attend handsome benefits through economic of scale, majority of the implementations fall during the FY 20-21 and are hence not considered under impact assessment for FY 19-20.

Demonstrations of VFD based Screw compressor with PM Motor has been completed in two textile units of Surat textile cluster. Implementation of the project has resulted in saving of 21 toe during FY 2019-20.

Demonstration project of PLC based Jet dye automation in three units of Surat textile cluster has resulted in saving of 593 toe during FY 2019-20.

CHAPTER 4

Buildings

In India, buildings sector (residential and commercial) constitutes 33% of total electricity consumption in India. If current scenario continues, 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 rate of growth in commercial buildings sector is amongst the highest, and hence, this sector needs to be moderated in its energy consumption. Details of the national electricity consumption including the share of commercial and domestic buildings sectors are presented in Figure 20.

The factors affecting energy demand in both domestic and commercial buildings sector have been divided into categories:

Lighting and Electro mechanical equipment: 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.

Electricity Consumption by Sectors in India, 2018-19

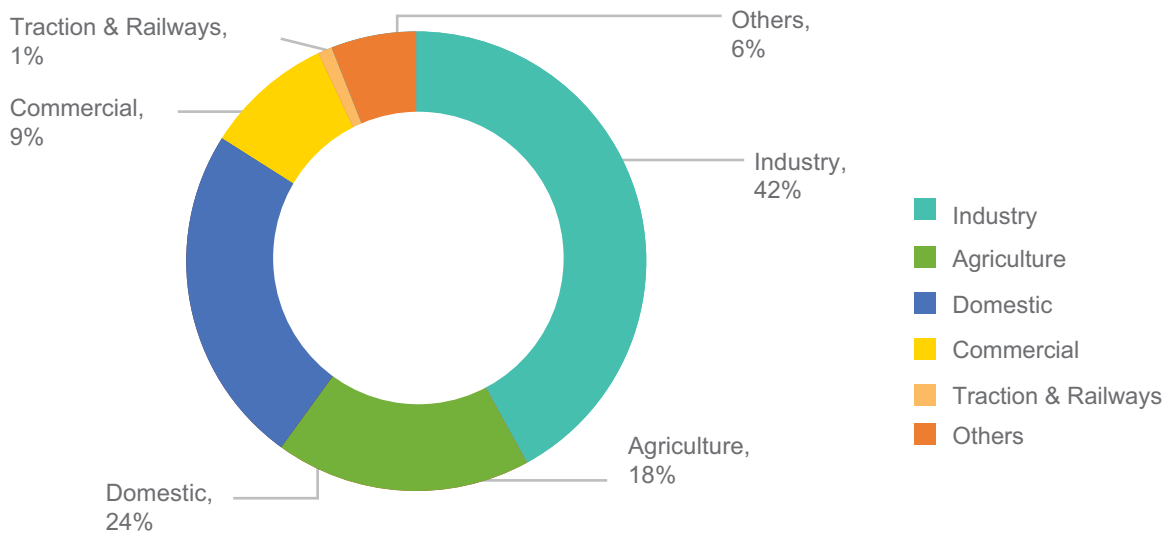


Figure 20: Electricity consumption in different sectors in India

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.

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.

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 21.

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.

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.

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 21: Programme initiatives in buildings sector

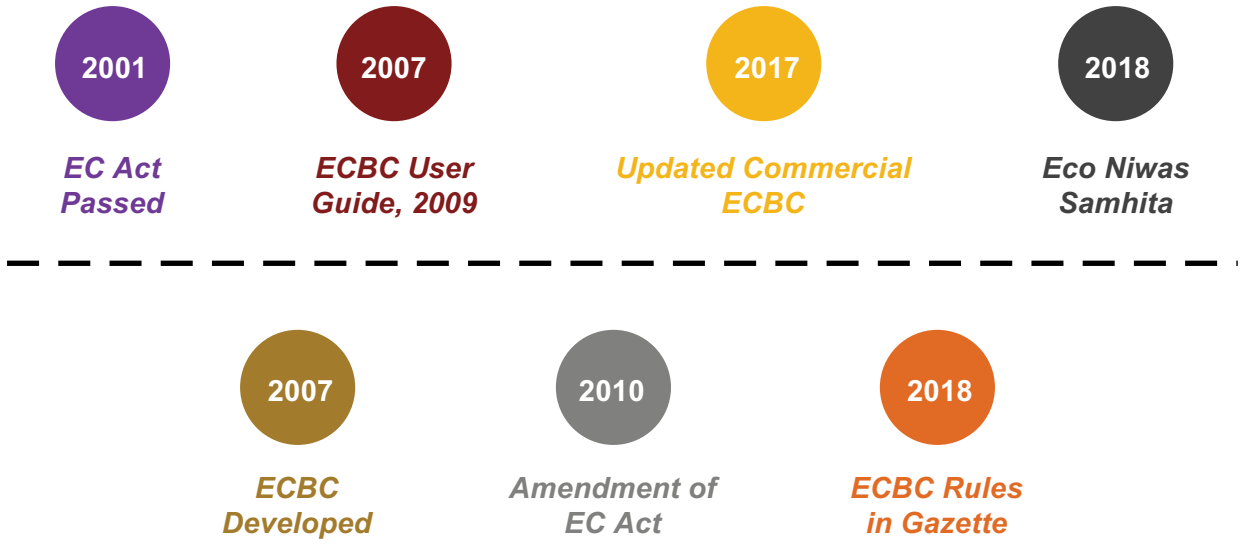


Figure 22: ECBC timeline

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.

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.

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.

Post its launch of ECBC during 2017, the code has been revised twice in April 2018 and November, 2019 based in market feedbacks and technical committee approval. Also, to strengthen and regulate implementation of ECBC, guidelines for its enforcement and implementation was developed by BEE which was notified and published in the official gazette of India as ECBC Rules, 2018.

As on 31st March 2020, ECBC has been notified in 15 states and two UTs : Arunachal Pradesh, Andhra Pradesh, Assam, Tripura, Himachal Pradesh, Kerala, Punjab, Haryana, Karnataka, Odisha, Rajasthan, Telangana, Uttarakhand, Uttar Pradesh, West Bengal, Union territory of Andaman & Nicobar Island & Puducherry.

Approval to the cabinet for implementation in 9 states have been processed for Bihar, Madhya Pradesh, Maharashtra, Meghalaya, Manipur, Mizoram, Jharkhand, Nagaland, & Goa. These states will be notified soon.

Telangana, Andhra Pradesh, Punjab, Kerala and Uttarakhand have stated implementation of the code and ECBC compliance is mandatory in a total of 47 Municipal Corporations in these states. Over 340 building have been approved for construction post compliance with ECBC. Other states are working on incorporation of ECBC in their Bye-laws.

Training Capacity building and Handholding Support

Over 500 training programs have been conducted across India (1 day/2 days/ 5 days) to create awareness and hands on workshops for capacity building of stakeholders in the area of ECBC and its implementation. Exclusive trainings focusing on government departments have been conducted for the officials, who will be responsible for implementation of the code are held in each state. Details of the programmatic interventions is presented in Table 35.

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
- Whole Building Performance Method

Table 35: Workshops conducted across India

Type of Workshop	No. of Workshops	Participants
One Day Awareness Workshop	222	9626
Two Day Technical Workshop	264	10307
3 Day Intensive Workshop	4	191
5 Day training (Telangana)	7	152
Master Trainer	13	317
TOTAL	**510**	**20593**

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 129 buildings across India that are either in the discussion stage, design stage, construction stage or have completed their construction as per ECBC guidelines across various states in India. Details are presented in Table 36 and Table 37.

Table 36: Details of buildings covered under ECBC

Construction Stage	No. of Buildings	Total Area in Mn. sqm
Completed	54	1.63
Design stage	75	1.89
Grand Total	**129**	**3.52**

Table 37: Category of buildings completed under ECBC as on 31st March 2020

Type of Buildings	No. of Buildings	Total Area, sqm
Hospital	2	260,039
Hotel	3	160,345
Institutional and IT	21	569,761
Office	23	442,251
Shopping Complex	5	201,228
Grand Total	**54**	**1,633,624**

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.

Total 54 buildings out of 129 buildings have completed their construction as on 31st March 2020 and are now operational. The same has been considered for the energy savings calculations. Out of these 54 buildings, 22 buildings were completed till 31st March 2019. Other 32 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 19-20, 50% of total energy savings is considered.

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 Built up area * (Conventional $_{EPI}$ – Proposed EPI for ECBC Complaint Building)*

Where Conventional EPI

*(1+%Saving $_{\text{of ECBC as per USAID ECO -III)}}$ * (Baseline $_{EPI}$)*

25 Conventional EPI is defined considering baseline of ECBC 2007, % saving is considered as per ECBC impact analysis done by IECC under USAID ECO III project.

total energy (electrical) saved under ECBC programme is 0.123 BU and total reduction in CO_2 emission is 0.101 $Mtco_2$.

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 2019-20 is considered as 0.116 BU and total reduction in CO_2 emission is 0.095 $MtCO_2$.

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 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.

Table 38: Energy Saving for ECBC compliant completed buildings FY 2017-20

Financial Year	No. of Buildings	Energy Savings in MU	Total Area in Mn. sqm
2017-19	22	49	0.43
2019-20	32	66.5	1.19
Total	**54**	**115.5**	**1.63**

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

27 Energy statistics, 2019- MoSPI

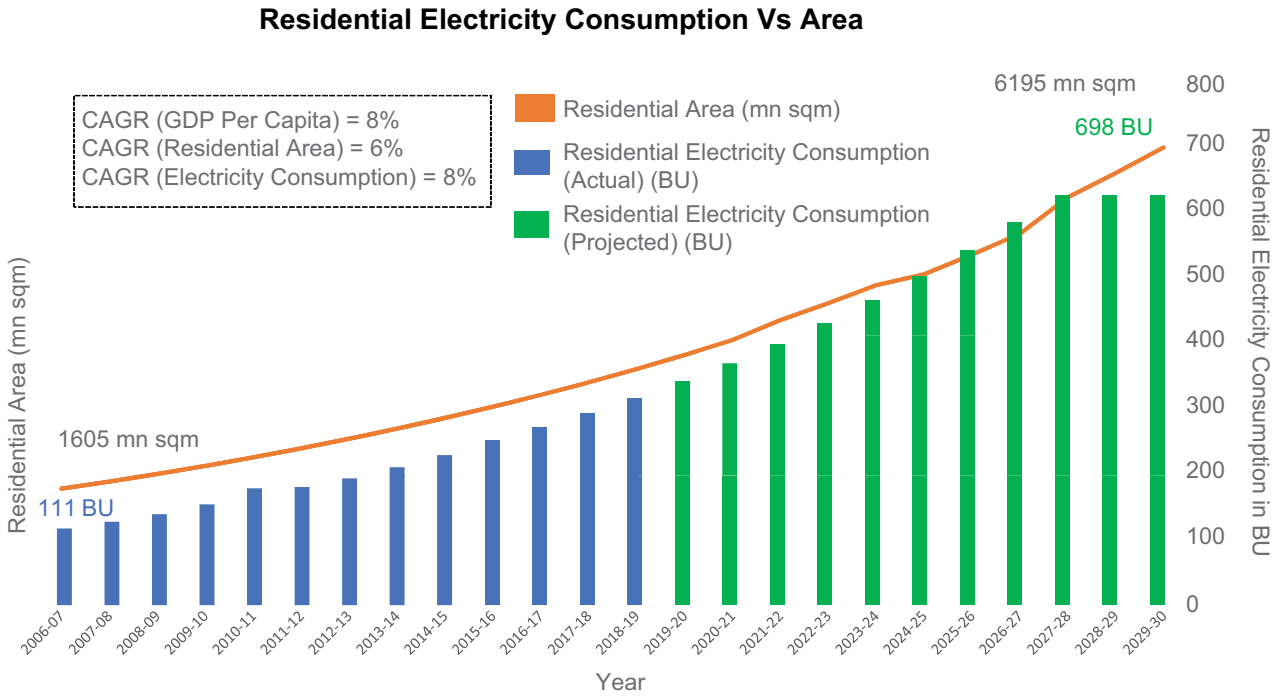


Figure 23: Area of the buildings in residential space and energy consumption forecast

4.2.1. About Eco Niwas Samhita ENS – Scope and Requirement

Increasing in residential building stock, coupled with increase in electricity use for space conditioning, is resulting in rapid increase in electricity use in residential buildings. As per projection done by NITI Aayog, electricity consumption for the residential sector is expected to increase 6-13 times by 2047. Another important aspect: thermal comfort, which is of utmost importance in all kinds of housing, but more so in case of affordable housing, so as to ensure health and well-being of the occupants. BEE envisaged a phased approach for the development of the residential building energy conservation code.

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. ECBC-R will help in making houses energy efficient is certainly a way of avoiding a long-term futile electricity consumption liability in residential buildings

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

Eco Niwas Samhita (ENS), Part -1

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 var y important envelope components such as wall type, window size, type of glazing, and external shading to windows to meet the compliance.

Eco Niwas Samhita (ENS), Part -2

Energy Conservation Building Code – Residential (ECBC-R) (Part II: Building Envelope) of the code provides energy efficiency standards for electro-mechanical systems of residential buildings and is in final stage of development.

Eco-Niwas Samhita Compliance (ENS) Tool:

Under the initiative BEE is developing the online compliance tool, to ensure ease of compliance and adoption by ULB's, home owners and developers.

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

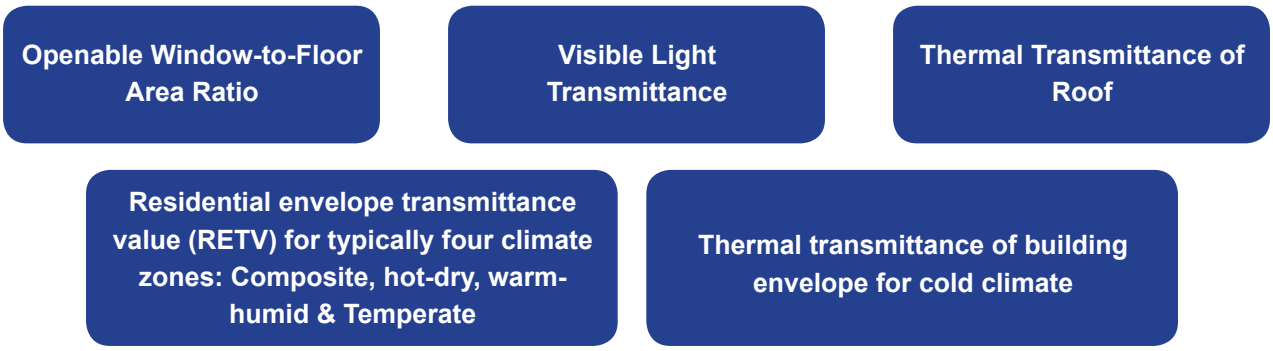


Figure 24: Key components of ENS part-1 building envelope

Other initiatives taken by BEE under the ENS are -

ENS Cell: Eco-Niwas Samhita (ENS) Cells were established in Delhi, Uttar Pradesh, Punjab, Karnataka and Maharashtra for implementation of the residential code for one year.

ENS Trainings: Stakeholder workshops and trainings have been conducted across India to appraise participants with the code and its benefits.

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

4.2..2.3. 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

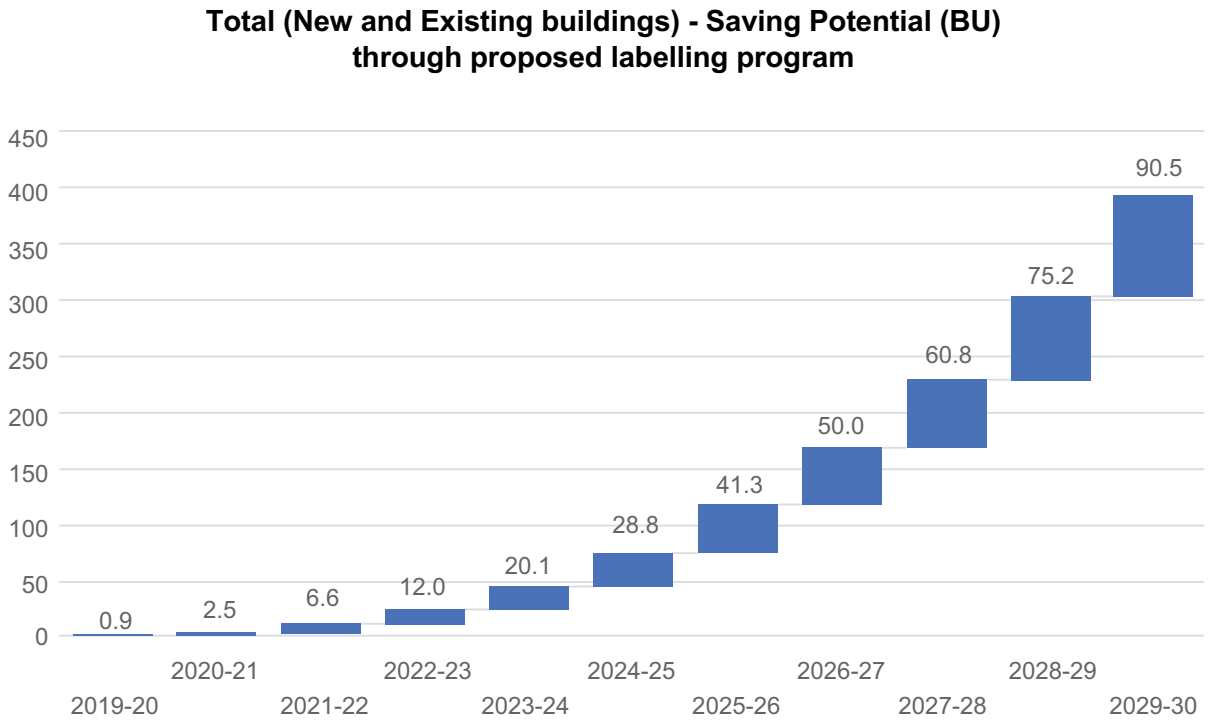


Figure 25: Energy saving potential in buildings through labeling programme

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 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), business process outsourcing (BPOs), shopping malls and hospitals 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, there are 264 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 26 and Table 39.

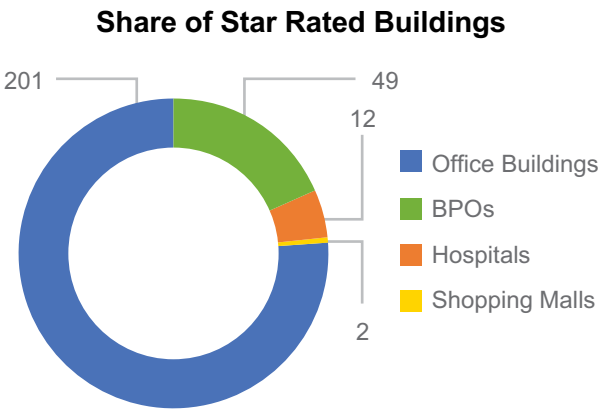


Figure 26: Share of Star Rated buildings

Table 39: BEE star rated buildings

Category	Number of Buildings
Office Buildings	201
BPOs	49
Hospitals	12
Shopping Malls	2
Total	**264**

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 27.

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

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 27: Baseline EPI for Star rated buildings

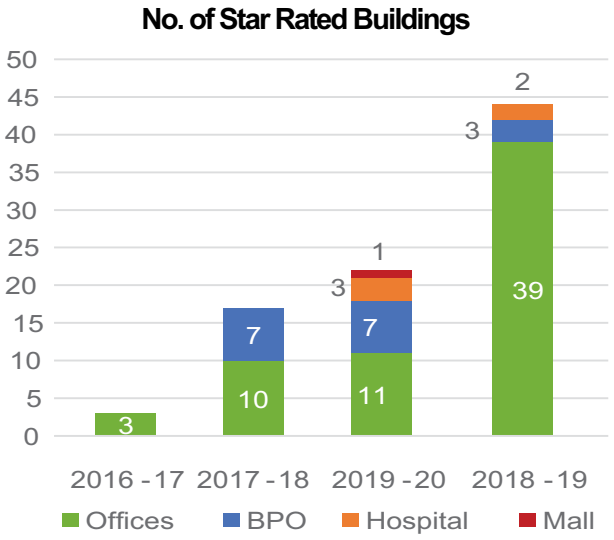


Figure 28: Number of Star rated buildings

Total Built up Area(Conventional EPI-Measured EPI for Star Rated Building)*

considered for building energy star rating programme is provided in the above section. Similarly, bandwidths for other typology of buildings (hospital, BOP, shopping malls) is considered for calculation of energy savings. Number of the buildings labeled during 2016-20 are presented in Figure 28.

Where Conventional EPI = Max EPI for 1 Star Rated building for specific category of building in specific climate zone

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

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

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 40.

***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 41.

Table 40: 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

Table 41: EPI for star label 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

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 42.

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 Rated Programme

As the star rating is valid for 5 years and there are 86 number of buildings that had received star rating from 2016-17 to 2019-20; so, it has been assumed that these buildings have been sustaining the energy savings post the star rating certification.

Out of these buildings, total 44 commercial establishments have received BEE star ratings in FY 2019-20. 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.

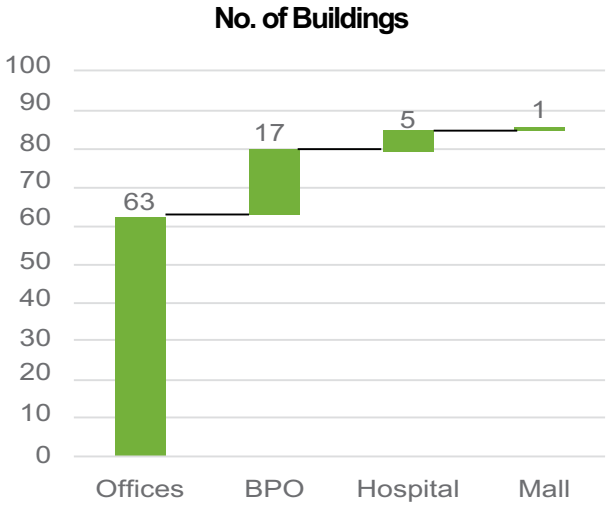


Figure 29: Number of Star rated Buildings

Table 42: EPI for star label 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

Table 43: Energy saving summary of Star rated building

Building Type	Energy Savings in MU					CO_2 Emisison (Mn Tonne)
	2016-17	2017-18	2018-19	2019-20	Total	
Offices	0.55	6.21	7.88	38.61	**53**	0.044
BPO	0.00	28.55	40.76	43.12	**112**	0.092
Hospital	0.00	0.00	3.46	1.19	**5**	0.004
Mall	0.00	0.00	8.91	0.00	**9**	0.007
Total	**0.55**	**34.77**	**61.00**	**82.91**	**179**	**0.147**

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 2019-20 is 179 MU. This has led to reduction of 0.147 Million Tonnes of CO_2. Details are presented in Table 43 and Figure 30.

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.

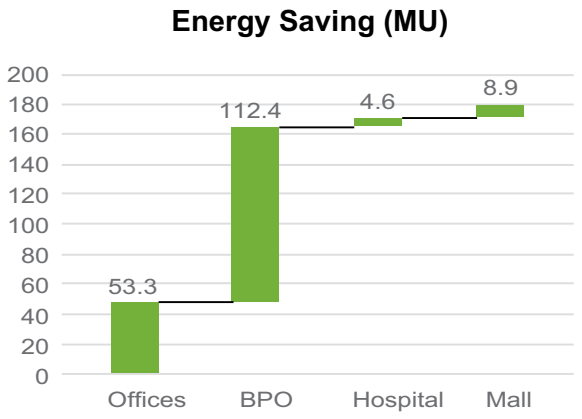


Figure 30: Energy saving of star rated buildings

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, 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 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.

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. As on 31st March 2021, 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 31 and Table 44.

Building Ownership:

There are a total 6648 commercial buildings under this programme. The type of commercial building includes, Central Government Buildings, District Courts, PWD Buildings and Railway Station buildings. The share of buildings

Coverage of commercial buildings in different states across India

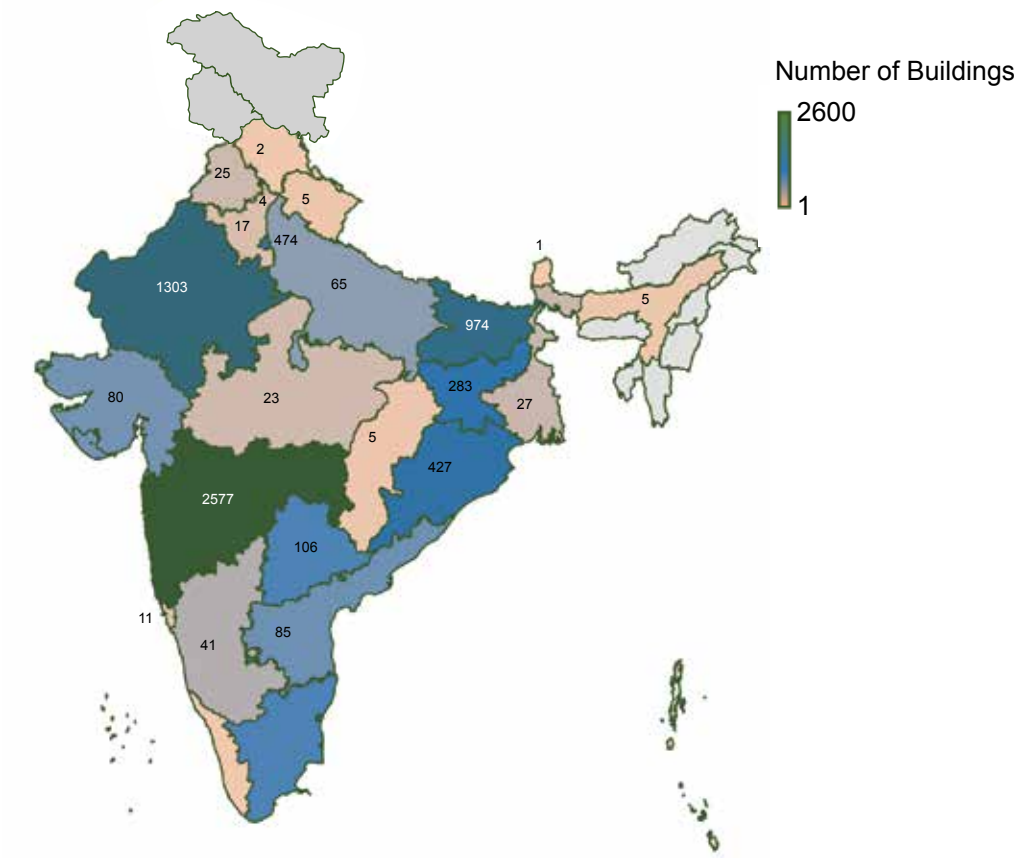


Figure 31: Commercial buildings in different state across India

Table 44: Commercial buildings in different state 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

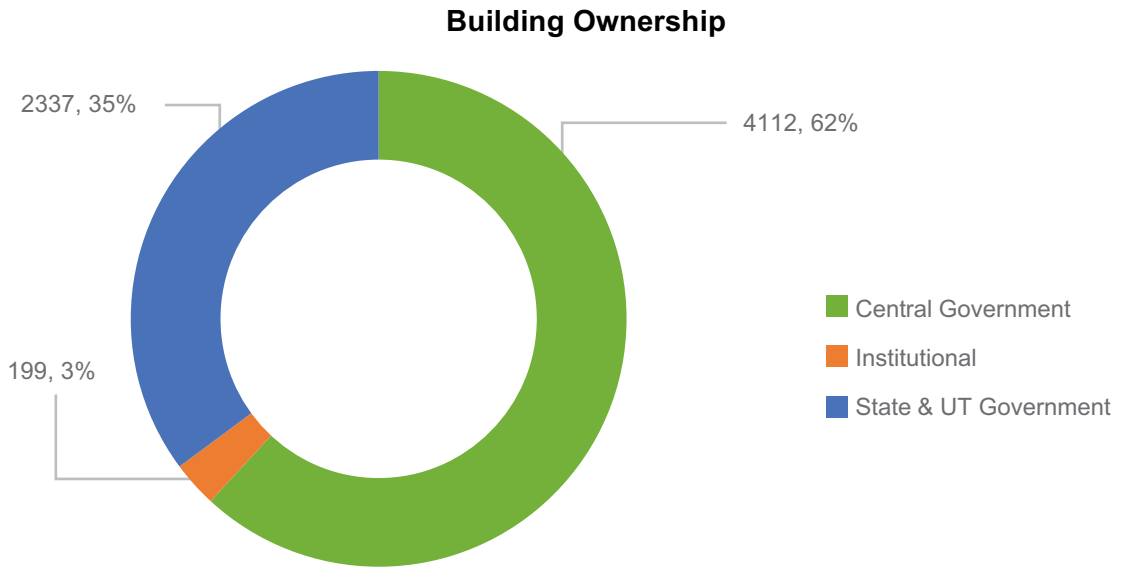


Figure 32: Share of builds under BEEP programme

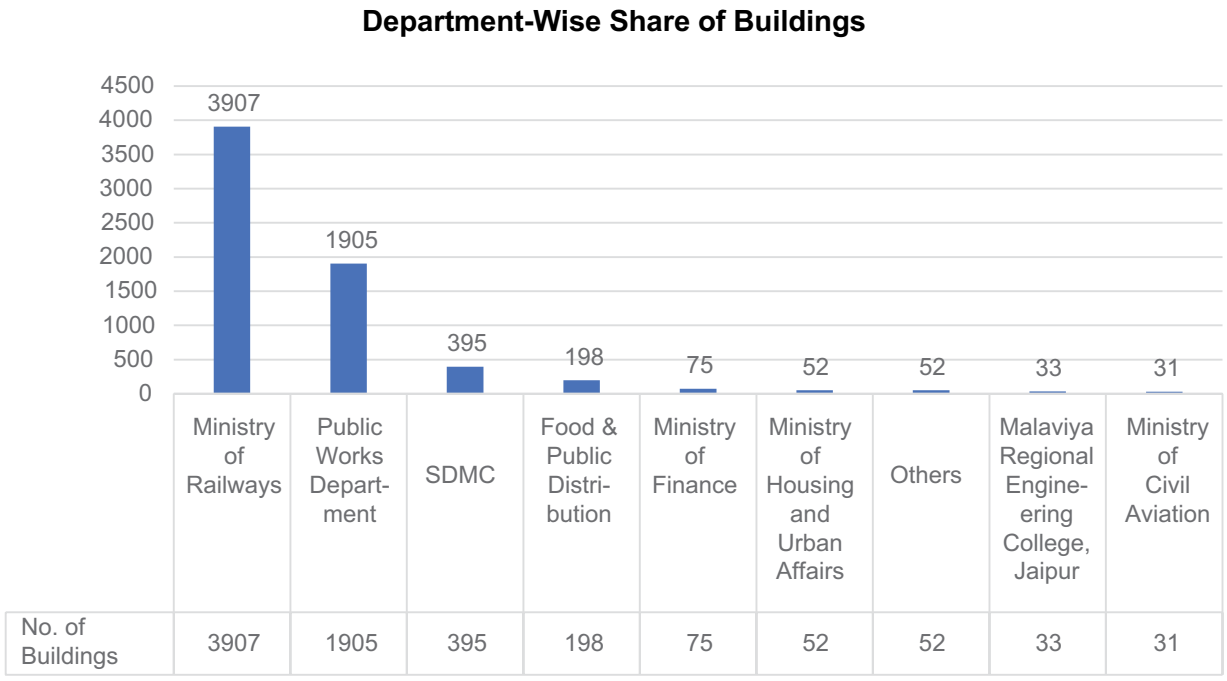


Figure 33: Department wise share of buildings under BEEP

under this programme as on March 31st, 2020 is presented in Figure 32 and Figure 33.

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.

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

Table 45: 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.

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. The impact of the BEEP in terms of energy (electrical) saved across India cumulatively for last four FY 2016-17, 2017-18, 2018-19 & 2019-20 is presented in Table 46. The total energy (electrical) saved under the BEEP scheme in the last four FY 2016-20 is 0.212 BU and total reduction in CO_2 emission[28] equals to 0.173 Million Tonne of CO_2, details are presented in next.

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.

Table 46: Appliances and Energy saving (MU) details of BEEP programme

FY	EE Indoor Lights	EE AC's	EE Fans	EE Outdoor Lights	Total (MU)
2016-17	1.0	0.3	0.04	0.04	1
2017-18	8.7	2.2	0.2	4.2	15
2018-19	62.7	56.6	35.9	31.5	187
2019-20	3.8	1.0	0.1	3.5	8
Total	**76.1**	**60.1**	**36.3**	**39.3**	**212**

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

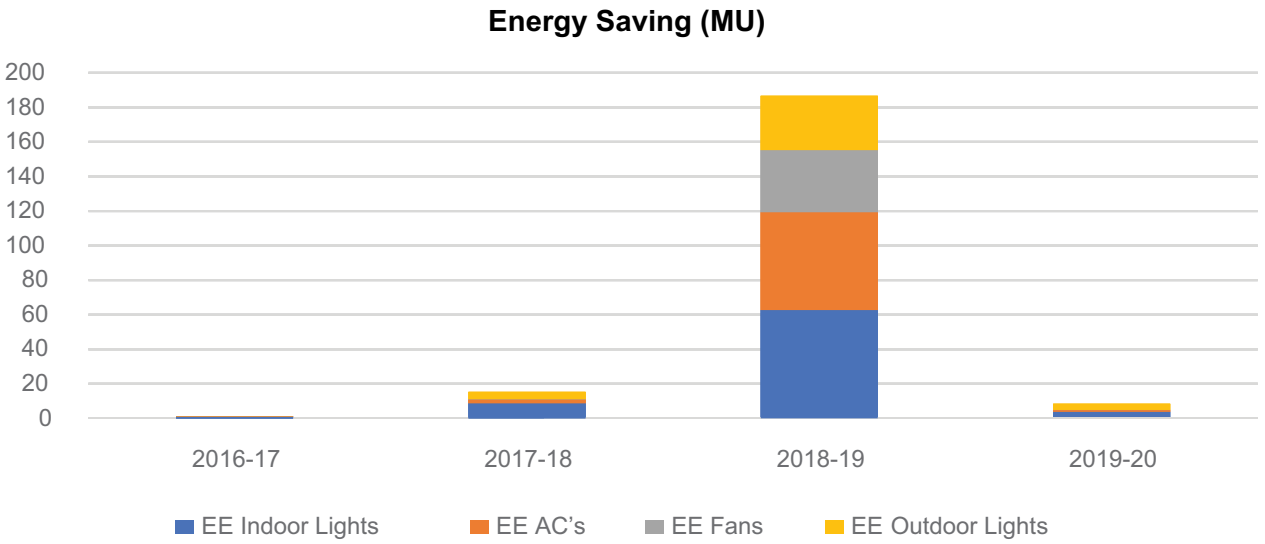


Figure 34: Energy saving from different EE appliances during 2016-2020

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 47.

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.

Table 47: 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

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 48: 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**

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 49.

Table 49: 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 are given as follows:

Table 50: 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

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.

Table 51: 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**

The detailed rankings are presented in Table 51.

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

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

Table 52: GRIHA Rating Thresholds values

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

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 52

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

As on 31st March 2020 , 1933 projects have been registered GRIHA. Split of the buildings across the different state is presented next Table 53 and Table 54.

Table 53: Number of Buildings registered under GRIHA

FY	Number of Buildings
2016-17	178
2017-18	209
2018-19	531
2019-20	206

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

Table 54: Number of Buildings registered under GRIHA across different stats

State	Number of GRIHA registered buildings	Built up area (Sq feet)
Andaman and Nicobar Islands	6	58,475
Andhra Pradesh	72	4,326,214
Assam	15	428,033
Bhubaneswar	1	58,150
Bihar	30	2,464,626
Chandigarh	3	93,501
Chhattisgarh	11	1,096,523
Delhi	147	8,109,939
Goa	21	251,362
Guatemala	1	2,287
Gujarat	56	1,711,947
Haryana	235	12,396,767
Himachal Pradesh	12	324,174
Hyderabad	1	26,952
Jammu & Kashmir	10	496,486
Jharkhand	19	611,181
Karnataka	71	1,360,050
Kerala	23	677,204
Madhya Pradesh	54	998,710
Maharashtra	770	12,875,437
Meghalaya	5	197,599
New Delhi	5	551,259
Odisha	37	1,732,380
Puducherry	13	89,457
Punjab	25	1,856,823
Rajasthan	42	2,194,098
Tamil Nadu	46	1,721,427
Telangana	21	366,549
Tripura	1	27,000
Uttar Pradesh	132	5,092,613
Uttarakhand	20	577,678
West Bengal	34	991,511
Total	**1939**	**63,766,411**

As on 31st March 2020 , 1939 projects have been registered and 206 newly constructed projects have been completed under GRIHA As on 31st March 2020.

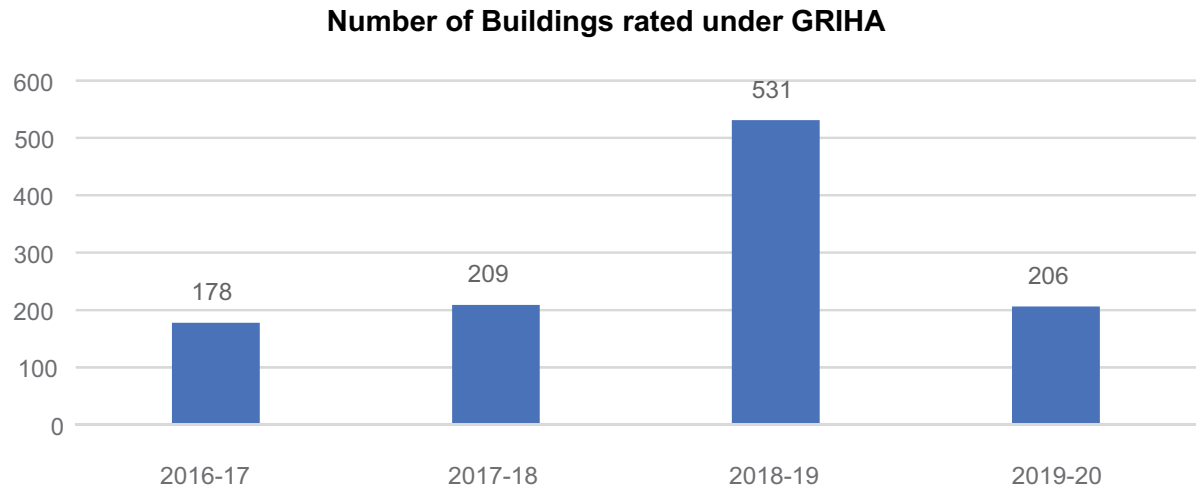


Figure 35: Number of Building certified under GRIHA (FY 2016-20)

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
- 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.

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

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.

CHAPTER 5

Standards and Labeling

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 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-six appliances are covered under the scheme, ten under the mandatory labeling regime and sixteen 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

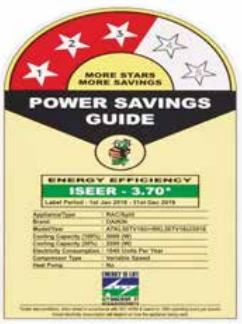
products, and factor lifetime running cost into their purchasing decision. The other is endorsement label which provides a 'certification' to inform prospective purchasers that the product is highly energy efficient for its category. Samples of both labels are illustrated in Table 55

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.

Table 55: Energy efficiency labels



Comparative Label

Endorsement Label

Two new appliances have been added during 2019-20. Deep freezers and light commercial air conditioners have been launched during March 2020, by the secretary Power during the 19th foundation day of BEE. The scheme was launched by the Hon'ble Minister of Power in May, 2006, currently covers 26 appliances under S&L programme. Details of the appliances are presented in section 5.1.

5.1. Appliances under S&L

The appliances covered[33] are presented in Table 56.

Table 56: List of S&L appliances[34]

Sr.No.	Appliance Name	Category
1	Frost Free Refrigerator	Mandatory
2	Tubular Fluorescent Lamps	Mandatory
3	Room Air Conditioners (RAC)	Mandatory
4	RAC (Cassette, Floor Standing Tower, Ceiling, Corner AC)	Mandatory
5	Distribution Transformer (DT)	Mandatory
6	Direct Cool Refrigerator	Mandatory
7	Stationary Storage Type Electric Water Heater (Geyser)	Mandatory
8	Color Television	Mandatory
9	Variable Capacity Air Conditioners	Mandatory
10	LED Lamps	Mandatory
11	Induction Motors	Voluntary
12	Agricultural Pump sets	Voluntary
13	Ceiling Fans	Voluntary
14	Domestic Liquefied Petroleum Gas (LPG) Stoves	Voluntary
15	Washing Machine (Front loaders (drum type))	Voluntary
	Washing Machine (Top loaders & semi-automatic machines)	Voluntary
16	Computer (Notebook/Laptops)	Voluntary
17	Ballast (Electronic/Magnetic)	Voluntary
18	Office equipment (printer, copier, scanners)	Voluntary
19	Solid State Inverter	Voluntary
20	Microwave Oven	Voluntary
21	Diesel Pump sets	Voluntary
22	Diesel Generator	Voluntary
23	Chillers (Air cooled)	Voluntary
	Chillers (Water cooled)	Voluntary
24	Solar Water Heaters	Voluntary
25	Light Commercial Air conditioners	Voluntary
26	Deep freezers	Voluntary

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

34 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 saving

Methodology adopted for the evaluation of the impact of the S&L programme is shown in Figure 36[35]

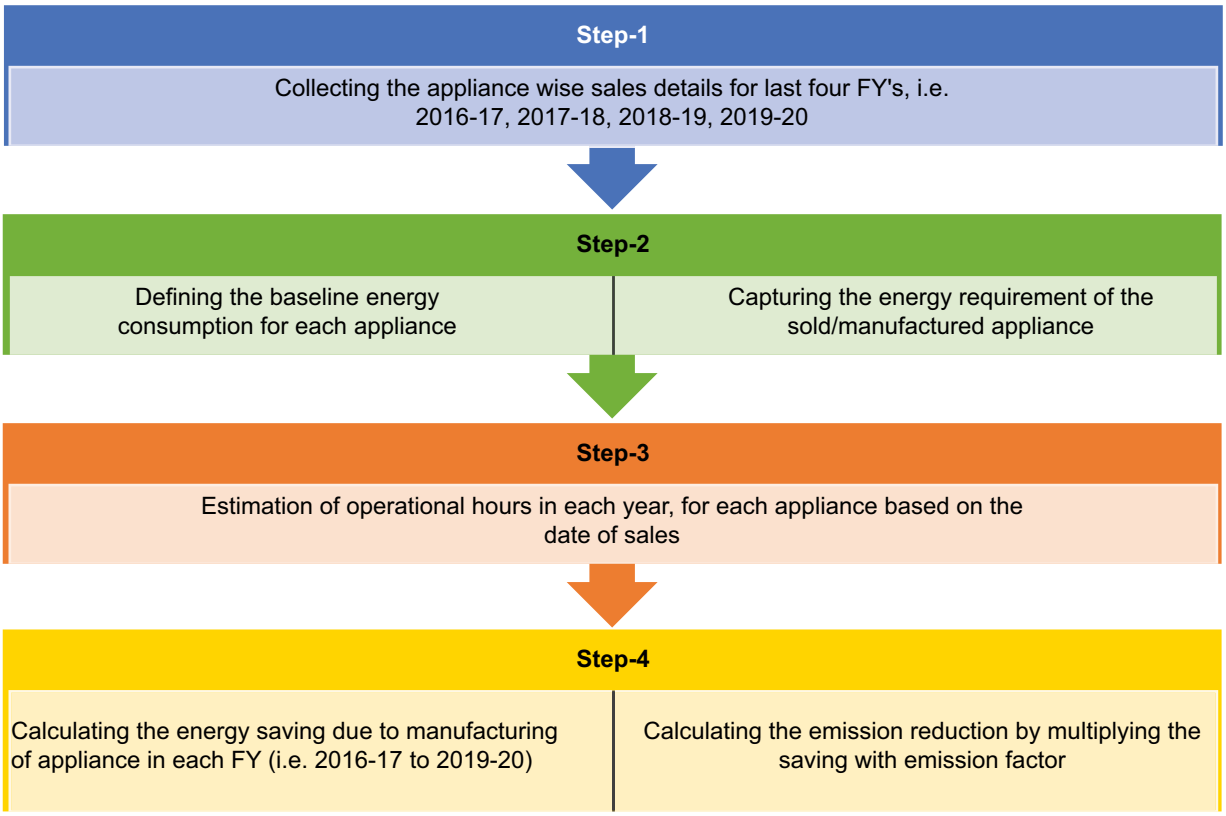


Figure 36: Methodology for impact assessment

5.3. Estimation of impact from S&L

5.3.1. Step-1: Production 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 manufactured have to be captured for registered appliances under the S&L scheme. Till 31st March 2020; 26 appliances were registered under the programme, out of which 17 have significant production volume based on data reported under the programme. For the other 9 appliances the recorded production volume 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 17 appliances being considered for impact assessment is presented in Table 57:

35 Average life of the appliances in considered as four years, hence energy savings due to the sales of Star labeled appliances from FY 2016-17 to FY 2019-20 are considered while evaluating the impact of the scheme for FY 2010-20 in this report. We have considered inventory as zero at the end of every quarter for energy saving (sales volumes for particular quarter is considered as total appliances manufactured that quarter for estimating the energy saving and emission reduction).

Table 57: List of appliances covered under S&L programme for impact assessment[36]

Sr.No	Appliance
Mandatory Appliances	
1	Color Television
2	Direct Cool Refrigerator
3	Distribution Transformer
4	Frost Free Refrigerator
5	LED Lamps
6	Room Air Conditioner (Fixed Speed)
7	Room Air Conditioner (Cassettes, Floor Standing Fixed speed)
8	Room Air Conditioner (Variable Speed)
9	Stationary Storage Type Electric Water Heater (Geyser)
10	Tubular Fluorescent Lamp (TFL)
Voluntary Appliances	
11	Ceiling Fan
12	Computer
13	Pump Set (Monoset)
14	Pump Set (Open well Submersible, Submersible)
15	Washing Machine (Front loaders, Top loaders & semi-automatic)
16	Domestic Liquefied Petroleum Gas (LPG) Stoves
17	Chillers

5.3.1.2. Production Volumes of the appliances for the respective FY (2016-17 to 2019-20)

Production data of the appliances considered under the evaluation is presented in Table 58:

Table 58: Sales figures of appliances[37, 38]

Appliance	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2016-20
Mandatory Appliance					
Distribution Transformer	289,019	347,515	500,544	464,389	1,601,467
Frost Free Refrigerator	1,955,699	2,578,277	2,861,285	3,074,275	10,469,536
Stationary Type Water Heater	2,406,708	2,741,279	3,287,462	3,736,438	12,171,887
Room Air Conditioner (Fixed Speed)	5,741,229	5,384,058	3,304,280	3,797,043	18,226,610
Room Air Conditioner-(Variable Speed)	702,652	2,267,364	3,924,884	5,050,951	11,945,851
Color Television	2,617,893	9,479,658	9,298,819	8,703,395	30,099,765

36 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

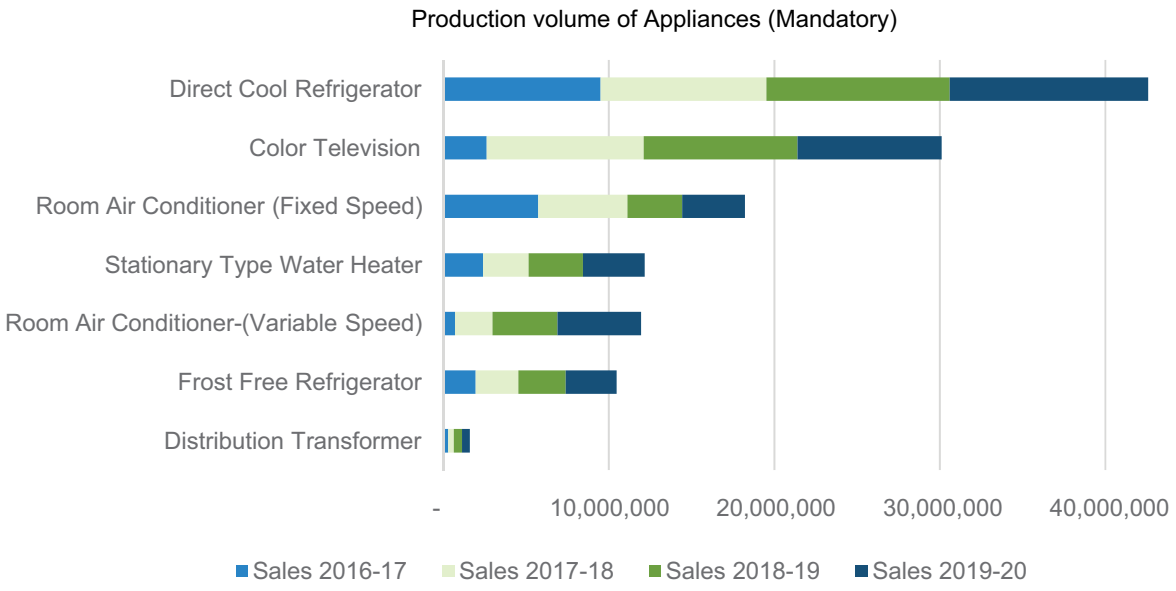
37 Assumption - Sales of appliances in each quarter is considered same as production data for appliances in that quarter

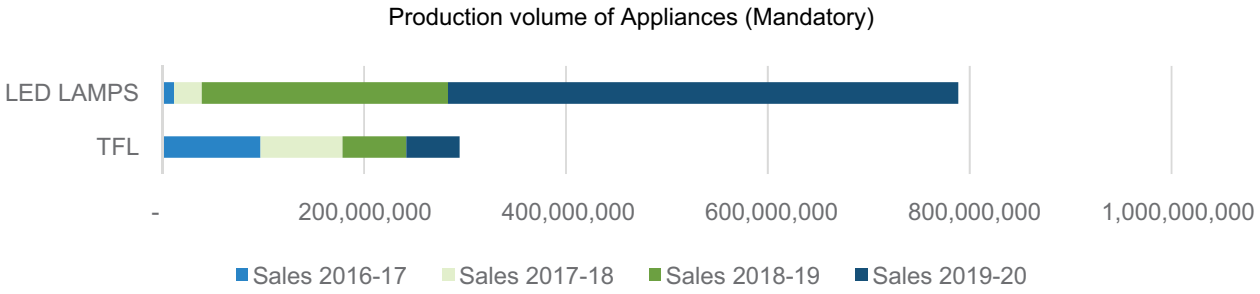
38 Appliances indicated nil were notified in FY 16-17

Appliance	FY 2016-17	FY 2017-18	FY 2018-19	FY 2019-20	FY 2016-20
Direct Cool Refrigerator	9,506,713	10,014,626	11,067,110	11,998,899	42,587,348
TFL	97,395,586	81,219,925	63,187,569	52,775,743	294,578,823
LED LAMPS	11,754,592	27,290,510	243,974,600	505,633,490	788,653,192
Voluntary Appliance					
Ceiling Fan	2,747,053	3,393,289	2,353,916	1,795,718	10,289,976
Monoset Pump	37,187	53,860	72,768	70,835	234,650
Submersible Pump Set	533,170	864,002	1,073,103	737,893	3,208,168
Openwell submersible pump Set	-	167,894	253,715	299,188	720,797
Washing Machines	-	-	-	1,791,020	1,791,020
Computers	2,592	-	-	-	2,592
Domestic LPG Stoves[39]	479,631	739,160	821,804	1,326,632	3,367,227
Chillers[40]				18	18

39 Saving of LPG burners are reported for first time by BEE during 2019-20

40 Chillers have been recently introduced and only data for sales of 18 chillers have been recorded during 2019-20





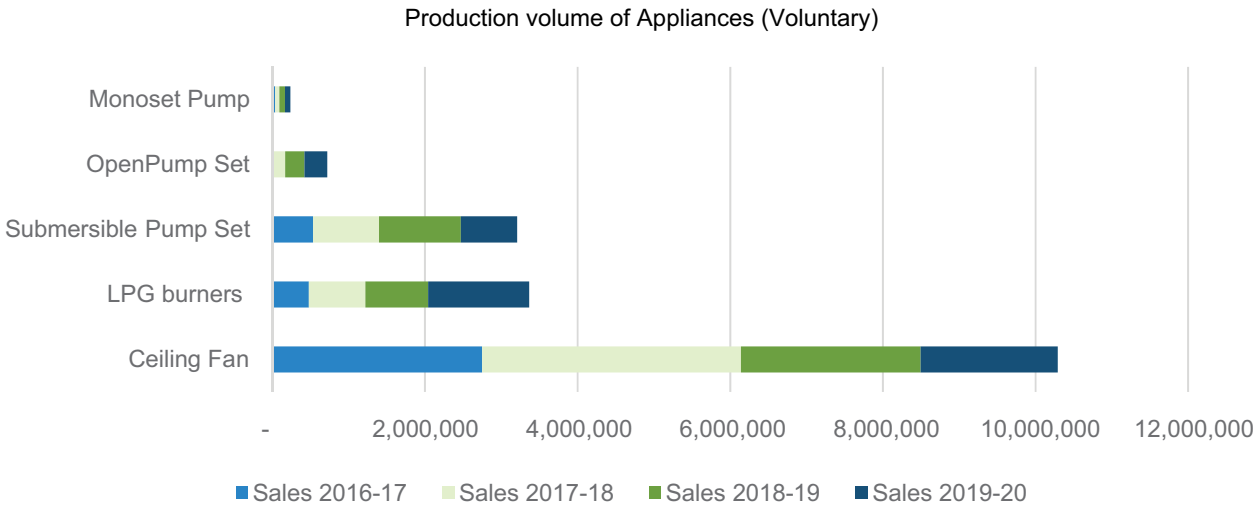
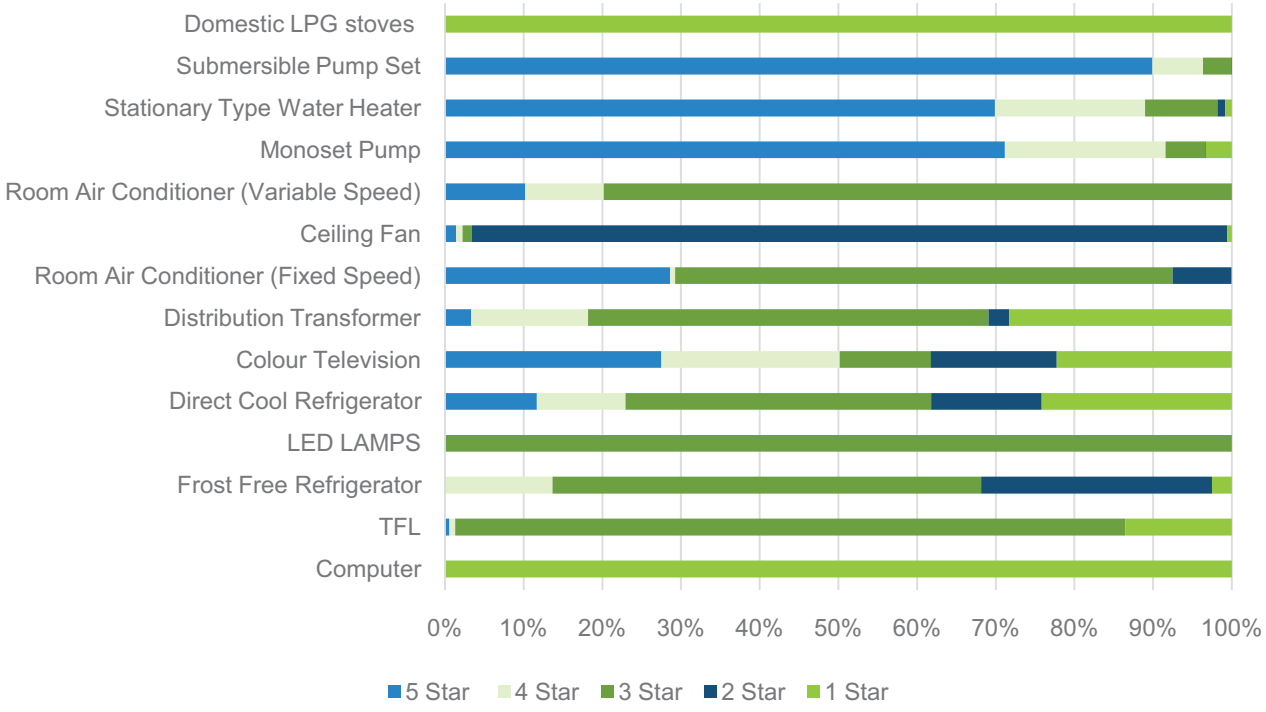


Figure 37 Sales volume of appliances in FY 2016-20

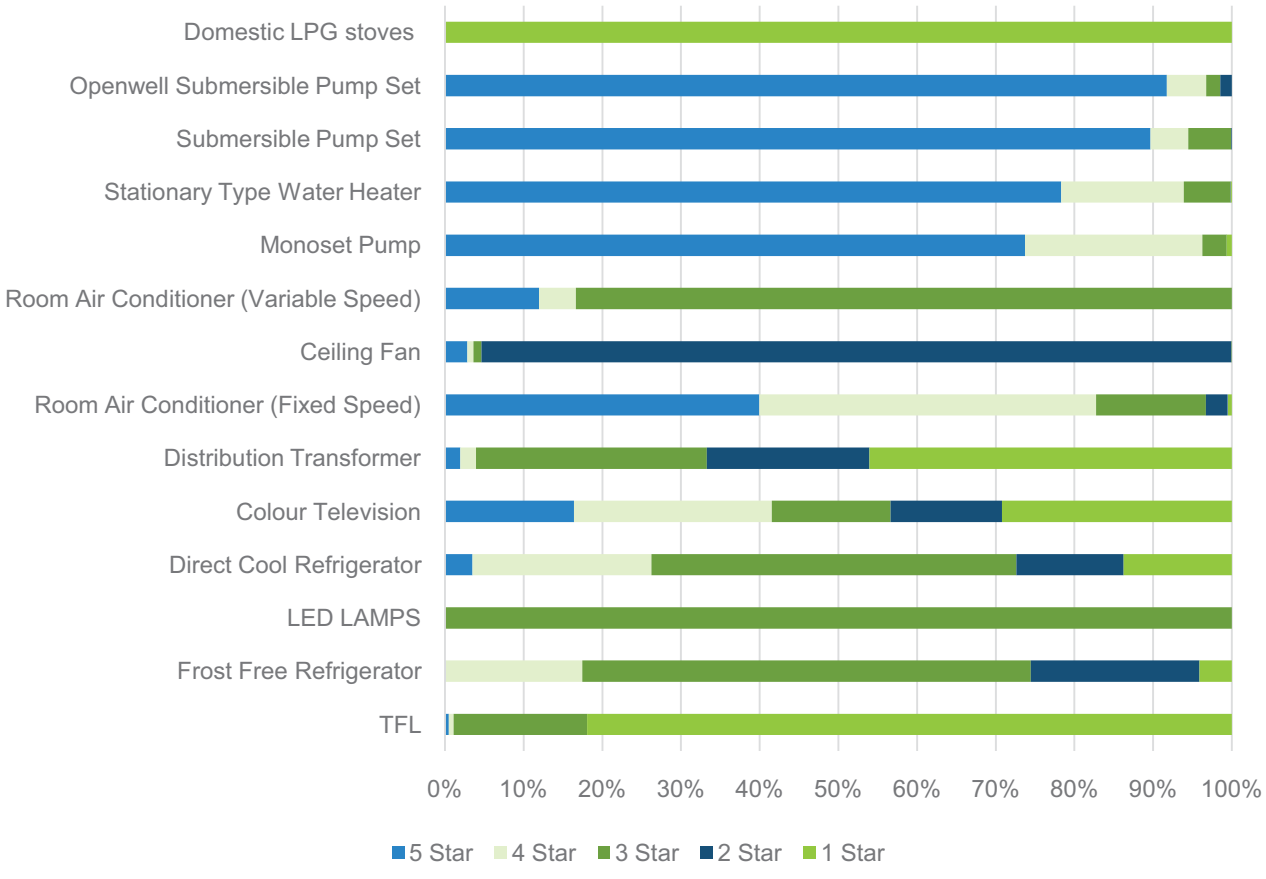
Only 2,592 computer production were recorded during 2016-17 and 18 chillers production have been recorded during 2019-20, these number are very less thus not presented in graph above.

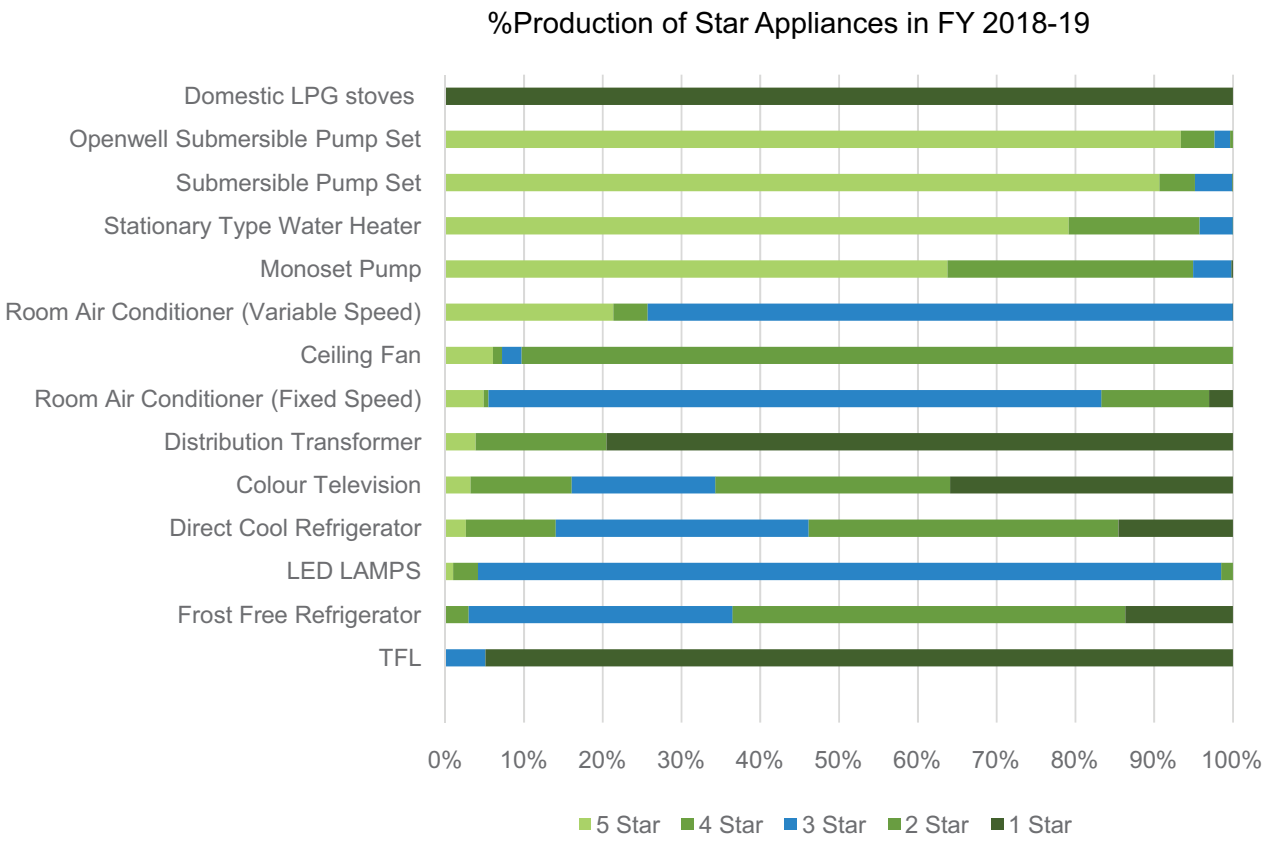
Percentage Sales of the appliance with respect to the star label categories from 1 to 5 stars is presented in Figure 38 for FYs from 2016-17 to 2019-20.

% Production of Star Appliances in FY 2016-17



%Production of Star Appliances in FY 2017-18





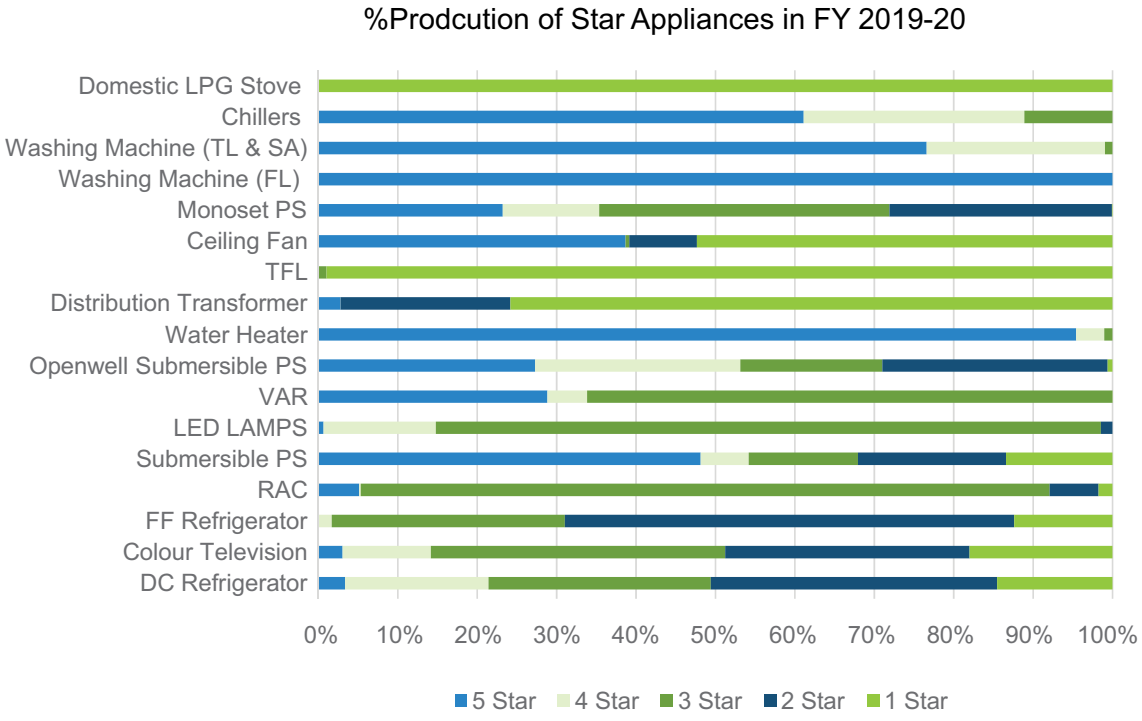


Figure 38: % Production of different star label appliance as manufactured during FY 2016-20

It can be inferred from the analysis above that the maximum percentage of 5 star labeled appliances manufactured during FY 2016-20 are pump sets, followed by water heaters and air conditioners and color televisions. Majority of LED lamps and tube lights manufactured fall under 3-star label category. Almost 99.9% LPG stove are manufactured in the market are 1 star labeled. % change in production volume for 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 manufactured volumes of the respective star rating with the energy saving potential i.e. *manufactured 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 59.

Table 59: Baseline energy consumption for appliances

Appliance	Label details	Baseline Energy / Baseline standard
Frost Free Refrigerator	Annual Energy consumption	759 + adjusted volume*0.8716
Tubular Fluorescent Lamps	Lumen /Watt	61
Room Air Conditioners (RAC)	ISEER	2.3
RAC (Cassette, Floor Standing Tower, Ceiling, Corner AC)	ISEER	2.3
Distribution Transformer (DT)	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)
Direct Cool Refrigerator	Annual Energy consumption	561 + adjusted volume*0.645
Stationary Storage Type Electric Water Heater (Geyser)	Standing energy loss in 24 hours	Matrix
Color Television	Annual Energy consumption	0.1494*screen area in m2 + 4.38
Variable Capacity Air Conditioners	ISEER	3.1 for Split AC 2.5 for Window AC
LED Lamps	Lumen /Watt	79
Induction Motors	Efficiency	IE2
Agricultural Pump sets	Performance factor	IS 14220 for Open well, IS8034 for Submersible pump set, IS9079 for moonset pump sets
Ceiling Fans	Service factor	3.1
Domestic Liquefied Petroleum Gas (LPG) Stoves	Thermal Efficiency	68%
Washing Machine (Front loaders (drum type))	kWh/kg/cycle	0.18

Appliance	Label details	Baseline Energy / Baseline standard
Washing Machine (Top loaders & semi-automatic machines)	kWh/kg/cycle	0.0185
Computer (Notebook/Laptops)	Endorsement	
Ballast (Electronic/Magnetic)	Ballast Efficiency Class	B1
Office equipment (printer, copier, scanners)	Endorsement	
Solid State Inverter	Efficiency Range	83%
Microwave Oven	Energy consumption per cycle (Wh)	60 Wh/cycle
Diesel Pump sets	Specific Fuel Consumption (g/h/m/l/s)	1
Diesel Generator	Specific Fuel Consumption (g/kWh)	336
Chillers (Air cooled)	ISEER	3 - 3.1 (Matrix)
Chillers (Water cooled)	ISEER	4.8 - 6 (Matrix)
Solar Water Heaters	Efficiency	40%
Light Commercial Air conditioners	ISEER	2.7
Deep freezers	Annual Energy Consumption(kWh)	5.07*V + 151.98 (Hard Top) 9.21*V+613.4 (Glass Top)

5.3.3. Step-3: Defining the operating hours

Energy saving for the appliances sold under FY2016-19[41]

Energy saving $_{(kWh/year)}$ = [Annual energy consumption $_{by\ appliance\ as\ defined\ by\ baseline\ (kW)}$ – Annual energy consumption $_{of\ star\ rated\ appliance\ (kW)}$] * number of respective star labeled $_{appliances\ sold\ during\ the\ FY}$ * annual operational hours $_{of\ the\ appliance\ as\ defined\ under\ the\ S\&L}$

Energy saving for the appliances sold under FY2019-20[42]

Energy saving $_{(kWh/year)}$ = (Energy consumption by appliance as defined by baseline (kW) – energy consumption of star $_{rated\ appliance\ (kW)}$) number of respective star labeled appliances $_{sold\ during\ the\ quarter}$ * annual operational hours of the appliance $_{available\ for\ the\ specific\ quarter}$*

Energy saving for the FY 2019-20 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.

41 Annual operating hours are considered as the appliances manufactured before the 1st April 2019 will operate for 100% hours as defined under the S&L guidelines

42 Quarterly production of the appliances are multiplied by the respective operating hours corresponding to the quarter of the sale. It is assumed that appliances manufactured in Q1 will be working for 100% of the operating hours, appliances manufactured in Q2 will work only for 75% of the annual operating hours, appliances manufactured in Q3 can only realize the saving for 50% of the annual operation hour of the respective appliance and similarly appliance sold in Q4 can give the saving corresponding to 25% of the annual operating hours.

Details of the operation hours for the different appliance is defined in Table 60

Table 60: Annual operation hours for appliance[43]

Appliance	Annual operation hours[44]
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
Color Television	8760
Variable Capacity Air Conditioner	1600
LED Lamp	1200
Pump set	2000 = (250 days and 8 hours a day)
Ceiling Fan	3600
Domestic LPG stove	730
Chillers	4000

Number of annual cycles for the washing machine is considered as 220.

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

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

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 61 and Figure 39.

Table 61: Energy Savings in FY 18-19 from appliances manufactured during FY 2016-20[45]

Appliance	Savings (MU) from appliance				Total Savings (MU) FY: 2016-20
	FY: 2016-17	FY: 2017-18	FY: 2018-19	FY: 2019-20	
Mandatory Appliances					
LED LAMPS*	28	65	695	939	1,539
Distribution Transformer	263	403	628	244	1,538
Stationary Type Water Heater	410	472	563	437	1,882
TFL	636	570	365	176	1,747
Room Air Conditioner (Variable Speed)	447	1,461	999	807	3714
Frost Free Refrigerator	1,473	1,967	2,178	1,558	7,175
Room Air Conditioner (Fixed Speed)	3,364	3,329	1,794	1,367	9854
Color Television	1,032	3,806	3,749	2,412	10,999
Direct Cool Refrigerator	4,059	4,459	5,072	3,634	17,224
Voluntary Appliances					
Submersible Pump Set	1,310	1,921	2,427	1,066	6,724
Open well Submersible Pump Set	368	426	590	439	1,822
Computer	6	0	0	0	6
Monoset Pump	43	46	50	28	167
Ceiling Fan	162	191	156	90	599
Washing Machine	0	0	0	17	17
Chiller	0	0	0	1.18	1.18
Total Savings (BU)	**13.6**	**19.1**	**19.3**	**13.22**	**65.011**

Saving of domestic LPG stoves is presented in Table 62.

It can be inferred from above that Direct Cool and Frost Free Refrigerator, Room ACs, Color TV, and pump sets contribute to 75%

S&L programme has led to saving of 65.011 BU and 7,249 toe during 2019-20 due to interventions carried out during the FY2016-20

45 Energy savings estimated for LED on account of sales of 70.23 Mn (58.2 +12.03) LED are considered under UJALA programme for FY 2018-20. Saving from 185 Mn LED during 2018-19 and saving from 493 Mn LED during 2019-20 is considered under S&L programme. Total discounted saving for LED under S&L programme during 2016-20 is 1,539 MU considered in total . Similar approach is used for emission calculations

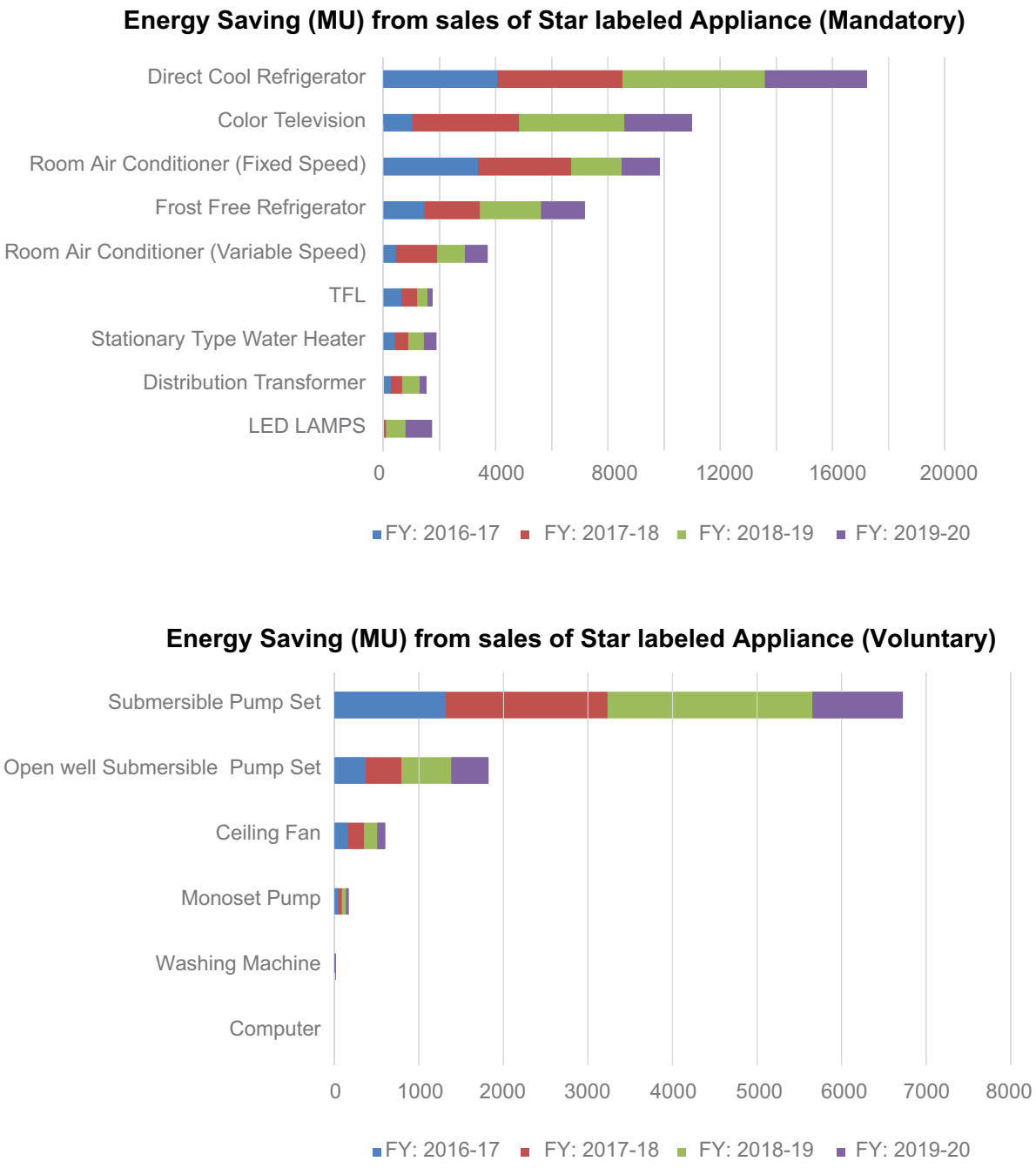


Figure 39: Energy savings for different appliances in FY2016-20

Table 62: Energy saving due to sale of Domestic LPG stoves during 2016-20

Year	Q1	Q2	Q3	Q4	Total (toe)
2016-17	240	226	481	422	1368
2017-18	490	562	345	238	1635
2018-19	330	450	279	308	1367
2019-20	793	1453	487	145	2879
Total (2016-20)					7249

of the savings due to appliances under S&L programme.

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[46]. Summary of the emission reduction is tabulated in Table 63.

S&L programme has led to reduction of 53.32 Mn tonne of carbon dioxide emissions during 2019-20 due to interventions carried out during the FY2016-20.

Table 63: Emission reduction (Mn tonne of CO_2 annually) due to S&L programme

Appliances	Emission reduction due to sales of appliances during				
	FY2016-17	FY2017-18	FY2018-19	FY2019-20	FY2016-20
Mandatory Appliances					
LED LAMPS	0.02	0.05	0.57	0.77	1.42
Distribution Transformer	0.22	0.33	0.51	0.20	1.26
Stationary Type Water Heater	0.34	0.39	0.46	0.36	1.54
TFL	0.52	0.47	0.30	0.14	1.43
Room Air Conditioner (Variable Speed)	2.76	2.73	1.47	1.12	8.08
Frost Free Refrigerator	1.21	1.61	1.79	1.28	5.88
Room Air Conditioner (Fixed Speed)	0.37	1.20	0.82	0.66	3.05
Color Television	0.85	3.12	3.07	1.98	9.02
Direct Cool Refrigerator	3.33	3.66	4.16	2.98	14.12
Voluntary Appliances					
Submersible Pump Set	1.07	1.58	1.99	0.87	5.51
Open well Submersible Pump Set	0.30	0.35	0.48	0.36	1.49
Computer	0.004	0.00	0.00	0.00	0.004
Monoset Pump	0.04	0.04	0.04	0.02	0.14
Ceiling Fan	0.13	0.16	0.13	0.07	0.49
Washing Machine	0.00	0.00	0.00	0.01	0.01
Domestic LPG stove	0.003	0.004	0.004	0.008	0.019
Chillers	0.00	0.00	0.00	0.001	0.001
Total (Million tonne to CO_2)	**11.153**	**15.684**	**15.804**	**10.849**	**53.32**

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

CHAPTER 6

Lighting

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 27.43 Crore LED bulbs during the FY 2016-20 out of total sales of 36.70 Crore LED bulbs till January 2021. EESL's UJALA programme sold around ~22.5%[47] of the total LEDs sold in the country since inception of this programme in all sectors of economy. LED industry has sold approximate 126 crore LEDs apart from UJALA till Jan 2020. Sales of these LEDs led to reduction of approximately 133 Mn tonne of CO_2.

In addition to LED sales under the programme EESL has sold 75.9 lakh LED tube lights and

47 http://www.ujala.gov.in/

23.4 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 in past five years. Details of the programme for all appliances are available online on the 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 40.

Total number of different appliances retrofitted under UJALA programme is shown in Table 64.

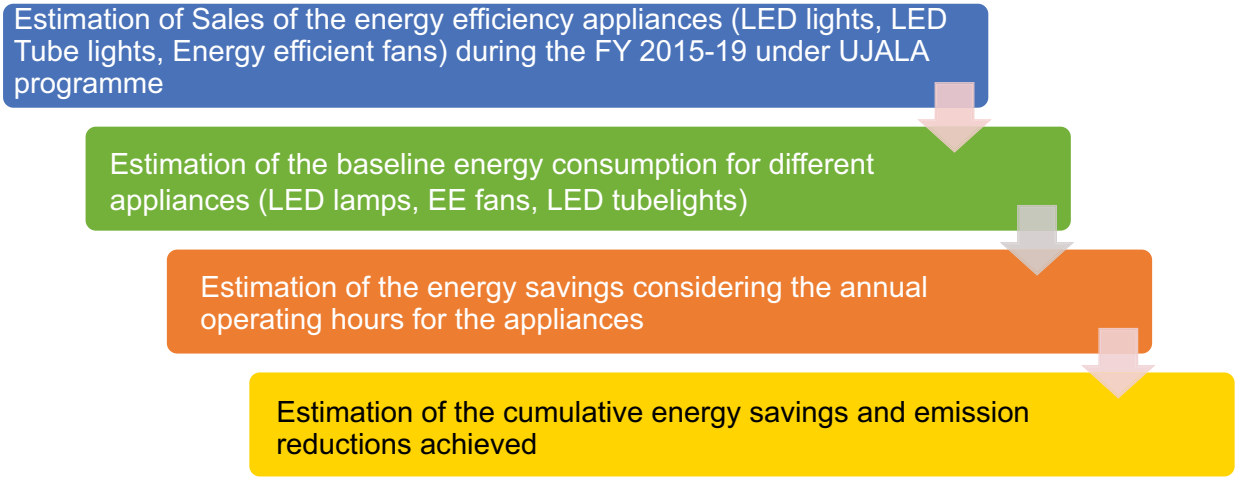


Figure 40: Methodology for estimation of Saving under UJALA scheme

Table 64: Sales of appliances under UJALA programme

Year	Number of units distributed (Million)		
	LED bulbs	LED Tube lights	EE Fans
2016-17	124.3	1.57	0.59
2017-18	79.8	4.26	1.06
2018-19	58.2	1.52	0.57
2019-20	12.03	0.24	0.11
Total	**274.3**	**7.59**	**2.34**

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 65.

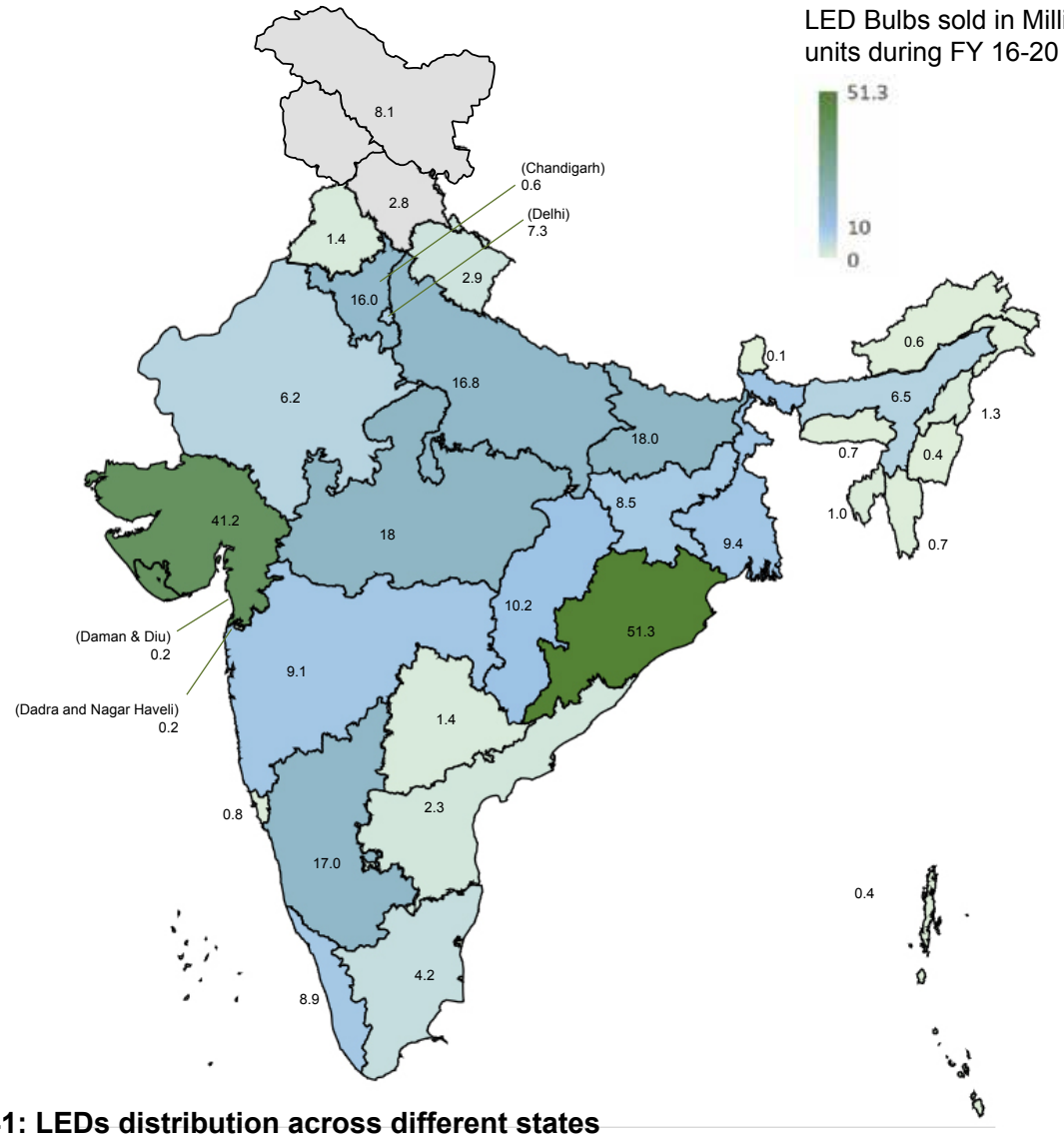


Figure 41: LEDs distribution across different states

Table 65: Power saving estimation per appliance

Appliance	Base line wattage of appliance	Wattage of energy efficient appliance	Reduction in wattage
LED Lamp[48]	59	9	50
LED tube light	40	20	20
EE Fan[49]	75	50	25

48 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

49 EE fan is 5 star rated 50 W BEE fan

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. Number of LED installed and Energy saving estimations are tabulated in Table 66: Number of LED bulbs distributed across *different states*.

Table 66: Number of LED bulbs distributed across different states[50]

States/UTs	No. of LED lamps distributed				Total No. (Lakh) FY-2016-20	Energy saving (MU) from LED bulbs during 2016-20
	2016-17	2017-18	2018-19	2019-20		
Andaman & Nicobar Islands	3.9	0.0	0.1	0.0	0.4	51.1
Andhra Pradesh	16.2	4.9	1.9	0.1	2.3	295.2
Arunachal Pradesh	0.0	2.5	3.2	0.1	0.6	74.5
Assam	7.5	7.4	49.5	1.0	6.5	834.0
Bihar	101.9	61.6	14.1	2.0	18.0	2294.4
Chandigarh	0.9	3.6	1.1	0.1	0.6	72.5
Chhattisgarh	51.3	39.8	9.8	1.3	10.2	1305.3
Dadra & Nagar Haveli	0.9	0.4	0.4	0.3	0.2	25.2
Daman & Diu	1.2	0.1	0.4	0.2	0.2	24.3
Delhi	50.0	15.8	4.5	2.5	7.3	931.4
Goa	8.2	0.0	0.0	0.0	0.8	104.8
Gujarat	304.0	90.9	13.1	3.7	41.2	5258.9
Haryana	103.4	47.0	8.4	0.8	16.0	2039.1
Himachal Pradesh	18.1	4.7	3.4	2.3	2.8	364.0
Jammu & Kashmir	61.6	17.1	2.6	0.1	8.1	1038.9
Jharkhand	36.5	32.9	13.8	1.4	8.5	1080.2
Karnataka	88.3	42.0	27.5	12.1	17.0	2170.1
Kerala	34.6	50.2	3.3	1.4	8.9	1141.4
Madhya Pradesh	103.4	57.9	13.4	5.0	18.0	2295.6
Maharashtra	74.3	14.3	2.6	0.2	9.1	1167.2
Manipur	0.0	1.3	2.9	0.3	0.4	56.5
Meghalaya	2.0	1.5	2.2	0.0	0.6	72.3
Mizoram	4.6	1.2	0.9	0.0	0.7	85.2
Nagaland	3.1	6.6	2.5	0.5	1.3	162.3
Odisha	58.8	61.0	323.3	70.2	51.3	6557.1
Puducherry	0.0	0.0	0.3	0.0	0.0	3.2
Punjab	0.0	9.4	3.8	1.2	1.4	184.0
Rajasthan	24.7	19.0	14.6	3.3	6.2	787.3
Sikkim	0.8	0.3	0.4	0.0	0.1	18.7
Tamil Nadu	0.0	19.3	18.4	4.2	4.2	535.6
Telangana	5.1	6.3	2.8	0.1	1.4	181.8
Tripura	4.7	2.3	2.9	0.1	1.0	127.9
Uttar Pradesh	34.7	110.6	19.7	3.1	16.8	2147.7
Uttarakhand	10.3	9.8	6.3	2.3	2.9	367.2
West Bengal	28.8	56.3	8.0	0.5	9.4	1195.0
Total	**1,243**	**798**	**582**	**120**	**274**	**35,047**

50 Distribution split of fans and tube lights are not available for different years

Table 67: Energy saving from UJALA programme[51]

Year	Energy savings (MU): LED lamps	Energy savings (MU): LED Tube lights	Energy savings (MU): EE Fans
FY 16-17	15,883	55	53
FY 17-18	10,195	153	99
FY 18-19	7,436	57	55
FY 19-20	1,533	8.7	10
Total	**35,047**	**274**	**217**

LED's contribute to 98.6% of the total energy savings under the programme, and tube lights contribute 0.8% of the savings. CO_2 emission reductions are calculated considering the grid emission factor as 0.82 kg/kWh.[52]

UJALA programme has led to energy savings of 35.58 BU during 2019-20 on account of the implementations carried out during the FY 2016-20

UJALA programme has led to reduction of 29.1 Million tonnes of carbon dioxide emissions during 2019-20 on account of the implementations carried out during the FY 2016-20

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

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

CHAPTER 7

Municipality

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.

With increasing population and improved standards of living, has increased the energy demand for the service provided by the urban local bodies has led to growth in the demand of the utilities in the urban ns semi urban area. The Municipality sector/urban local bodies (ULBs) consume electricity for various utility services like street lighting, water pumping, sewage treatment, and in various public buildings.

Public lighting and public water works account for nearly 3.75% of India's net power consumption which stands at nearly 27.5 billion units and is expected to rise to approximately 51.23 billion units by 2021-22. As per BEE/NPC study, there is a savings potential of nearly 23% in municipalities by adopting demand side management initiatives.

In order to tap the energy savings potential of municipalities, BEE initiated nation-wide Municipal DSM (MuDSM) programs to address energy efficiency in water pumping, sewage pumping, street lighting and public buildings across Urban Local Bodies (ULBs) in the country. 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.

7.1. 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. LED street lights installed by EESL under the programme are equipped with Central Control

Over 101 lakh LED street lights have been installed during the FY 2016-20 across India.

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

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/ .

7.2. Methodology for energy saving estimations

Energy savings due to number of inefficient street lights that have been replaced by LED street lights during FY 2016-20, are calculated. In order to calculate the energy (electrical) savings and emission reduction, following steps are used:

7.2.1. Step-1: Identification of the lights installed during the FY 2016-20

Total number of lights installed during the FY16 -20 are presented in Table 68

Table 68: State wise installations of LED street lights[53]

States/UTs	No. of LED street lights installed in FY				Total Number of LED lights installed (Lakhs)
	2016-17	2017-18	2018-19	2019-20	2016-20
Andaman & Nicobar Islands	0	13,364	136	1,237	0.14
Andhra Pradesh	367,179	436,616	1,505,402	357,639	23.09
Assam	5,203	15,691	2,757	17,086	0.24
Bihar	150	16,450	176,471	250,920	1.93
Chandigarh	0	41,394	548	1,534	0.42
Chhattisgarh	10,639	254,566	82,136	58,606	3.47
Delhi	142,994	41,839	250	26,078	1.85
Goa	83,917	122,874	0	2,866	2.07
Gujarat	139,186	708,680	35,632	5,081	8.83
Haryana	179	11,226	52,596	16,340	0.64
Himachal Pradesh	19,041	32,864	515	3,789	0.52
Jammu & Kashmir	700	11,291	0	74,728	0.12
Jharkhand	5,093	88,386	1,380	389,493	0.95
Karnataka	0	9,592	290	2,428	0.10
Kerala	9,685	1,535	30,032	46,768	0.41
Lakshadweep	0	0	0	1,000	0.001
Madhya Pradesh	9,643	49,710	22,518	35,567	0.82
Maharashtra	33,731	37,428	326,110	420,956	3.97
Odisha	1,879	49,349	254,397	29,601	3.06
Puducherry	0	100	50	0	0.0015
Punjab	3,772	21,380	52,866	29,288	0.78
Rajasthan	491,708	229,478	79,712	68,827	8.01

53 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 Number of LED lights installed (Lakhs)
	2016-17	2017-18	2018-19	2019-20	2016-20
Sikkim	0	868	0	0	0.01
Tamil Nadu	0	6,689	0	1,010	0.07
Telangana	21,370	763,772	49,926	161,403	8.35
Tripura	9,589	30,028	1,559	375	0.41
Uttar Pradesh	36,429	474,378	323,644	204,178	8.34
Uttarakhand	500	26,164	8,715	12,304	0.35
West Bengal	0	14,971	5,568	59,690	0.21
Total	**1,392,587**	**3,510,683**	**3,013,210**	**2,278,792**	**101**

7.2.2. 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 69 and Table 70.

Table 69: Energy savings 2016-20 from Street-Lighting programme

FY	Number of Installations	Number of States	Annual energy savings in BU
2016-17	1,392,587	21	0.934
2017-18	3,510,683	28	2.356
2018-19	3,013,210	24	2.022
2019-20	2,278,792	27	1.529
Total	**10,195,272**		**6.841**

7.2.3. Step-3: Estimation of the emission reduction[54]

Table 70: Energy saving and emission reduction from SLNP programme (state wise)

States/UTs	No. of LED street lights installed in FY-2016-20	Energy Savings in FY 2016-20 (MU)	Emission reduction (Million Tonne of CO_2)
Andaman & Nicobar Islands	14,737	9.89	0.01
Andhra Pradesh	2,666,836	1789.45	1.47
Assam	40,737	27.33	0.02
Bihar	443,991	297.92	0.24
Chandigarh	43,476	29.17	0.02
Chhattisgarh	405,947	272.39	0.22
Delhi	211,161	141.69	0.12
Goa	209,657	140.68	0.12
Gujarat	888,579	596.24	0.49

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

States/UTs	No. of LED street lights installed in FY-2016-20	Energy Savings in FY 2016-20 (MU)	Emission reduction (Million Tonne of CO_2)
Haryana	80,341	53.91	0.04
Himachal Pradesh	56,209	37.72	0.03
Jammu & Kashmir	86,719	58.19	0.05
Jharkhand	484,352	325.00	0.27
Karnataka	12,310	8.26	0.01
Kerala	88,020	59.06	0.05
Lakshadweep	1,000	0.67	0.001
Madhya Pradesh	117,438	78.80	0.06
Maharashtra	818,225	549.03	0.45
Odisha	335,226	224.94	0.18
Puducherry	150	0.10	0.00
Punjab	107,306	72.00	0.06
Rajasthan	869,725	583.59	0.48
Sikkim	868	0.58	0.00
Tamil Nadu	7,699	5.17	0.00
Telangana	996,471	668.63	0.55
Tripura	41,551	27.88	0.02
Uttar Pradesh	1,038,629	696.92	0.57
Uttarakhand	47,683	32.00	0.03
West Bengal	80,229	53.83	0.04
Total	**10,195,272**	**6841.03**	**5.61**

SLNP programme has led to energy savings of 6.8 Billion units and reduction of 5.6 Million tonnes of CO_2 emissions during FY 2019-20 on account of the implementations carried out during the FY 2016-20.

7.3. Municipal Energy Efficiency Programme (MEEP)

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 pump sets across 500 AMRUT cities. As on 31st March 2020 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 dashboard where the detailed status of the programme are made online for the public : https://meep.eeslindia.org/dashboard/.

Over 250 ULB's have been audited during FY 2016-20 and discussions are being held with ULBs for implementation.

CHAPTER 8

Transport

Increased economic activity in past decade has lead to growing income per capita. As standards of living rise and the demand for personal transportation increases, the shift from non-motorized to motorized mobility has seen multifold rise in past decade in India.

With increasing demand for motorized transport, consumption of petroleum products has touched the levels of 211 million metric tonnes during 2019 causing a significant expenditure on oil import[55]. In view of the growing demand of fossil fuel and rapidly growing motor vehicle fleet in India, Government of India has set a target for 10% reduction on imports by 2022.

The Indian automotive industry produces a wide variety of vehicles including 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

Tyres as an important component of vehicle has been identified for potential saving of fuels. BEE has initiated the programme to bring automobile tyres under the S&L programme.

BEE has also initiated the development of a computer-based simulation tool (like VECTO in EU) for testing of the vehicle fuel efficiency prior to the launch of a model.

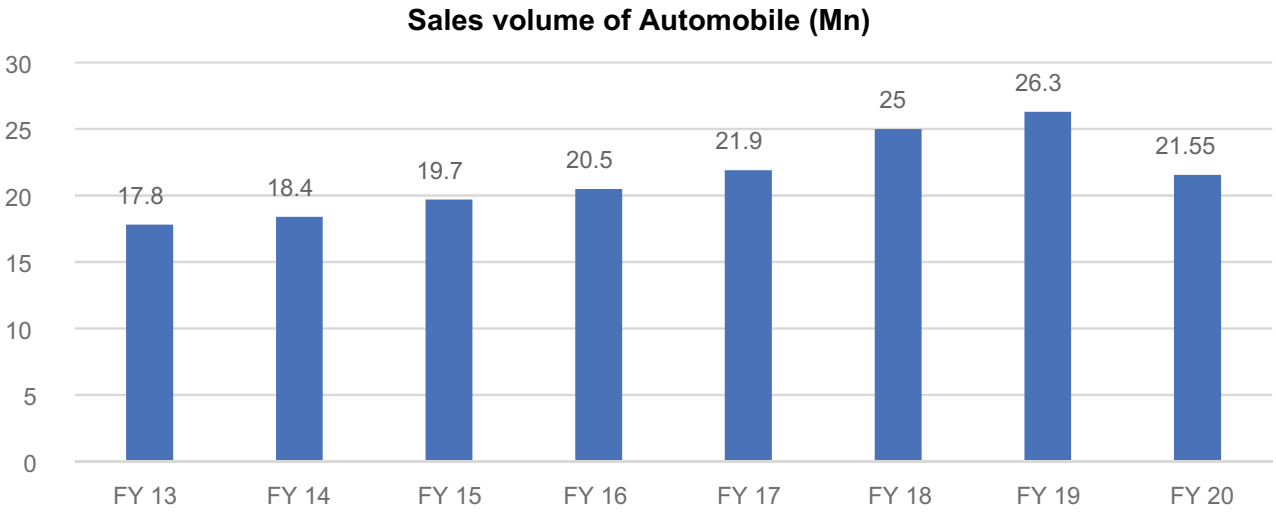


Figure 42: Sales of Automobiles

55 https://www.statista.com/statistics/715241/india-consumption-volume-of-petroleum-products/#:~:text=The%20consumption%20volume%20of%20petroleum,petroleum%20products%20does%20not%20suffice.

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[56]. In the passenger car segment, India is mainly a small car market. Sales of Automobiles has decreased to 21.55 Mn during 2019-20 from 26.3 Mn during FY 2018-19. 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 80.8% and 13% of over 21.55 million vehicles sold in FY20, respectively. The market share by vehicle type and the total vehicle sale in India between FY13-FY 20 is presented next.[57]

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 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 the Figure 44.

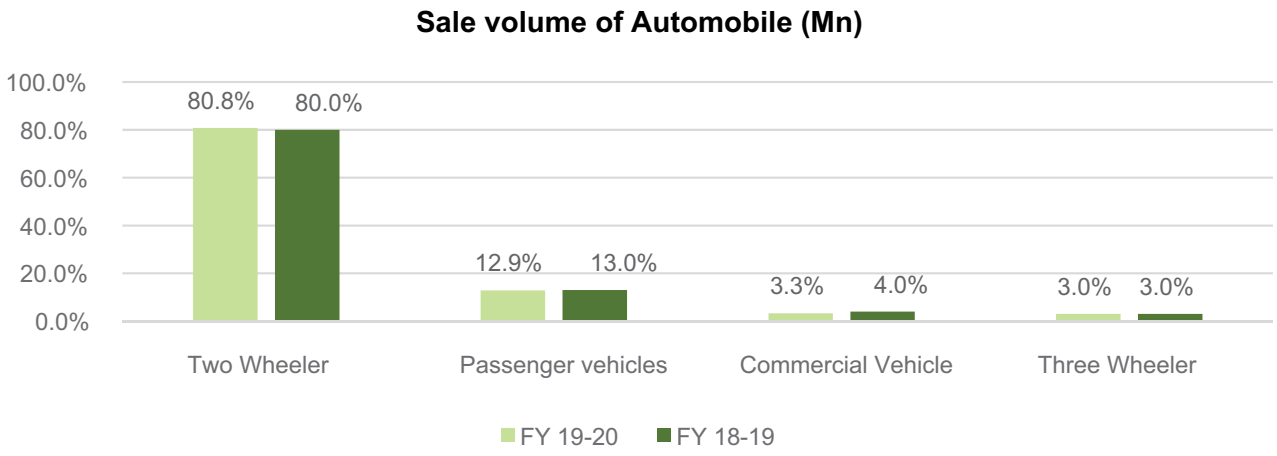


Figure 43: Segment wise % sales of Automobiles

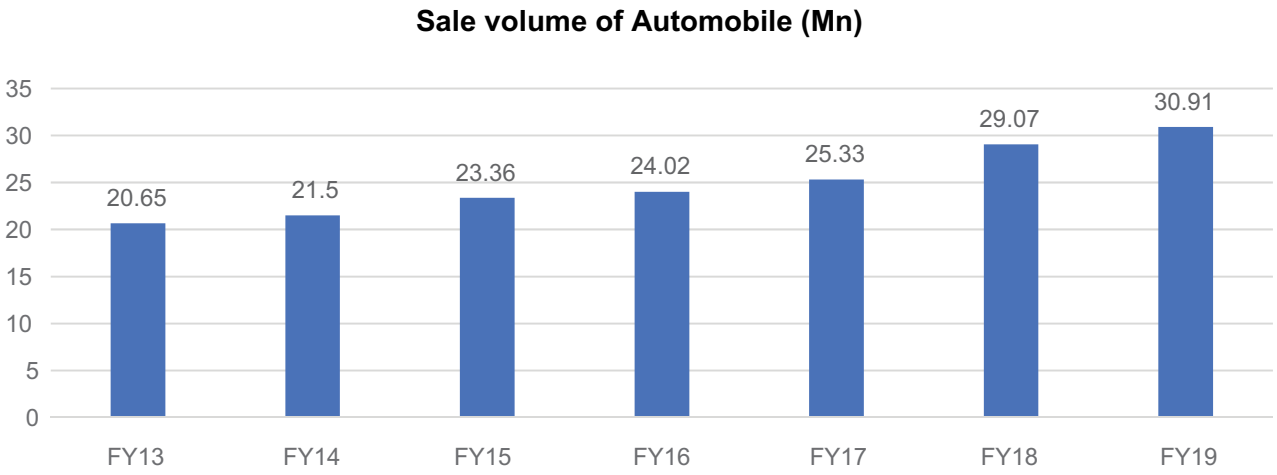


Figure 44: Production details of Automobiles

56 https://www.statista.com/statistics/608392/automobile-industry-domestic-sales-trends-india/

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

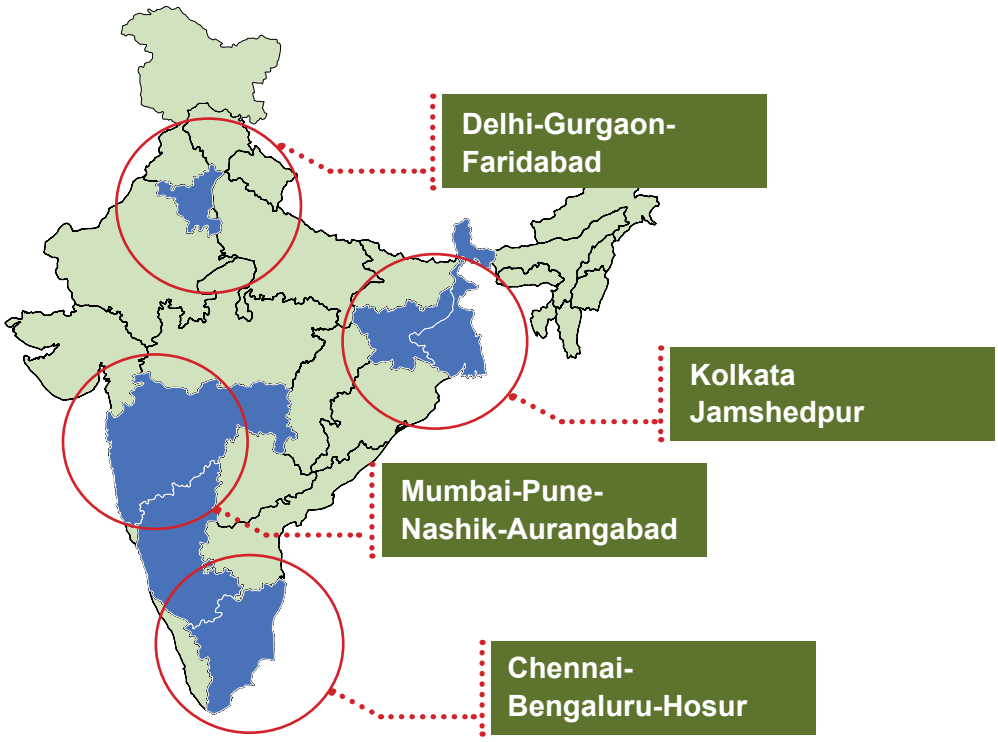


Figure 45: Major automobile manufacturing clusters in India

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.

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.

Table 71: 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

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.

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

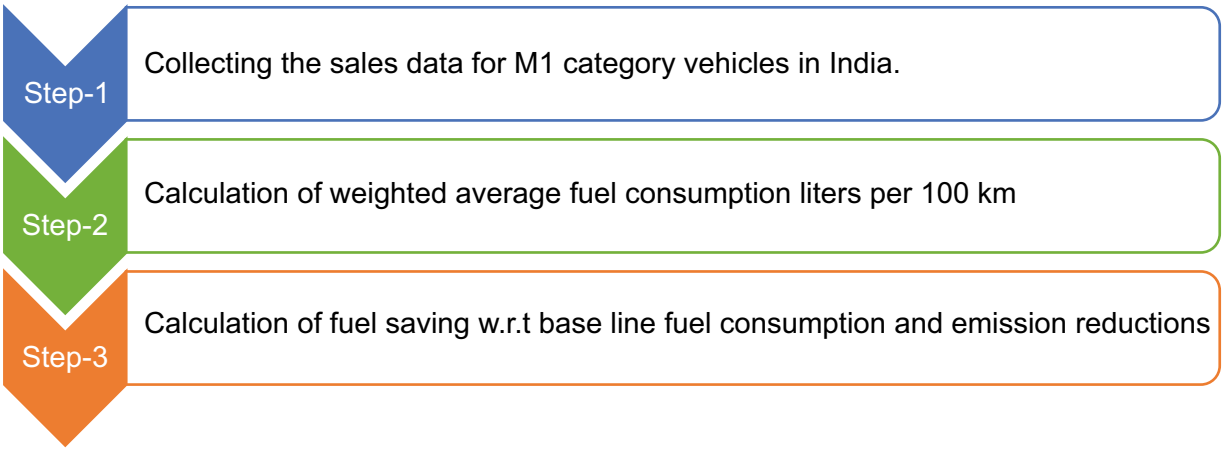


Figure 46 : Methodology for saving calculation under CAFE norms

8.2.2. Energy and emission saving calculations

Sales data for M1 vehicle category was received from ICAT and is presented in Table 72 and Figure 47 (including petrol, diesel, CNG, EVs including includes pure electric, plug in hybrid and strong hybrid models):

Table 72: Sales of M1 category vehicles in India in 2017-20

2017-18	2018-19	2019-20*
3323754	3408712	2792220

**Sales figures from two manufacturers is not included as data is not available*

Share of the petrol vehicles is highest (61.6%) followed the by the sales of the diesel vehicle (36.2%). Sales of the hybrid vehicles were only 0.07% during the FY 2017-20.

Step-2: Calculation of fuel consumption per 100 km

The fuel consumption per 100 km for the vehicles sold during FY 2017-20 is 6.64, 6.65, 5.16 liters per 100. Value of baseline fuel consumption is calculated using the formula *0.0038*weight of vehicle +2.58.*

% Sales of the different Vehicles during FY 2017-20

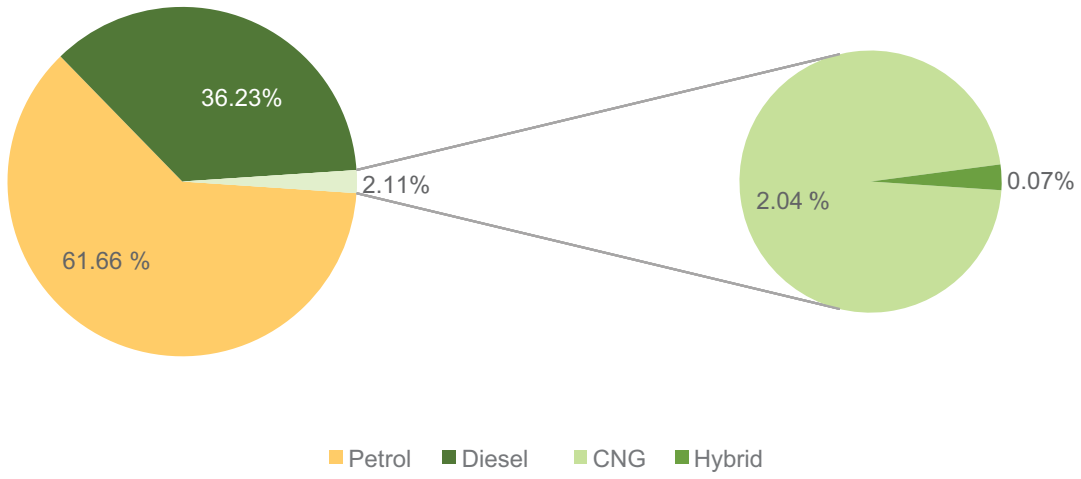


Figure 47: % Share of sales of different vehicles (FY 2017-20)*
**Hybrid – includes pure electric, plug in hybrid and strong hybrid models*

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. The fuel savings in 2017-20 in petrol equivalent and Mtoe is shown in Table 73

Table 73: Fuel savings (in Mtoe)

Year	Savings in Mtoe
2017-18	0.42
2018-19	0.43
2019-20[58]	0.35
Cumulative 2017-20	1.2

The CO_2 emission savings for 2017-20 is presented in Table 74:

Table 74: CO_2 emission savings (in $MTCO_2$)

Year	CO_2 emission reductions
2017-18	1.28
2018-19	1.32
2019-20	1.08
Cumulative 2017-20	3.7

8.3. Accelerating E-mobility adoption in India[59]

In order to achieve the commitment for reducing the green house emission as committed by the GoI during COP21, transport sector will also play a vital role. Introduction of alternative means in the transport sector which can be coupled with India's rapid economic growth, rising urbanization, travel demand and country's energy security. Electric mobility presents a viable alternative in addressing these challenges, when packaged with innovative pricing solutions, appropriate technology and support infrastructure and thus, has been on the radar of Government of India. To boost the faster adopting of the EVs as mode of transportation, government plans to increase the share of the EV to 30% in the total sales by 2030.

Electric vehicles could help diversify the energy needed to move people and goods thanks to their reliance on the wide mix of primary energy sources used in power generation, greatly improving energy security.

EV's capacity of energy storage could help support the uptake of clean energy by enabling seamless integration and use of variable renewable generation. These initiatives combined with smart grid and fostering RE power generation will help in decarbonization of the power sector, electric vehicles would also provide major contributions to keep the world on track to meet its shared climate goals.

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.

Given the nascent market, over the past few years, the central 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 vehicles in the country. The

58 Will be revised on receipt of the updated data

59 Section will be updated on receipt of data for 2019-20

EESL has commissioned captive chargers across all offices located in the State/UT of Andaman & Nicobar Island, Andhra Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Gujarat, Haryana, Jharkhand, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Telangana, Uttar Pradesh, West Bengal, Tamil Nadu, Arunachal Pradesh and Uttarakhand.

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. 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. The scheme planned to focus on:

- Technology development
- Demand creation
- Pilot projects
- Charging infrastructure
- Public EV charging infrastructure

Individual budget had been allocated for 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 INR 918 Crore over the period of two years, INR 300 crore for FY 2015-2016 and INR 618 crore for FY 2016-2017.

FAME-II

The FAME-II scheme acts 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 INR 10,000 Cr. The scheme is proposed to be implemented through the following verticals: Demand Incentives, Establishment of network of public charging stations and administration of the scheme. The subsidies that have been provided under the scheme is presented in Table 76

Table 75: Component wise budget under FAME-I

S. No.	Component of the scheme	2015-2016 (INR Crore)	2016-2017 (INR Crore)
1	Technology platform	81	138.75
2	Demand incentives	179.25	392.25
3	Public charging infrastructure	11.25	23.25
4	Pilot projects	23.25	57.75
5	IEC/Operations	5.25	5.25
Total		**300**	**618**
Grand Total			**918**

(considering 1USD=75INR).

Table 76: 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

Other highlights under the scheme are as follows:

- Electrification of Public Transport - The policy focuses on penetration of EV's in public transport, with a maximum demand incentive of INR 3545 Crore. set aside for e-buses
- Under the FAME – II policy, subsidies have only been provided 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

During 2019-20, total of 2636 public charging stations have been sanctioned and EESL, NTPC, REIL are the major implementing agencies. As on 31st March 2020 , EESL has issued the LoA for 333 number of the public EV charging, RIL and NTPC has issued 73 and 81 LoA respectively.

Hyderabad is most progressive city where total of 114 LoAs have been singed for installation of public charging EV infrastructure As on 31st March 2020 , followed by Ahmedabad and Noida with 82 and 54 public EV charging stations respectively.

Till March 2020, 17393 EV were sold under FAME II, 17 number of OEMs have register under FAME-II. 48 EV models have been approved for the subsidy under FAME-II. Details are presented in Table 77.

EESL has commissioned captive chargers across all offices located in the State/UT of Andaman & Nicobar Island, Andhra Pradesh, Assam, Bihar, Chhattisgarh, Delhi, Gujarat, Haryana, Jharkhand, Kerala, Madhya Pradesh, Maharashtra, Rajasthan, Telangana, Uttar Pradesh, West Bengal, Tamil Nadu, Arunachal Pradesh and Uttarakhand.

NTPC has commissioned the chargers in cities of Bhopal, Jabalpur and Hyderabad.

REIL has supported the drive across 8 cities across India.

Initiative for development of the Public Charging EV Infrastructure

Ministry of Power designated Bureau of Energy Efficiency (BEE) as the Central Nodal Agency (CNA) to coordinate for rolling out of the public charging EV public charging infrastructure in various states across India. 26 states nodal agencies have also been designated by state governments for the National-level rollout of public charging infrastructure in the country.

Public EV charging infrastructure is identified as the key to the uptake of EVs in India. In absence of policies to foster faster growth of public charging infrastructure such as notifying

Table 77: Number of Models, OEM registered and vehicle sold under Fame -II

Category of eVehicle	Number of models approved under FAME II	Number of OEMs, Registered under FAME II	Number of Vehicle sold
E-2W	18	9	12622
E-3W	16	6	3896
E-4W	14	2	875
TOTAL	**48**	**17**	**17393**

EESL has supported, 97 nos. of Public Charging Stations (PCS) have been installed in NDMC Delhi, SDMC Delhi, CMRL Chennai, Maha Metro Nagpur, Noida Authority and NKDA Kolkata.

PowerGrid has in installed four number of EV public charging stations in Hyderabad till March 2020.

NTPC has installed 100 EV public charging stations in 17 cities across 13 States.

EESL launched India's first public charging plaza at Chelmsford Club, New Delhi. It was inaugurated by Hon'ble Power Minister. The charging plaza can charge 14 e-cars at the same time.

public 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[60].

Government has taken several steps for creating the public EV charging infrastructure and building the road map for cleaner transport for the Nation. Few of the key initiatives taken during the 2019-20 are:-

- Government announced setting up public EV charging infrastructure for one e-charging kiosk at around 69,000 petrol stations across India
- Government took slew of measures to promote EVs like cutting GST to 5%, allowing delinking of battery cost of 2-3 wheelers from vehicle cost as it accounts for 40% of the cost
- In February 2020, the government sanctioned setting up of 2,636 public EV charging stations under FAME-II.

8.3.1. Methodology to calculate fuel savings from adoption of EVs

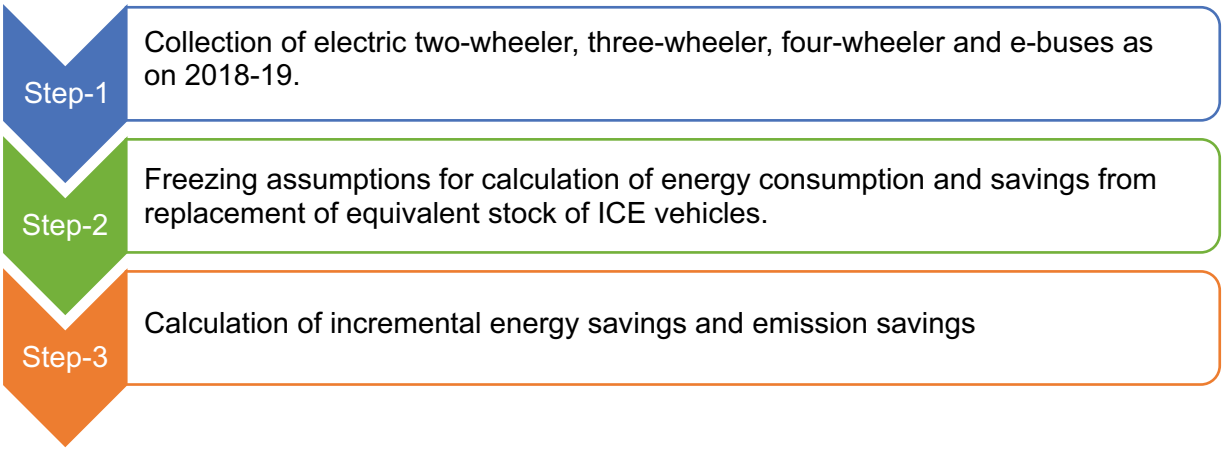


Figure 48: Methodology for fuel saving estimation due to EVs

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

8.3.2. Energy and emission saving calculations

EESL has deployed 1514 e-cars to various government ministries across the country.

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 78

Table 78: Number of EVs supported under FAME-I and FAME -II (as on March 2020)

Vehicle segment	Number of vehicles supported FAME -I	Number of vehicles supported FAME -II
e- 2-wheeler	1,70,000	12622
e- 3-wheeler*	2598	3896
e- 4-wheeler	12,447	875
e-Bus (6-8 mts)	400	0
e-Bus (8-10 mts)		
e-Bus (10-12 mts)		

**Though the number of electric three wheelers in India number 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 79.

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 80

Table 79: 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

Table 80: Annual running (Kilo meter) for ICE vehicles

Parameters	Electric 2W	Electric 3W	Electric 4W	Electric Buses
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[61]	44 g/km	92 g/km	231 g/km	1056 g/km

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

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 2018-20 are given in Table 81

Table 81: Energy and CO_2 savings in 2019-20[62]

Particular	Savings due to sales during 2018-19	Savings due to sales during 2019-20	Saving in achieved during 2019-20
Energy savings in Mtoe	0.04	0.005	0.045
CO_2 emission savings in $MtCO_2$	0.07	0.007	0.077

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 1,26,366 km of track over a route length of 67,956 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.

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[63].

It is estimated that Indian Railways have exceeded the targets set under PAT-II and have achieved additional energy savings of 1,18,790 toe, totaling to 1,95,894 toe. The emission reduction through the implementation of PAT Cycle-II is about 0.27 million tonnes of CO_2.

The total electricity consumption in traction energy in Indian Railways over the years is presented in Figure 49 and Figure 50.

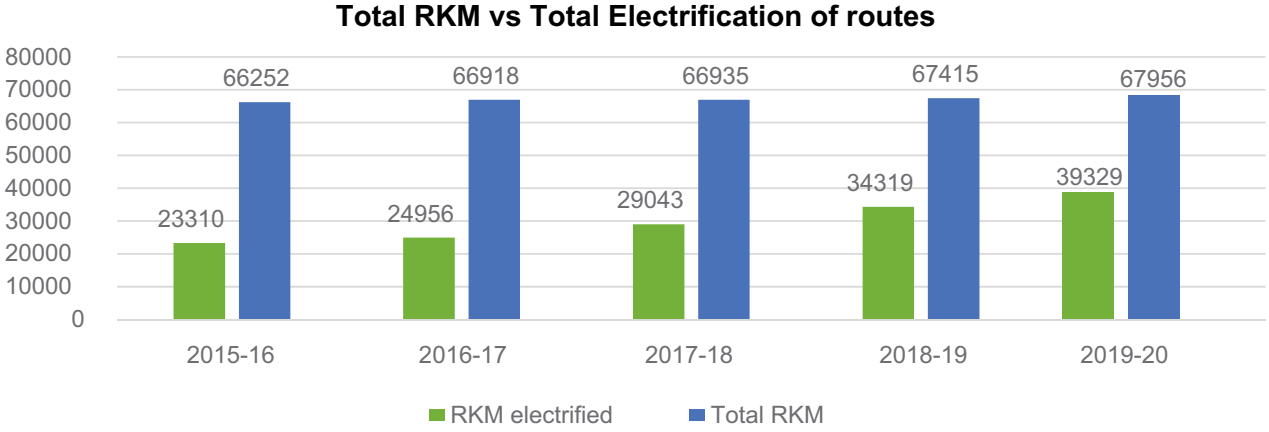


Figure 49: Route electrification in Indian Railways

62 Fame I savings are reflected

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

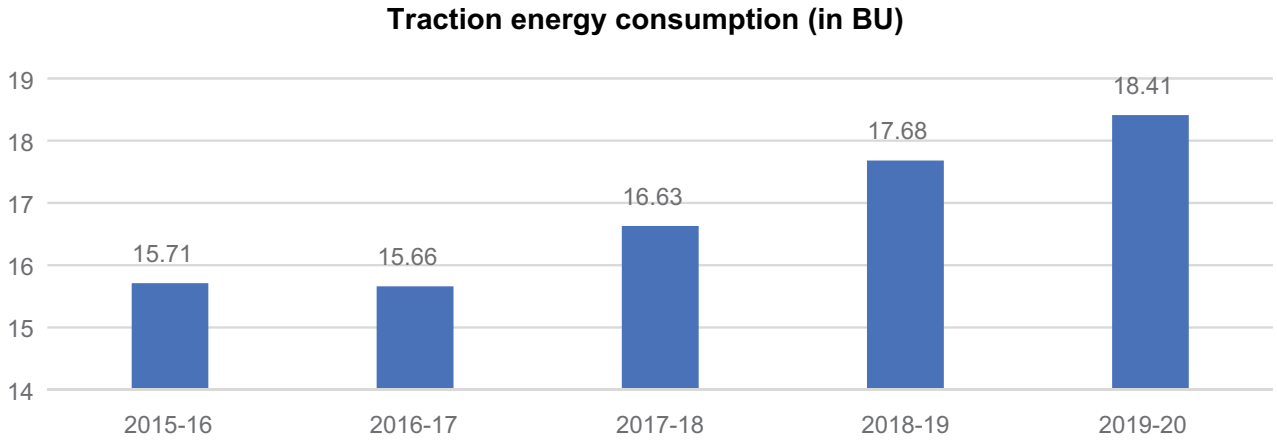


Figure 50: Traction energy consumption by Railways[64]

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 the figure above. To counter this increase, the Indian railways has taken several steps to 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 all Broad-Gauge routes by December 2023 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 4378 RKM in 2019-20 taking percentage of electrified routes over IR to 61.63%. 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 has been discontinued from 31st March 2019.

Ramp up production of Electric locomotives: The year 2019-20 saw the highest ever locomotive production, which included 784 electric locos, 4 diesel converted electric locos working as multi-units during 2018-19 and one diesel loco was converted to electric during 2019-20. 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.

A cumulative production of 784 electric locomotives has been achieved during 2019-20 utilizing the capacity of CLW, DLW & DMW

HOG (Head-on-Generation) Trains: More and more trains are being taken on HOG

64 http://indianrailways.gov.in/railwayboard/uploads/directorate/stat_econ/Annual-Reports-2019-2020/Summery-sheet-Annual-Report-English_2019-20.pdf

system resulting in saving of diesel in power cars. All WAP-7 locomotives being produced by Indian Railways are fitted with Hotel Load Converters. Over 1120 trains have been taken on HOG scheme resulting in saving of over Rs 2241.16 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. 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

Indian Railways is having total Non-Traction power requirement of about 400MW. With a view to reduce energy consumption in non-traction area, Indian Railways has initiated various measures. IR consumed around 2.34 billion units of electricity for its non-traction usage in 2019-20. The consumption of non-traction energy has largely been static from 2008 onwards, despite increase in electric load (lifts & Escalators) and addition of railway assets on stations buildings such as air-conditioned waiting rooms, new platforms, etc. an indication of efficacy of energy conservation efforts of Indian Railways, The non-traction energy consumption over the years is in presented in Figure 51.

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 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

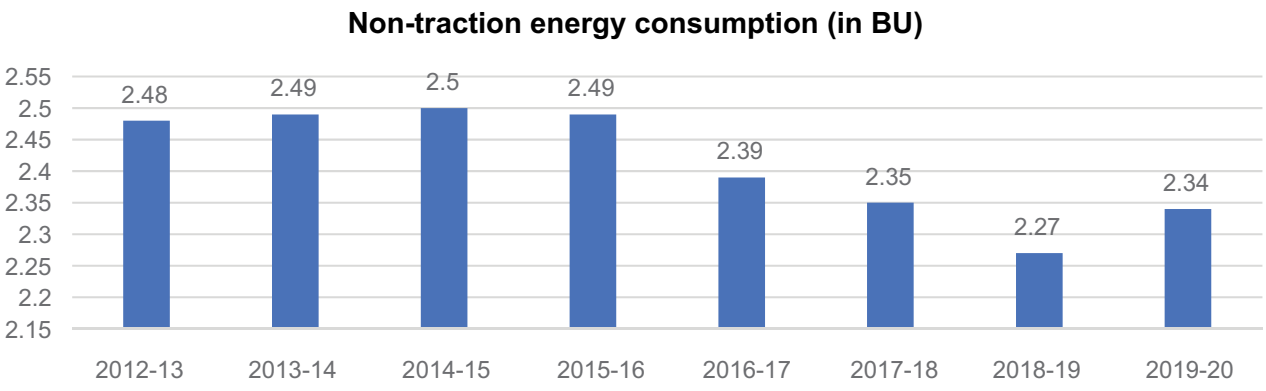


Figure 51: Non traction energy saving

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 Government 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.

CHAPTER 9

Agriculture

Agriculture plays a vital role in India's economy over 70 per cent of the rural households depend on agriculture. Agriculture is an important sector of Indian economy as it contributes about 17% to the total GDP and provides employment to over 60% of the population. Gross Value Added (GVA) by agriculture, forestry and fishing was estimated at Rs. 19.48 lakh crore (US$ 276.37 billion) in FY20 (PE). Growth in GVA in agriculture and allied sectors stood at 4% in FY20.[65] The electricity consumption in the sector over the last 9 years is presented in Figure 52

During 2018, an MoU was signed between Indian Council of Agricultural Research (ICAR) and Bureau of Energy Efficiency (BEE), Ministry of Power, to create awareness for energy efficient pump sets and operational practices so as to adopt energy and resource efficient approaches with an aim **to create awareness**

on energy efficiency and conservation in agricultural practices, particularly in using agriculture pump sets, tractors and other machines and to improve fuel and water resource use efficiency thereby reducing the

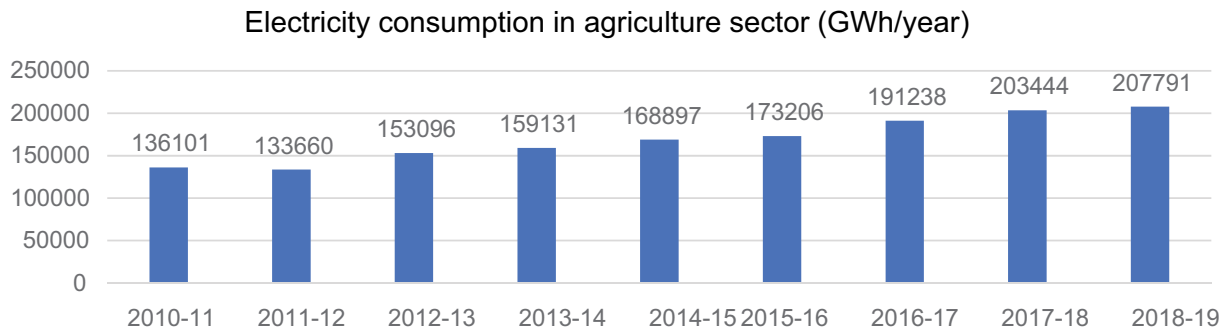


Figure 52: Energy consumption in agriculture sector

65 https://www.ibef.org/industry/agriculture-india.aspx

cost of cultivation so as to increase farmer's income in harmony with strategies of **"Per drop more crop" and "Doubling Farmers' income"**.[66]

In line with the MoU signed, suitable official from SDA's / Krishi Vigyan Kendra (KVKs) Agriculture universities / ESCOs were engaged to discuss the information pertaining to Energy Efficiency and its conservation in agriculture practices. 155 farmer training workshops have also been conducted by SDAs with support of KVKs on "Energy and Water Conservation" and around 11,114 farmers have been benefitted by these programs.

Benefit derived by the farmers from KVK's -

- Awareness on energy efficiency and conservation in agricultural practices, particularly in using agriculture pump sets, tractors and other machines.
- Improving fuel efficiency and water resource use efficiency thereby reducing the cost of cultivation so as to increase farmers' income in harmony with strategies of "Per drop more crop" etc.
- Development of Fuel Economy norms for Agricultural tractors is also under process, by BEE. BEE is working to develop the S&L for the tractors and it will be rolled out in coming years.

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 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 are 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 electricity 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 along with creating awareness for using 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 82.

66 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1696466

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

Table 82: 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%

Benefits to various stakeholders under the programme

The AgDSM programme involves several stakeholders such as farmers (the main beneficiary), Discom (implementing agency/ project owner) the State Electricity Regulatory Commission (SERCs) and ESCOs. Benefit accrued by various stakeholders by implementation of AgDSM are presented in Figure 53

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 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:

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 53: Benefits of the AgDSM programme

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 SERCs. 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.

The current status of the number of pumps installed in state of Andhra Pradesh and Uttar Pradesh and summary of these installations is presented in Table 83.

9.1.2. Methodology adopted to calculate energy savings and CO_2 emission savings

There are total 10,784 BEE 5 star rated 5 HP pumps which were distributed during FY 2019-20 to replace inefficient pumps. For the purpose of energy saving calculations in 2019-20, 50% of the total number of installations in the year 2019-20 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.

Table 83: Number of pump-set installations under AGDSM

Particular	2016-17	2017-18	2018-19	2019-20
Number of pumps	5109	18,018	40,488	10,784

9.1.3. Impact of the scheme

Prior to the FY 2019-20, total 63,615 BEE five star rated 5 HP pumps were installed across India. In the financial year 2019-20, there were total 10,784 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 54

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 2019-20 is 0.18 BU and reduction in emission of CO_2 is 0.148 Million Tonne.

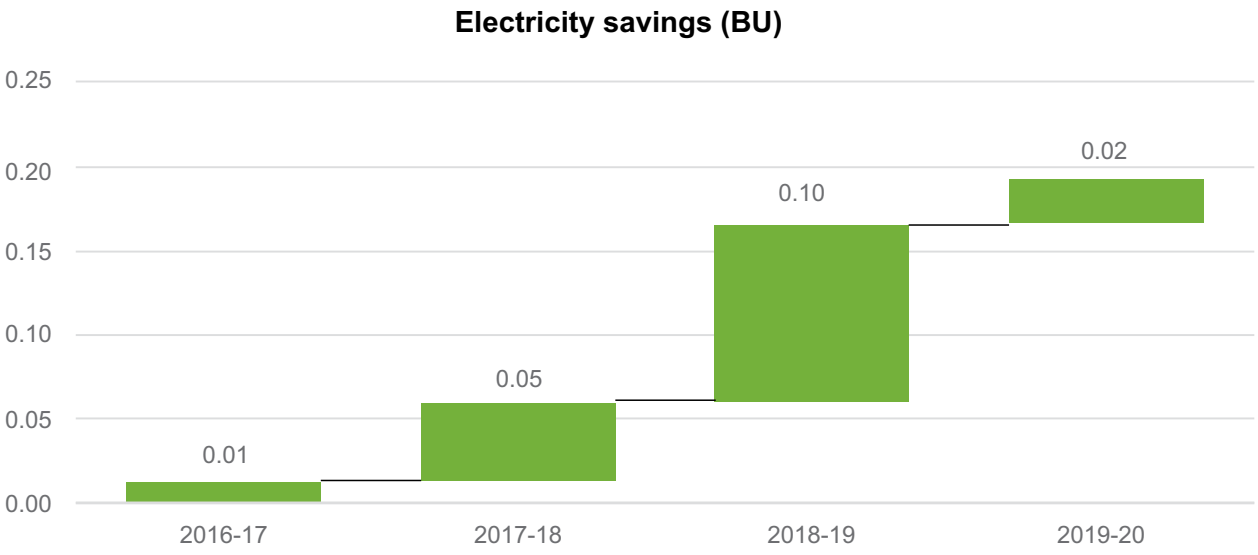


Figure 54: Energy saving from AgDSM

CHAPTER 10

State Designated Agency

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. SDAs are assigned no direct energy saving target for the central schemes. For building the capacity of SDAs, they have been encouraged to take up energy efficiency projects with due monitoring and verification. Across the states, different agencies' have been nominated to be SDAs such as Renewable Energy Development Agency, Electrical Inspectorate, Distribution Companies or Power Departments.

At present, there are total of 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.

BEE supports the capacity building of SDAs by providing technical and financial assistance to undertake specific activities. Financial support is provided for the following activities:

- Creation of database for Energy Managers / Energy Auditors and Designated Consumers and other stakeholders.
- Organizing workshops/training program, develop communication through electronic/ print media to increase awareness of stakeholders in the field of energy efficiency
- Conduct investment grade energy audit and preparation of Detailed Project Reports of Government Buildings
- Development of adequate IT infrastructure for database management and communicating with stakeholders.
- Implementation of Energy efficiency Demonstration Projects in the area of energy efficient street lighting, revamping of drinking water pumping system and energy efficiency in SMEs clusters as well as rural and urban households

10.1. SAATHEE portal

The Power and New & Renewable Energy Minister RK Singh has launched 'SAATHEE' *(State-wise Actions on Annual Targets and*

Headways on Energy Efficiency) – a portal for *State Designated Agency for state level activities. The portal was launched during the 30th National Energy Conservation Awards (NECA) function organized by the Ministry of Power in association with BEE.*

Management Information System based portal 'SAATHEE' will support BEE and SDA for real-time monitoring of the progress of implementation of various energy conservation endeavors at state level. This portal will also support BEE in decision making, coordination, control, analysis, and implementation and enforcement of the compliance process for various energy consumers at the pan India level.

This portal will support BEE in providing information regarding best practices, major achievements and upcoming important events of each SDA.

SAATHEE portal will present the physical and financial progress of SDAs in the form of multiple reports and provide tracking of progress made by the SDAs

10.2. 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).

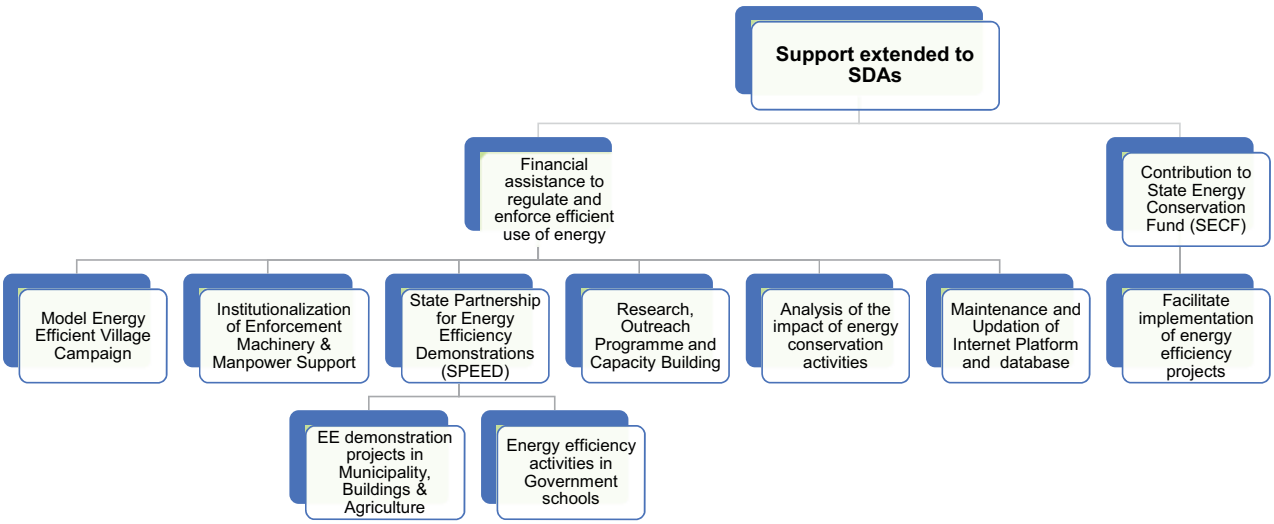


Figure 55: SDA Activities and initiatives

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

10.2.1. 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 Government schools is undertaken by SDAs under this head along with disseminating awareness amongst school children by way of establishing energy clubs, organizing debates, quiz programs, etc.

2. Model Energy Efficient Village Campaign – The Model Energy Efficient Village Campaign is initiated to convert villages into model energy efficient villages by replacing existing inefficient electrical equipment / appliances with BEE star rated appliances including household bulbs, street lights, fans, water pumps, etc.

3. Institutionalization of Enforcement Machinery at State level – BEE provides financial assistance to the SDAs under this head for the purpose of establishment of an enforcement machinery at the State level and for development of a robust mechanism to enable this machinery to discharge its duties / tasks effectively.

4. Manpower Support to SDAs – This component enables the SDAs to engage manpower to coordinate, administer, regulate and enforce activities pertaining to energy efficiency within the State.

5. State Energy Efficiency Research & Outreach Programme – This component covers the following objectives.

- To strengthen partnership between policy makers and educational institutions to forward the energy efficiency drive.

Activities in villages

- To enhance the outreach activities undertaken by SDAs.

6. Workshops / Capacity Building of energy professionals – SDAs organize workshops/ capacity building programmes at regular interval to disseminate information regarding energy efficiency to energy professionals like Accredited / Certified Energy Auditors, Energy Managers, Designated Consumers, Financial Institutions, Energy Service Companies (ESCOs), building professionals, architects, ECBC Master Trainers, equipment / appliance manufacturers and retailers, DISCOM officials, etc. and to address issues faced by them.

7. Maintenance and updating of Internet Platform and other database created on energy efficiency – All the SDAs have established dedicated website highlighting energy efficiency measures undertaken in the State. The websites are linked with that of the Bureau of Energy Efficiency and with other SDAs to facilitate ease of information exchange.

8. Analysis and survey of the impact of energy conservation activities by SDAs – SDAs document the outcomes of various energy conservation activities undertaken by them and submit the same to BEE.

10.2.2. 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. As on 31st March 2020, 31 states have constituted SECF out of which about 25 States have also provided matching contribution.

10.3. Andaman & Nicobar

Energy Efficient Village Campaign was been supported by SDA for the implementation of Energy Efficient measures across different villages in the region. Thirteen schools have been identified for implementation of Energy Efficiency measures. Andaman & Nicobar

Demonstration projects

Activities in Govt. schools

administration has notified ECBC for the building sector in the union territory.

10.4. Arunachal Pradesh

PHED has implemented the IE3 motors at different pumping station, this will result in the lower energy consumption at the pumping stations. During the FY 19-20 various EE initiatives had been led by Arunachal Pradesh Energy Development Agency (APEDA). APEDA has undertaken replacement of existing conventional electrical equipment with 3044 LED Bulbs, 2182 EE Fans, 1,757 LED Tube lights in nineteen Government schools.

Amendment of ECBC has been completed by the state. SDA has also promoted the EE drive in the five villages across the state.

10.5. Andhra Pradesh

SDA has undertaken replacement of 750 ordinary agricultural pump sets with energy efficient pumps. Further, SDA has conducted Investment Grade Energy Audit (IGEA) for 528 pump sets across ten districts. SDA supported the drive to transform two villages as model energy efficient villages (Vinjarampadu village in Krishna districts and Peddapodillu of Kurnool district). State Government of Andhra Pradesh has notified ECBC for building sector.

10.6. Assam

SDA is in process of replacing conventional luminaries and fans with energy efficient luminaries and fans in 100 government schools. During first phase 50 schools have been retrofitted with EE appliances. SDA has identified 10 villages for uptake of Model Energy Efficient Village Campaign therein.

10.7. Bihar

SDA has completed retrofitting of existing inefficient lighting system and fans with energy efficient luminaries and fans at Mangal Talab Auditorium, Patna. SDA supported the energy audit activities at Governor's residence.

SDA has received nomination of 31 government schools out 101 proposed (one school from each sub division) from district collectors within the state for carrying out replacement of existing inefficient lighting system and fans with energy efficient luminaries and fans therein. 1587 EE fans, 1650 LED bulbs and 858 LED Tube lights have been replaced in 31 schools.

SDA has implemented Model Energy Efficient Village Campaign in 10 villages, converting them into model energy efficient villages by replacing existing conventional household lamps, street lights and fans with energy efficient ones.

SDA has supported implementation of EE pump sets for rural drinking water system at Bhojpur, Nalanda, Gaya and Jahanabad; and SDA is in the process of replacement of inefficient pumps by energy efficient pumps in the Urban Local Body of Patna.

State Government of Bihar has amended the ECBC notification.

10.8. Chandigarh

SDA carried out the replacement of inefficient lights with LED at government press building sector- 18, High Court, and government senior secondary school in sector 23.

10.9. Chhattisgarh

SDA has implemented energy efficiency demonstration projects in 68 government schools. SDA has also identified over 100 schools for undertaking replacement of existing conventional lights and ceiling fans with energy efficient ones.

SDA is in process of implementing Model Energy Efficient Village Campaign in 8 villages across Chhattisgarh.

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

10.10. Daman and Diu

SDA is implementing pilot EE drive in one government building, one government school, and one village. Further, SDA has envisaged to develop Energy Conservation Centre at these model building, school, and village.

10.11. Delhi

SDA has implemented energy efficiency measures in Delhi Secretariat building through PWD, based on recommendations of energy audit conducted therein.

EEREMC is in process of implementing energy efficiency measures in five government hospitals within the territory of Delhi, as pilot project. 106 government schools have been identified by EEREMC for formulation of energy clubs and subsequent uptake of EC activities and celebration EC week therein on large scale.

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

10.12. Goa

SDA has engaged M/s. EESL for conversion of 16 Government Schools and 7 Kendriya Vidhalayas to model energy efficient schools by replacing all existing conventional appliances by energy efficient ones. State Government of Goa has amended the ECBC and the notification of ECBC is currently under process.

10.13. Gujarat

SDA supported in installation of 5000 BLDC Fans in different police stations across the state. SDA has undertaken installation of 5000 LED batten and EE fans in government schools/ residential school/ Ashram region. SDA has identified five village with population of 3000-4000, for providing the LED Street light, LED bulb, LED TL and five star rated fans in schools and panchayats.

10.14. Haryana

SDA has supported the implementation of energy conservation measures at Navodaya Vidyalayas, Kasturba Gandhi Balika Vidyalaya's. SDA is implementing energy efficient drive across 220 government schools.

Haryana Government has amended and notified ECBC as per the local conditions and subsequently issued directions for incorporation of the notified ECBC in the building by-laws of Urban Local Bodies.

10.15. Himachal Pradesh

SDA supported in implementation of street lighting demonstration project at Himachal Pradesh University, Shimla by retrofitting 500 old inefficient street lights and implementation of 5000 LED lights is in progress.

Energy Efficiency activities in Jawahar Navodya Schools/Kendriya Vidyalayas and Sainik Schools in the state have been planned where replacement of inefficient electrical equipment such as luminaries, fans and street lights in all Jawahar Navodya Vidyalyas and Kendriya Vidyalyas of the State shall be undertaken.

State Government of Himachal Pradesh has notified ECBC.

10.16. Jammu & Kashmir

Under the provisions of "Charging Infrastructure for Electric Vehicles-Guidelines and Standards" issued by Ministry of Power on 14th December, 2018, Jammu & Kashmir has designated following agencies as the State Nodal Agency (SNA) to set up EV charging infrastructure in the state-

- EM&RE Wing Jammu as "Nodal Agency for Jammu Division".
- EM&RE Wing Kashmir as "Nodal Agency for Kashmir Division".
- EM&RE/Generation Wing Ladakh as "Nodal Agency for Ladakh Division".

ECBC cell has been established. This ECBC cell is working towards the notification of ECBC through Government of J&K as per their local conditions. Subsequently, the notified ECBC is required to be incorporated in the building byelaws of ULBs.

10.17. Jharkhand

Drinking Water & Sanitation Department, Jharkhand has submitted a proposed based on IGEA conducted by UNDP to SDA for implementation of EE Demo Projects in Municipal Water Pumping Stations in Ranchi.

State of Jharkhand has amended the ECBC. Notification of ECBC is currently under process.

10.18. Karnataka

SDA supported the replacement of conventional street lights with energy efficient LED street lights in the premises of "Sri Adi Chunchanagiri Kshethra, Malemahadeshwara temple hilly place, Sri kengal Anjaneya temple, channapatna".

SDA also supported in replacement of the existing low efficient electrical appliances by the energy efficient appliances such as LED bulbs, Tube lights, EE fans at selected hundred government schools across the state.

SDA supported activities for replacing the existing low efficient HPSV/ MV / FTL / CFL / Incandescent street lights by appropriate capacity Energy Efficient LED lights on the existing ESCOM poles with control units at the five selected backward villages across the state.

10.19. Kerala

Ranni Grama Pnachayat, Pathanamthitta was selected for the implementation of Model Energy Efficient Village campaign programme.

SDA supported energy efficiency drive at Guruvayur Dewasom temple and associated buildings. SDA replacement of inefficient electrical appliances with energy efficient ones at 20 government schools.

10.20. Lakshadweep

EESL has submitted a project proposal to SDA for replacement of 118 less efficient water pumps (0.75 hp to 7 hp) by energy efficient BEE star rated pumps along with control panel, complete with all accessories at Government Institutions at Kavaratti and Amini.

SDA supported the installation over 1 lakh EE LED lights (domestic lighting and street lighting sector) under UJALA programme.

10.21. Madhya Pradesh

SDA is supporting the implantation of model energy efficient village campaign at six villages, by converting the entire villages into model energy efficient villages.

Government of Madhya Pradesh 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.

10.22. Maharashtra

SDA (MEDA) has undertaken replacement of old inefficient pump with energy efficient pump in Municipal Corporation / Municipal Council area. SDA supported implementation of EE measures at 100 Government Schools and implementation of EE activities in 3 villages is under process.

Government 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.

10.23. Manipur

DSM Cell has been established at MSPDCL. Training programmes on EE & DSM have been conducted for middle level management and circle level officials of MSPDCL.

Government of Manipur has amended the ECBC and the notification of ECBC is currently under process.

10.24. Meghalaya

Meghalaya SDA has completed the replacement of conventional luminaries and fans with energy efficient luminaries and fans in 100 Government schools across the state. SDA is in process of implementing the Model Energy Efficient Village Campaign in 3 villages.

Government of Meghalaya has amended the ECBC and the notification of ECBC is currently under process.

10.25. Mizoram

SDA has successfully replaced 300 inefficient existing energy street lights 250 HPSV with 90-Watt LED street lights at prominent places in 7 districts. SDA has successfully replaced conventional lights and fans with 400 (9W) LED bulbs, 200 (20W) LED tube lights & 400 (50W)

celling fans in 100 school across the state.

SDA has successfully completed energy efficiency activities in eight number of selected villages. SDA has already amended the ECBC, however, notification of amended ECBC is pending.

10.26. Nagaland

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

The Model Energy Efficient Village Campaign has been successfully completed in 4 villages Nagaland.

SDA has engaged M/s. EESL for implementation of energy efficiency measures in 5 Government hospitals.

10.27. Puducherry

SDA supported activities for replacement of existing conventional light and high mast fittings into energy efficient LED lightings at Central Bus Station, Puducherry and Karaikal; replacement of existing conventional light fittings into LED lightings and energy efficient fans at Tirunallar Saniswaran Temple, Karaikal and Sri Kokilambigai Vudanurai Sri Thirukameswarar Temple, Villiyanur, Puducherry. Replacement of existing conventional light, fans and A/C into energy efficient LED lightings, fans and A/C in 10 government libraries in Puducherry and Karaikal region.

SDA supported activated for setting up of a DC e-vehicle fast charging station for four and two-wheeler at the center city, Puducherry.

SDA carried out activated for replacement of existing street lights & mini mast fittings into LED lights in selected 6 rural villages of UT of Puducherry. Implementation of Energy Efficiency activities in 100 Government Schools.

Puducherry has already amended and notified the ECBC 2007 codes and rules and amended the rule as per ECBC 2017.

10.28. Punjab

SDA has undertaken replacement of existing drinking water pumps with energy efficient pumps at DWSS, Chandigarh. Installation of energy efficient electrical appliances in KVs and JNVs of Punjab is under process.

Punjab Government has amended and notified ECBC as per the local conditions and subsequently issued directions for incorporation of the notified ECBC in the building by-laws of Urban Local Bodies.

10.29. Rajasthan

SDA supported activities for replacement of bulbs, fans with LED bulbs and EE fans at selected 2 villages.

Rajasthan SDA is undertaking the replacement of conventional luminaries and fans with energy efficient luminaries and fans in 100 Government 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

SDA has supported replacement activities for conventional appliances (bulbs, lights and fans) with energy efficient LED bulbs, LED tube lights celling fans in 70 government school in the state.

The State of Sikkim has amended the ECBC-2017 and the notification of ECBC is currently under process. Subsequently, incorporation in building byelaws of ULBs needs to be done.

10.31. Tamil Nadu

SDA supported activities for replacing 3600 FTL and, 4800 conventional fans with LED and EE fans across hundred schools.

Tamil Nadu government has amended code as per ECBC 2017. The amended code is with Energy Department for approval.

10.32. Telangana

SDA has prepared State Energy Conservation action plan to strengthen Energy Conservation activities covering all the sectors. Energy auditing of the Government buildings, SC/ ST Hostels and Implementation of the energy efficiency measures is in process. As on 31st March 2020, Programme was implemented in the identified 100 SC/ST/BC/ Social Welfare Govt Hostels across Telangana State.

SDA supported implementation of energy efficiency drive in four selected villages. Energy Survey of the fire stations, branch Post Offices in the districts along with replacing the existing inefficient appliances with EE appliances is carried out successfully in the state.

Model Energy Efficient Village Campaign was implemented in Mahasamudram village, Peddakottapally Mandal, Nagarkurnool District and Gamya Naik Thanda, Kollapur Mandal, Nagarkurnool District.

The state of Telangana has notified the ECBC as per the 2007 version and the same has also been incorporated in their building by-laws of Urban Local Bodies (ULBs). 30 nos of buildings are already covered under ECBC.

10.33. Tripura

SDA has completed retrofitting of conventional appliances with EE appliances in 28 Government schools in 28 nos. school. Activity of replacement of conventional appliances with EE appliances in another 72 schools is in progress.

Tripura Government has notified ECBC.

10.34. Uttar Pradesh

SDA has initiated activity of replacement of existing conventional luminaries and ceiling fans with energy efficient ones in 200 Government Secondary Schools.

UP Government has notified ECBC.

10.35. Uttarakhand

SDA supported retrofitting of conventional appliances with EE appliances has been completed in 28 Government schools across 3 district.

SDA supported activities for replacement of 1787 conventional street lights with energy efficient LED Street lights (74W). Activities for replacement of 7866 conventional lights with EE LEDs (12W) in 26 villages under Model Energy Efficient Village Campaign is under process.

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

10.36. West Bengal

SDA has undertaken replacement of existing conventional electrical equipment with energy efficient equipment viz. lights and fans in 100 government schools.

SDA supported replacement of existing conventional luminaries, pumps and fans with LED luminaries, energy efficient BEE Star Rated pumps and fans respectively at Panchayat Bhavan, Community Centers, Health Centers etc.

CHAPTER 11

Conclusion

Energy sector in India has experienced considerable growth in the last two decades encompassing demand sectors from industrial to transport as well as residential. High urbanization 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.

While continued economic growth is an area of focus for the nation, India has also been aware of the importance of sustainable development. 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.

The tentative findings of the report reflect that the adoption of energy efficiency schemes/ programs presented in Table 84 has led to the overall thermal energy savings in the order of 15.59 Mtoe, while overall electricity savings are to the tune of 145.03 BU. Overall, these energy savings translated into monetary savings of worth INR 115,702 crores and contributed in reducing 177.6 Million Tonnes of CO_2 emission.

Table 84: Summary of Energy Saving (2019-20[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	7.193	8.176	7.896	35.939	18142
	Supply side sectors - TPP, DISCOMs & Refineries	7.121	29.772	9.681	51.015	30967
MSMEs	BEE-SME Programme	0.001		0.001	0.004	2
	BEE-UNIDO-GEF Programme	0.011		0.011	0.047	19
	BEE-WB-GEF Programme	0.012		0.012	0.073	22
Standards and labeling Programme		0.008	65.009	5.599	53.307	39020
UJALA Programme**			35.047	3.014	28.739	21028
ECBC – Commercial buildings programme			0.116	0.010	0.095	69
BEE Star rating buildings			0.179	0.015	0.146	107
Building energy efficiency Programmes			0.212	0.018	0.174	127
Other Green Building Programmes			0.070	0.006	0.057	42
MuDSM (Street Lighting Programme)			6.841	0.588	5.610	4105
AgDSM (Star Rated Pumps)			0.180	0.015	0.148	108
Corporate Average Fuel Economy (CAFE)		1.200		1.200	2.650	2208
FAME Scheme		0.042		0.042	0.077	77
Total		**15.59**	**145.03**	**28.06**	**177.6**	**115,702**

Highlights from each scheme / programme in FY 2018-19[69]:

Industry Sector

PAT Scheme[70]

Interventions in large industries, DISCOMs, Railways, & Buildings under PAT Scheme has led to total energy savings of 17.58 Mtoe (Thermal energy savings of 14.31 Mtoe and 37.95 BU of the electrical energy savings) under PAT cycle II, III. Energy savings for various PAT cycles is presented in Table 85.

68 Savings of AgDSM, BEEP, Star rating building is primarily on account of the retrofitting of the energy efficient BEE star labeledappliances. As saving of the Appliances is accounted in S&L programme thus saving indicated under these heads are not includedin total (to avoid double counting).

** Savings from LEDs under UJALA programme is considered here, LED industry has sold approximate 126 crore LEDs apart from UJALA till Jan 2020. Sales of these LEDs led to reduction of approximately 133 Mn tonne of CO2.

69 M&V data for 90 DCs under PAT III has been considered

70 Updated data for Energy saving of PAT Cycle – II is considered for 542 DCs

Table 85: Total Energy saving Achieved from PAT cycle, II, III

PAT Cycle	Total Energy Savings Achieved		
	Thermal (Mtoe)	Electrical (BU)	Total (Mtoe)
PAT II	10.945	36.466	14.08
PAT III	3.368	1.483	3.496
Total	**14.313**	**37.949**	**17.58**

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 23 clusters during FY 19-20. Under the program, several energy efficiency and renewable energy initiatives have led to energy savings of over 10,556 toe and has contributed to reduction of 56,619 tonnes of carbon dioxide emissions annually due to interventions carried out during 2016-20.

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 19-20, there are 10 Mandatory appliances and 16 voluntary appliances. This scheme has led to savings of 65.011 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 53.307 Mn tonnes of carbon dioxide emissions annually. Sales of the some of the appliances might be impacted due to national lock down during 2020-21.

Table 86: Energy Savings in FY 18-19 for appliances sold during FY 2016-20[71]

Appliance	Savings (MU) due to sales of appliance				Total Savings (MU) FY: 2016-20
	FY: 2016-17	FY: 2017-18	FY: 2018-19	FY: 2019-20	
Mandatory Appliances					
LED LAMPS*	28	65	695	939	1,539
Distribution Transformer	263	403	628	244	1,538
Stationary Type Water Heater	410	472	563	437	1,882
TFL	636	570	365	176	1,747
Room Air Conditioner (Variable Speed)	447	1,461	999	807	3,715
Frost Free Refrigerator	1,473	1,967	2,178	1,558	7,175
Room Air Conditioner (Fixed Speed)	3,364	3,329	1,794	1,367	9,854
Color Television	1,032	3,806	3,749	2,412	10,999
Direct Cool Refrigerator	4,059	4,459	5,072	3,634	17,224
Voluntary Appliances					
Submersible Pump Set	1,310	1,921	2,427	1,066	6,724
Open well Submersible Pump Set	368	426	590	439	1,822
Computer	6	0	0	0	6
Monoset Pump	43	46	50	28	167
Ceiling Fan	162	191	156	90	599
Washing Machine	0	0	0	17	17
Chiller	0	0	0	1.18	1.18
Total Savings (BU)	**13.6**	**19.1**	**19.3**	**13.22**	**65.011**

Saving of domestic LPG stoves is presented in in table below-

Table 87: Energy saving due to sale of Domestic LPG stoves during 2016-20

Year	Q1	Q2	Q3	Q4	Total (toe)
2016-17	240	226	481	422	1368
2017-18	490	562	345	238	1635
2018-19	330	450	279	308	1367
2019-20	793	1453	487	145	2879
Total (2016-20)					**7249**

71 Energy saving estimated form LED considered under UJALA programme during 2018-20 are discounted tin the total saving figure

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. As on 31st March 2020, 129 buildings have been registered under ECBC, of which, 54 buildings are ECBC compliant while 75 buildings are under design stage. The 54 constructed and ECBC compliant buildings with total area of 1.63 Million square meter have led to energy savings of 116 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. As on 31st March 2020, 264 buildings have been labeled under the programme. During FY 16-20, 63 Offices, 17 BPOs, 5 Hospitals, and one shopping mall have been certified with star label leading to energy savings of 179 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. As on 31st March 2020, 6545 commercial buildings have been covered under this programme. Type of commercial buildings covered under the programme includes Central Government Buildings, District Courts, PWD Buildings and Railway Stations. This programme has led to energy savings of above 212 MU during FY 2019-20.

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: As on 31st March 2020, 1939 projects have been registered.

LEED: As on 31st March 2020 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: 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 27.4 Crore LED lamps during the FY 2016-20. This programme has saved over 35.5 BU and has led to avoidance of 29.1 million tonnes of carbon dioxide emissions annually.

Table 88: Energy savings from UJALA programme[72]

Year	Energy savings (MU): LED lamps	Energy savings (MU): LED Tube lights	Energy savings (MU): EE Fans
FY 16-17	15,883	55	53
FY 17-18	10,195	153	99
FY 18-19	7,436	57	55
FY 19-20	1,533	8.7	10
Total	**35,047**	**274**	**217**

SLNP

Street Lighting National Programme (SLNP) is being implemented in 28 States/UTs, to replace the conventional street-lights with BEE 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 6.8 BU and has led to avoidance of 5.6 Mn tonnes of carbon dioxide emissions annually.

Table 89: Energy savings from Street Lighting National Programme[72]

Financial Year	Number of Installations	Number of States	Annual energy saving BU
2016-17	1,392,587	21	0.934
2017-18	3,510,683	28	2.356
2018-19	3,013,210	24	2.022
2019-20	2,278,792	27	1.529
Total	**10,195,272**		**6.841**

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 FY17-20. A total of 74,399 energy efficient star rated pump sets have been installed, which has led to energy savings of 0.18 BU and avoidance of 0.148 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

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

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 1.2 Mtoe during FY19-20.

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 0.042 Mtoe and 0.077 Mn tonnes of carbon dioxide emission reductions during FY19-20.

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 2019-20

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 585 Mtoe and the total primary energy supply stands at 926 Mtoe during FY 19-20[73].

Energy Savings (Demand Side)

The energy efficiency schemes at national as well as state level carried out by BEE and other agencies has led to the reduction of 18.38 Mtoe in the demand side energy consumption, amounting to 3.14% of the energy demand (585 Mtoe) during 2019-20. A comparison of the energy savings across various sectors of the economy vis-à-vis energy consumption is presented in Table 90.

Industry sector has contributed to 42% of the total energy savings while domestic sector

Table 90: Sector wise energy savings vis-à-vis energy consumption in demand-side sectors

Sector	Energy Consumption in FY 2019-20 (Mtoe)	Energy[74] savings in FY 2019-20 (Mtoe)	% Savings[75]
Industry (Excluding TPP, DISCOMs, and Refineries)[76]	327.07	7.72	2.36%
Domestic (S&L and UJALA)	53.47	7.73	14.46%
Commercial Buildings (Including buildings under PAT)	8.70	0.15	1.70%
Agriculture (Star Rated Pumps)	19.35	0.75	3.87%
Transport (Including Railways)	58.47	1.44	2.46%
Others (Including Municipal)	118.09	0.59	0.50%
Total	**585.13**	**18.38**	**3.14%**

73 2.8% escalation is considered over the data reported by MoSPI for FY 2018-19 (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 for demand side energy savings

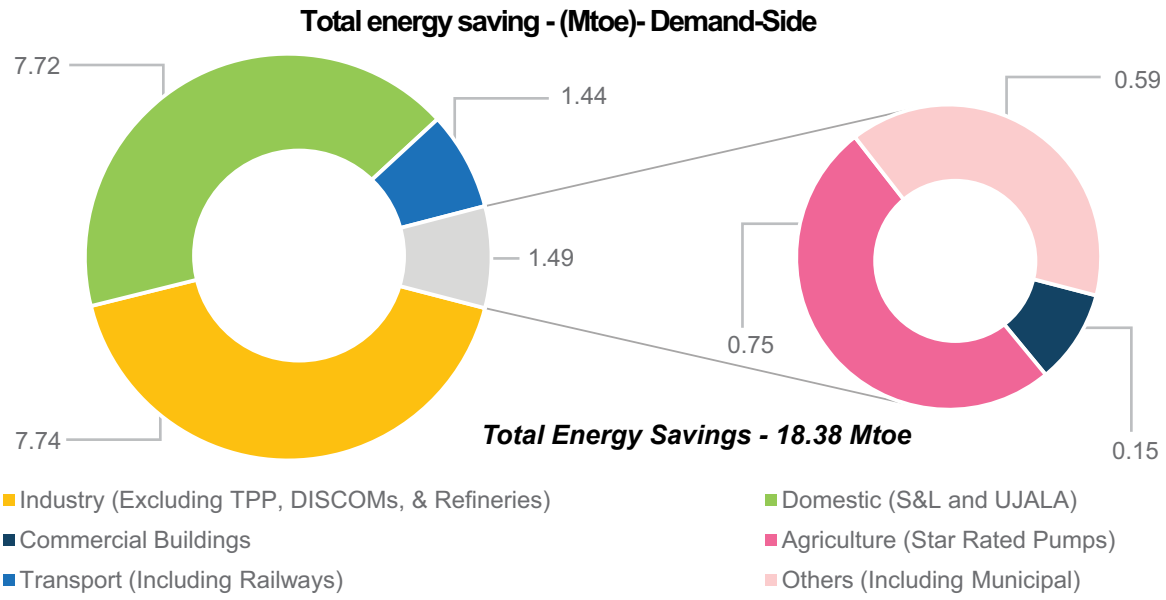


Figure 56: Share of Energy Savings across sectors of the economy

has contributed to 42.1% of the total savings achieved during FY 19-20. While, remaining sectors contributed to around 16% of total energy savings for 2019-20.

Electrical energy Savings (Consumption Side)

Adoption of energy efficiency schemes/ programmes as considered for this study has reduced the overall electricity consumption by 115.258 BU. This has led to the reduction of 9.71% of the electrical energy requirement (1186 TWh)[77] across various sectors of the economy in 19–20.

Domestic sector has the highest contribution (77.9%) in the total electrical energy savings from all energy efficiency interventions carried out during FY 2019-20.

Table 91: Sector wise electrical energy savings (BU) vis-à-vis consumption in demand-side sectors

Sector	Electrical Energy Consumption (BU)	Electrical Energy Savings 2019-20 (BU)	% Savings[78]
Industry (Excluding TPP, DISCOMs, & Refineries)[79]	496.9	7.47	6.48%
Domestic (S&L and UJALA)	287.5	89.80	77.91%
Commercial Buildings (Including buildings under PAT)	99.6	1.72	1.50%
Agriculture (Star Rated Pumps)	212.8	8.71	7.56%
Transport (Including Railways)	17.2	0.71	0.61%
Others (Including Municipal)	72.9	6.84	5.94%
Total	**1186.97**	**115.25**	**9.71%**

77 1186 is calculated by inflating the energy consumption values of 2018-19 by CAGR of 2.48% (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

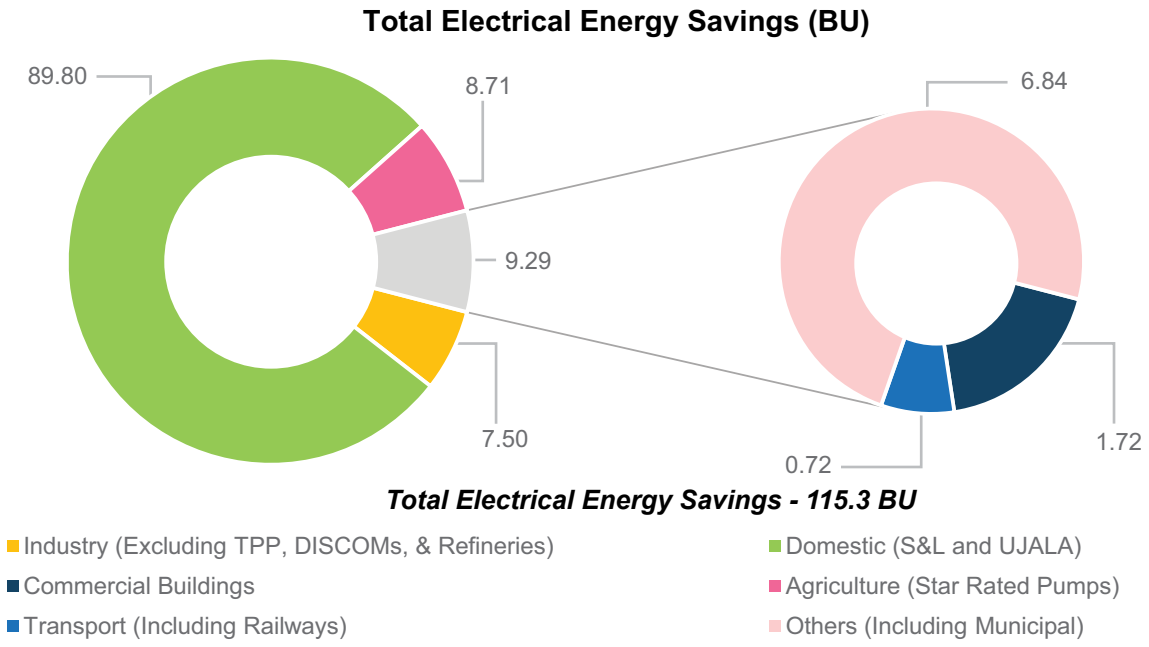


Figure 57: Share of Electrical Energy Savings across sectors of the economy

Total Energy Savings (Including Supply Side)

Similarly, Energy savings at the supply side has been achieved in the order of 28.08 Mtoe (inclusive of demand side energy savings). These energy savings amount to 3.03% of the total primary energy supply (926 Mtoe) during 2019-20.

11.1.1. Way Forward

As energy has always been recognized as one of the most important inputs to determine the economic growth of a country, hence the gap between energy supply and energy demand should 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

Table 92: 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 three years (2017-20)	Total Savings (Mtoe) for Last three Years (2017-20)	Achievement as compared to the target energy savings (Mtoe)
	(A)	(B)=(A)*21.4%	(C)	(D)=(C)-(B)
Agriculture	5.7	1.22	0.75	(0.47)
Commercial	4.9	1.05	0.15	(0.90)
Domestic	12.1	2.60	7.73	5.14
Municipal	0.1	0.02	3.01	2.99
Industrial	47.5	10.19	14.98	4.79
Transport	15.8	3.39	1.44	(1.95)
Total	**86.9**	**18.47**	**28.06**	**9.59**

"ambitious" implementation of EE programs by year 2031 which stands at 15% reduction in energy demand as compared to BAU approach to energy savings. The consolidated values of energy savings achieved for all these schemes during last 3 years is compared with energy savings target for various demand sectors and presented in Table 92.

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, in 2020, the coronavirus pandemic has exacerbated many of the existing challenges the energy sector faces to its financial and physical resilience.

India has suffered the devastating impacts of Covid-19, raising health, economic and social challenges. However, when the Indian economy will come back to pre-Covid levels by the next financial year (2021-22), the resilience of the power sector has become critical. It is this crisis and the government's response that could create the strongest momentum for energy efficiency reforms in coming years.

It is possible that the future landscape would be driven by disruptive technologies due to change in behavior post co-vid such as remote production, process automations, economic mega-trends such as industry 4.0, e-mobility which will change the dynamics of energy sector.

BEE's National Strategic Plan on Energy Efficiency includes these 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.

Energy saving through adoption of new technologies, increasing the scope of the wide gamut of energy related policies and programs and sensitizing the consumers towards the importance of saving energy in their day-to-day lives would go a long way in making India energy secure, self-reliant and resource efficient.

80 Moderate scenario

81 Energy Savings targets are for 14 years from 2017 to 2031. Pro-rata savings are considered for two years (3/14)%= 21.4%

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