Azadi Ka Amrit Mahotsav

G20 भारत 2023 INDIA

सत्यमेव जयते
Ministry of Power

LiFE Lifestyle for Environment

ऊर्जा जीवन है, संरक्षण करें
BEE
Energy is Life, Conserve it

Impact of Energy Efficiency Measures

For The Year 2021-22

ऊर्जा जीवन है, संरक्षण करें
BEE
Energy is Life, Conserve it

Bureau of Energy Efficiency

Imprint

Study by
Deloitte Touche Tohmatsu India LLP (DTTILLP).
7th Floor, Building 10 B, DLF Cybercity,
Gurgaon 122002

Commissioned on behalf of
Bureau of Energy Efficiency
Ministry of Power, Govt. of India
4th Floor, Sewa Bhawan, R.K. Puram
New Delhi 110 066, India

Version
New Delhi, May 2023
Picture courtesy: Shutterstock images

Preface:

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

While rolling out schemes and programmes to conserve energy is an important aspect, assessing their impact on the ground is essential to gauge their effectiveness, and derive learnings for future interventions. Therefore, an impact assessment of all the schemes related to energy efficiency is required, periodically.

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

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

In compliance to this direction, BEE hired the services of an expert agency (Deloitte India) to conduct this study for the FY 2021-22. 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 2021-22. The study estimates energy efficiency achievements based on the impact of the schemes / programmes since FY 2017-18.

The objective of this study is to assess the overall impact of all the energy efficiency schemes at the national as well as state level for the FY 2021-22 and compare it with a situation where the same were not implemented. This study focused on the 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.

The findings of the report reflect that the adoption of energy efficiency schemes/programs has led to the overall energy savings of 44.43 Million Tonnes of oil Equivalent for the year 2021-22. This study has estimated that various energy efficiency measures have led to the overall thermal energy savings in the order of 23.85 Million Tonnes of oil Equivalent, while overall electricity savings are to the tune of 249.89 Billion Units in the year 2021-22

Overall, these energy savings translated into monetary savings worth INR 160,721 crores per annum. The equivalent reduction in CO_2 emissions is around 280.77 Million Tonnes annually.

May 2023
New Delhi

Abhay Bakre
Director General, BEE

Table of Contents

List of Tables

List of Figures

Abbreviations

AC	Air Conditioner
BEE	Bureau of Energy Efficiency
BEEP	Building Energy Efficiency Programme
BU	Billion Units
CEA	Central Electricity Authority
CO2	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	Unlock National Energy Efficiency Potential
UT	Union Territories
VLT	Visible Light Transmittance
W	Watt
WBP	Whole Building Performance
Yr	Year

Executive Summary

Energy is among the most critical components of infrastructure, crucial for the economic growth and welfare of nations. The existence and development of adequate energy and power infrastructure is essential for the sustained growth of the Indian economy.

India's energy sector is one of the most diversified in the world. Sources of power generation range from conventional sources such as coal, lignite, natural gas, oil, hydro and nuclear power to viable non-conventional sources such as wind, solar, and agricultural and domestic waste. The total Primary Energy Supply added up to 739.386 million Tonne of Oil equivalent (TOE) in the FY 2021-22. The two major contributors to the total energy supply in the country were Coal which accounted for 56.13% of the total and Crude Oil which accounted for 33.40% of the total energy supply[1].

Energy demand and consumption in the country has increased rapidly and is expected to rise further in the years to come. The total energy consumption in India has grown from about 332.93 million tons of oil equivalent (TOE) in 2012 to about 525.708 million TOE in 2022[2].

Energy efficiency across all sectors of the economy is essential to enable decoupling of energy supply growth from economic growth, while ensuring that energy service demands are met.

India has remained progressive and one of the front runners in achieving its energy efficiency potential, through innovative programmes such as the Perform Achieve and Trade (PAT) scheme, Standards & Labeling (S&L), Unnat Jyoti by Affordable LEDs for All (UJALA) scheme, Energy Conservation Building Code (ECBC), Electric Vehicle mission, Smart metering, etc. However, the rhythm and momentum of energy transition have been curbed as activities under various programmes and schemes were affected due to the COVID-19 pandemic during FY 2021-22.

At the country level, there is still an immense potential to be tapped from the large-scale implementation of energy efficiency interventions in the various demand sectors like industry, agriculture, transport, municipal, domestic & commercial lighting and appliances, and MSMEs. This should help to limit the energy imports and perpetual headlong rush towards new production capacities which still require huge investments and significant financing.

The 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.

[1] Source: Energy Statistics 2023, MoSPI
[2] Source: Energy Statistics 2023, MoSPI

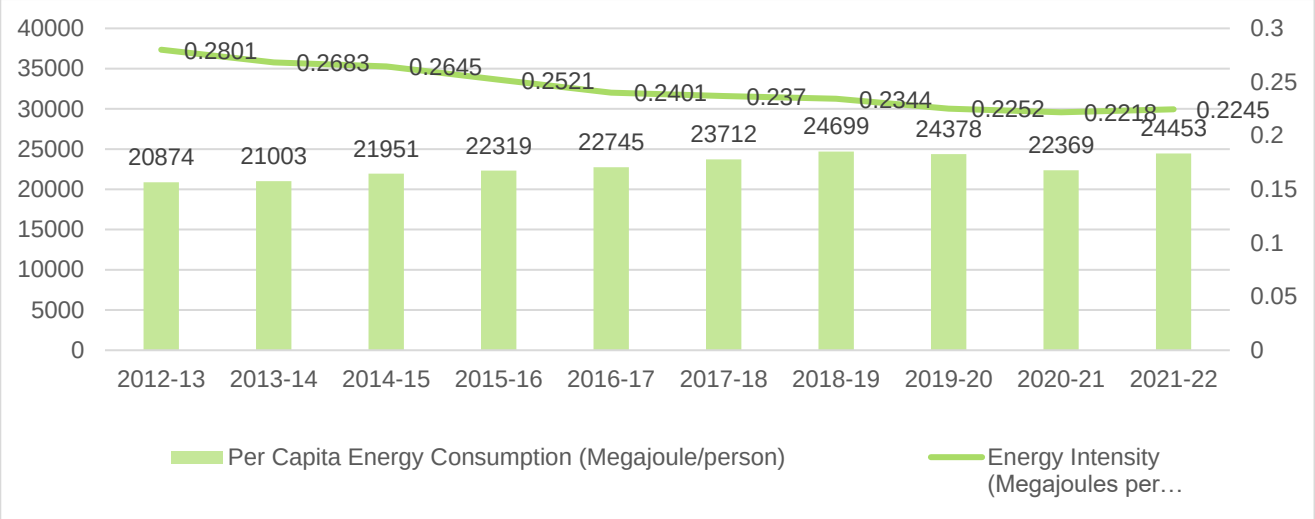


Figure 1: Energy intensity and Per capita Consumption trend

India's energy intensity decreased from 0.2801 Mega joules per rupee in 2012-13 to 0.2245 Mega Joules in the FY 2021-22 (Figure 1[3]), which is a significant decrement of 19.85%. Similarly, Per-capita Energy Consumption increased from 20,874 Mega joules in 2012-13 to 24,453 Mega joules in the FY 2021-22. This decline is also 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 the figure below:

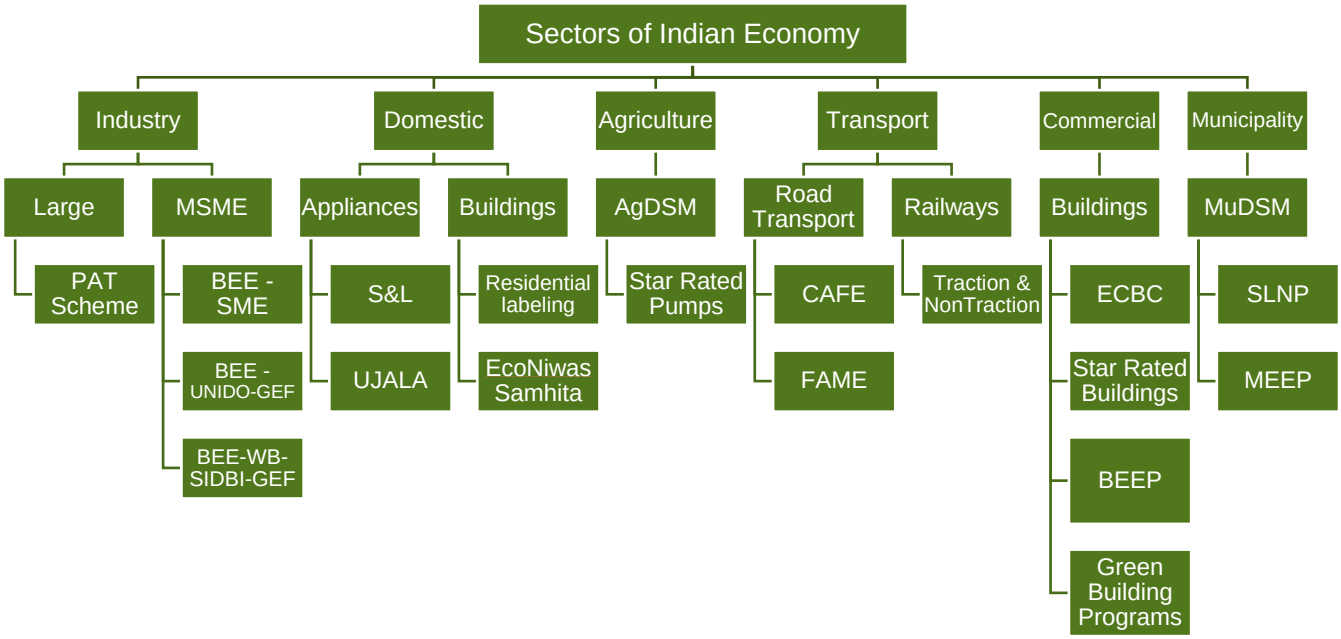


Figure 2: Energy Efficiency Schemes in India

[3] Energy Statistics 2023, MoSPI

Rationale and Objective

To assess the impact of various energy efficiency schemes/programmes, the Bureau of Energy Efficiency conducts an annual study. It estimates the impact by comparing the actual energy consumption with the estimated energy consumption had the current energy efficiency measures not been undertaken i.e., counterfactual.

The overall objective of the study was to assess the impact of all the energy efficiency schemes/ programmes in India in terms of total energy saved and reduction in CO_2 emissions during FY 2021-22. To assess the impact, the agency has carried out the following tasks:

- Review of all the national level schemes for 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 2021-22

The adoption of energy efficiency schemes/programmes has led to the overall energy savings of 44.43 Mtoe, i.e., 6.0% of the total primary energy supply of the country for the year 2021-22.

A summary of savings from various schemes and interventions is presented in the table below:

Table 1: Summary of energy savings (2021-22)[4]

Program/ Scheme	Sector	Electricity Savings (BU)	Thermal Savings (MTOE)	Total Energy Savings (MTOE)	GHG Reduction (MtCO2)	Monetary Savings (INR Crore)
PAT- III	Large Industry	0.62	1.59	1.59	5.59	3205.30
PAT- II		36.47	10.95	14.08	68.43	42020.59
PAT- I		3.01	9.25	8.67	31.00	9500.00
PCRA EE Programs		0.01	0.00027	0.0009	0.0044	5.98
PRSF	MSME	0.05	-	0.0041	0.04	28.74
4E		0.03	0.00010	0.0026	0.02	151.87
GFS		0.01	-	0.0009	0.01	128.36
BEE-GEF-EESL		0.0015	0.0018	0.0019	0.009	4.49
BEE-UNIDO-SME		0.00	0.00	0.0057	0.038	36.72
FLCTD	Large/MSME	0.00009	0.000657	0.0007	0.002	1.22
ECBC	Commercial Buildings	0.1609	-	0.0138	0.1303	25.46
BEE Star Rating		0.2492	-	0.0214	0.2019	39.43
Green Building Rating Program (GRIHA)		0.0882	-	0.0076	0.0714	13.96
ENS	Residential Buildings	0.0024	-	0.00021	0.0019	0.38
S&L	Appliances	70.43	0.02	6.06	57.05	42258.92
	Others (AgDSM, SEAC, etc.)	0.4693	-	0.041	0.37	281.57
UJALA	LED Lamps	47.78	0.00	4.11	38.70	19112.00
	LED (Private Market)	82.00	0.00	7.05	67.00	32800.00
SLNP	Municipal	8.52	-	0.73	5.87	5109.60
FAME	Transport	-	0.14	0.14	0.53	1559.88
CAFÉ		-	1.89	1.89	5.69	4436.35
Total		**249.89**	**23.85**	**44.43**	**280.77**	**160720.8**

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 23.85 Mtoe** amounting to **INR 43,887 Crores** and a reduction of **78.36 Million tonne of CO_2 emission**. While overall

[4]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.

electricity savings are to the tune of **249.88 BU annually**. These electricity savings resulted in cost savings worth **INR 149,931 Crores and a reduction of 202.41 Million tonne of CO2 emissions**.

Overall, these energy savings translated into monetary savings worth INR 160,721 crores in the year 2021-22. The equivalent reduction in CO_2 emissions is around 280.77 million Tonnes annually.

PAT scheme contributed to 54.85% of the total energy savings, while S&L and UJALA accounted for 38.78% of the total energy saving from all major interventions carried out during FY 21-22. The share of various schemes in the total Energy savings is presented in Figure 3.

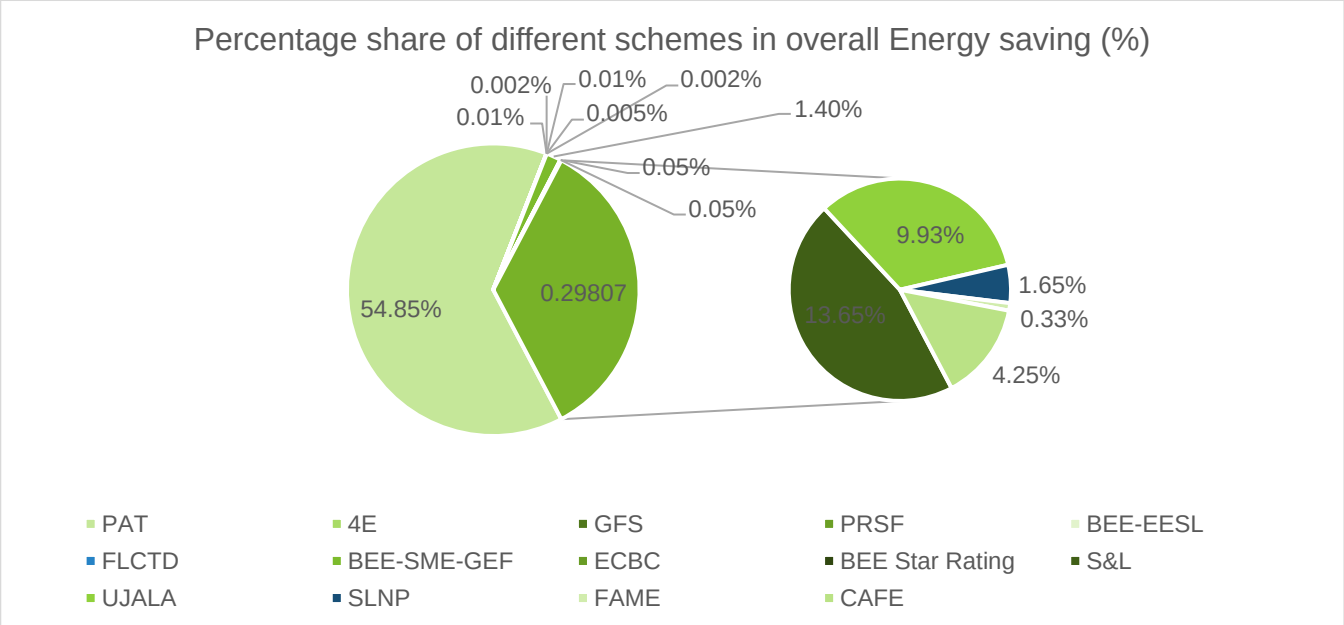


Figure 3: Total energy savings (Mtoe) by Scheme / Programme (2021-22)

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

Implementation of energy efficiency interventions has led to the reduction of 33.35 Mtoe in the demand side energy consumption, amounting to 6.34% of the energy demand (525.708 Mtoe[5]) during the year 2021-22. The total energy savings achieved (including both Supply Side and Demand Side sectors of the economy) is of the order of 44.43 Mtoe. These energy savings amount to 6.0% of the total primary energy supply (739.38 Mtoe[5]) during 2021-22.

Thermal and Electrical Energy savings contribution from various economic sectors is presented in the table below:

[5] Energy Statistics 2023, MoSPI report.

Table 2: Sector-wise energy saving summary

Sector	Thermal Saving (Mtoe)	Electrical Saving (BU)	Total energy savings (Mtoe)	Emission reduction (Million Tonne of CO_2/year)	Estimated monetary savings (INR crore)
Industry[6]	21.80	40.19	24.36	105.15	55083.28
Domestic[7]	0.019	200.21	17.22	162.75	94170.92
Buildings[8]	-	0.4980	0.0428	0.4034	78.80
Transport (including Railways)	2.03	-	2.03	6.23	5996.23
Others (including Municipal)	-	8.52	0.73	5.87	5109.60
Agriculture (including Star Rated pumps)	-	0.007	0.006	0.0049	279.98
Total	**23.85**	**249.89**	**44.43**	**280.77**	**160720.8**

The industry sector has the highest contribution with a share of 54.88% of the total energy savings while the domestic sector has contributed 38.79% of the total savings achieved during FY 21-22.

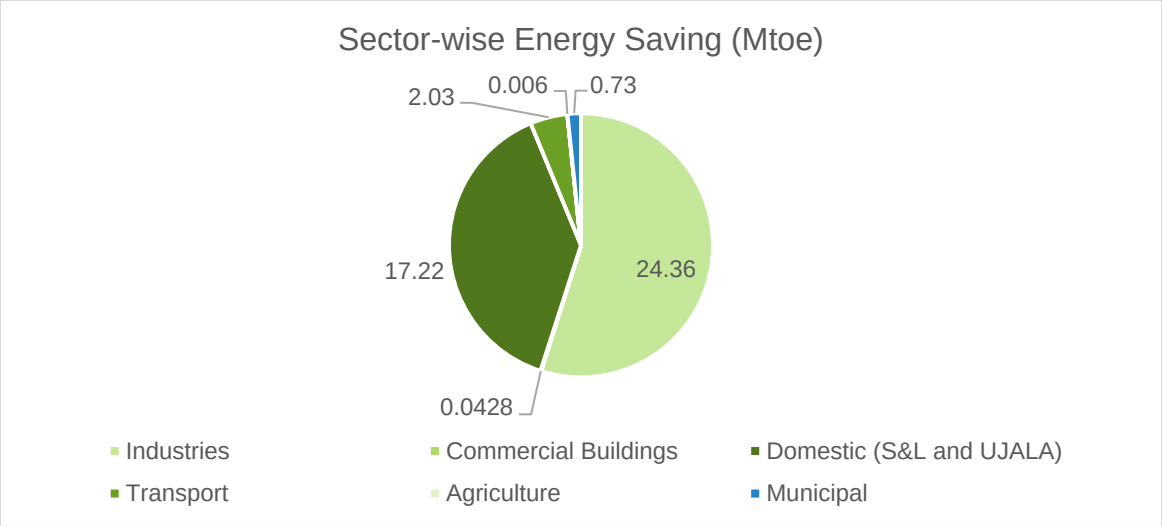


Figure 4: Total Energy Savings by Economic Sectors (2021-22)

Overall, these energy savings translated into monetary savings worth INR 160,721 crores and contributed to reducing 280.77 million Tonnes of CO_2 emission in the FY 2021-22. Emission reductions from the various schemes are presented in Figure 5:

[6] Industry Sector includes the savings from PAT (Excluding – DISCOM, Buildings, Railways) and MSMEs
[7] Domestic Sector includes the savings from S&L (except pump sets and DTs) and savings from UJALA programme
[8] Includes both Commercial & Residential buildings

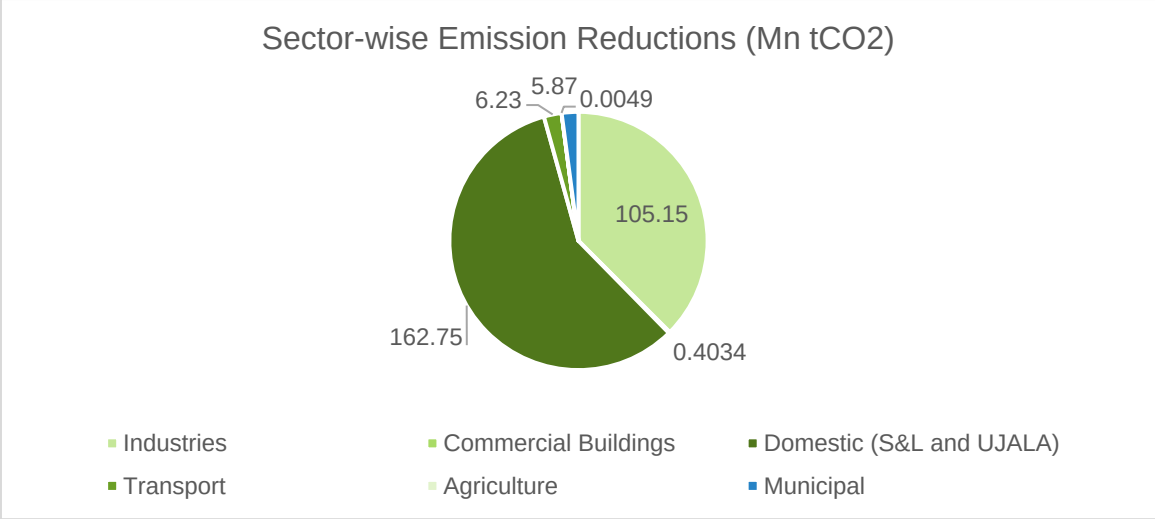


Figure 5: CO_2 Emission Reductions by Economic Sectors (2021-22)

Impact of various Energy Efficiency Interventions in India

Based on the energy savings data provided in the previous section, it is quite evident that all these schemes/programmes, were largely successful in generating a 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, the Bureau of Energy Efficiency and various other institutions have initiated multiple energy efficiency programs for the promotion and adoption of energy efficiency in India, by various sectors. The consolidated values of energy savings achieved for all these schemes during 2011-12 to 2021-22 across various sectors viz. Industry, building (domestic and commercial), municipal, agriculture, transport, and miscellaneous are calculated and the impact of various schemes is presented in Figure 6.

The role of energy efficiency remains crucial in complying with India's emission intensity reduction targets. Therefore, to capture the impact of all these interventions we have compared the energy savings achieved during the years by implementing EE technologies/ solutions with the total energy consumption of the country for the respective years:

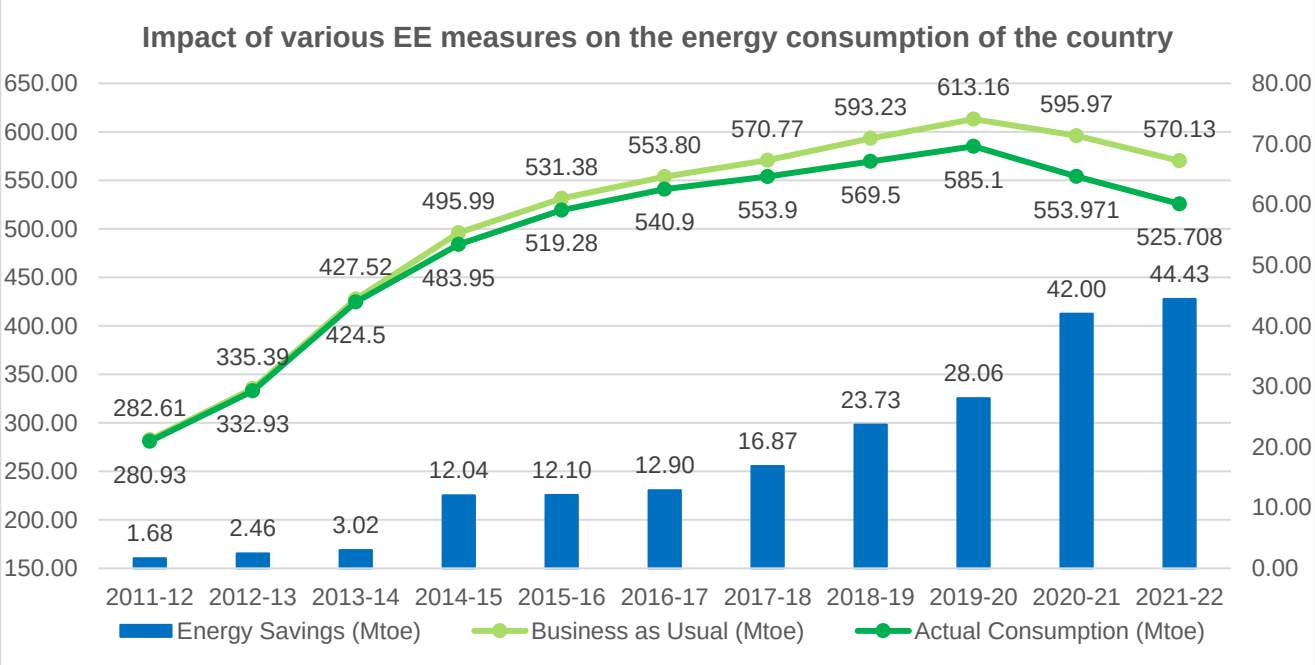


Figure 6: Impact of various EE measures (Mtoe)

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

Way forward

Climate change is one of the most critical global challenges. Recent events have emphatically demonstrated country's growing vulnerability to climate change. Energy efficiency has taken centre stage in the priority list of nations, economies and companies that aim to be sustainable, going forward. India has set a target of achieving Net Zero by 2070 and to meet half of its energy needs from renewable sources by 2030. Currently, the country ranks fourth in the world in terms of carbon dioxide emissions, after China, the United States and the European Union.

India has demonstrated a sustained commitment in combating climate change and is one of the few parties to the Paris Agreement to have adopted emissions reduction targets that are compatible with a two- degree global warming scenario. In August 2022, India has updated Nationally Determined Contributions (NDCs) to the Paris Agreement include:

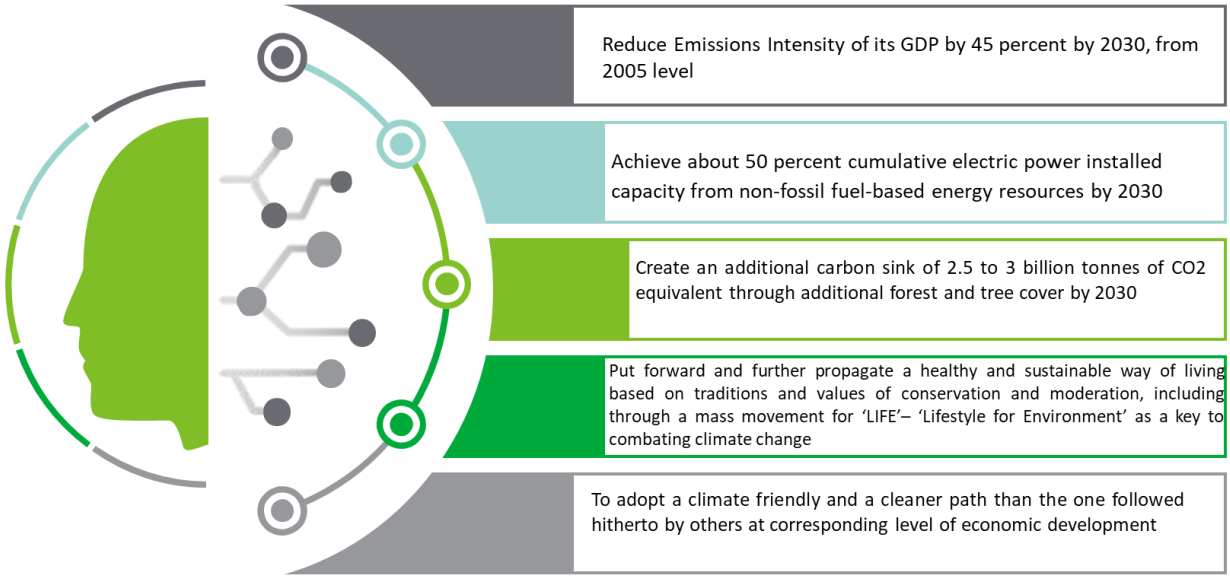


Figure 7: Updated NDCs of India

India's strategy and progress in terms of energy transition goals by 2030 appear to be sound. India is likely to surpass its declared goals for this decade if it addresses a few remaining challenges. In fact, the per-capita emissions in India being just close to one-third of the world average and India's track record in accelerating its energy transition stands out globally.

An aggressive energy efficiency strategy, combined with the ramping up of renewables to replace fossil fuels, is the most realistic path towards halving emissions by 2030. Yet phasing out fossil fuels is a complex task for countries heavily reliant on coal - especially given the imperatives of a just and fair transition for workers and communities. The share of coal-based generation of electricity in India is planned to slash from about 73% in FY22 to less than 55% in FY30[9] to lay the trajectory for effective energy transition.

It may be noted that almost half of our success in energy transition in this decade would depend on implementing consumption-side efficiency or fuel switch initiatives. Industrial sector is projected to contribute almost half of emission reduction against the total projection of 740 million tonne per year by 2030 in India[10].

BEE is playing crucial role in shaping India's Energy Transition roadmap and has undertaken various steps and initiatives to encourage preferential treatment for the use of energy-efficient equipment or appliances and energy conservation across segments through various programmes such as Standards and Labelling, the Energy Conservation Building Code (ECBC), and the Perform, Achieve and Trade (PAT) scheme etc. The current policy and schemes successfully achieved significant energy savings across different sectors.

As India has committed 2070 as the year for achievement of carbon neutrality, robust and granular data on energy can provide an easy pathway for the achievement of this national

[9] and [2] https://economictimes.indiatimes.com/news/india/the-consumption-aspect-of-energy-transition-story/articleshow/100057883.cms

commitment. It will also help in assessing the effect of various policies. Timely, reliable and comprehensive energy data have always been a requirement for effective decision-making.

Hence, **a dedicated Energy Data Management Unit (EDMU) is established in Bureau of Energy Efficiency** which will compile and publish data regarding the supply and consumption of energy in various sectors of economy. EDMU will prepare data collection methodologies, standardization definitions, terminologies, and calculation methodology of all the key parameters in the energy sector in line with international standards so that reporting of data is uniform across all sectors and sources. It will also provide the guidance for developing India Energy Dashboards which can be referred to as an authentic energy related data source of Government of India.

Thus, BEE's current initiative will enable the government and other track country's progress towards its energy transition goals, enable energy policy decisions that are evidence-based, provide accountability and transparency on a nation's energy supply as well as demand.

Chapter 1: Introduction

1. *Introduction*

India is one of the fastest growing economies in the world and has witnessed rapid increase in the energy consumption. The rise in energy consumption is mainly attributed to rapid economic growth, access to affordable energy, increased industrialization, building infrastructure and other end uses of energy

In 2021-22, the total final Energy Consumption (End Use) in India was 5,25,708 kTOE[11]. The industrial sector was the largest consumer of energy in the country with this sector itself using more than half, i.e., 50.59% of the total final energy consumption. The consumption of the residential, agriculture, commercial & public sectors, No-specified(others) and non-energy purpose represented 38.53% of the total final consumption in the country, whereas transport sector accounted for 10.88% of Total Final Consumption.[12]

The total final energy consumption by the major sectors of the Indian economy is depicted in the figure below:

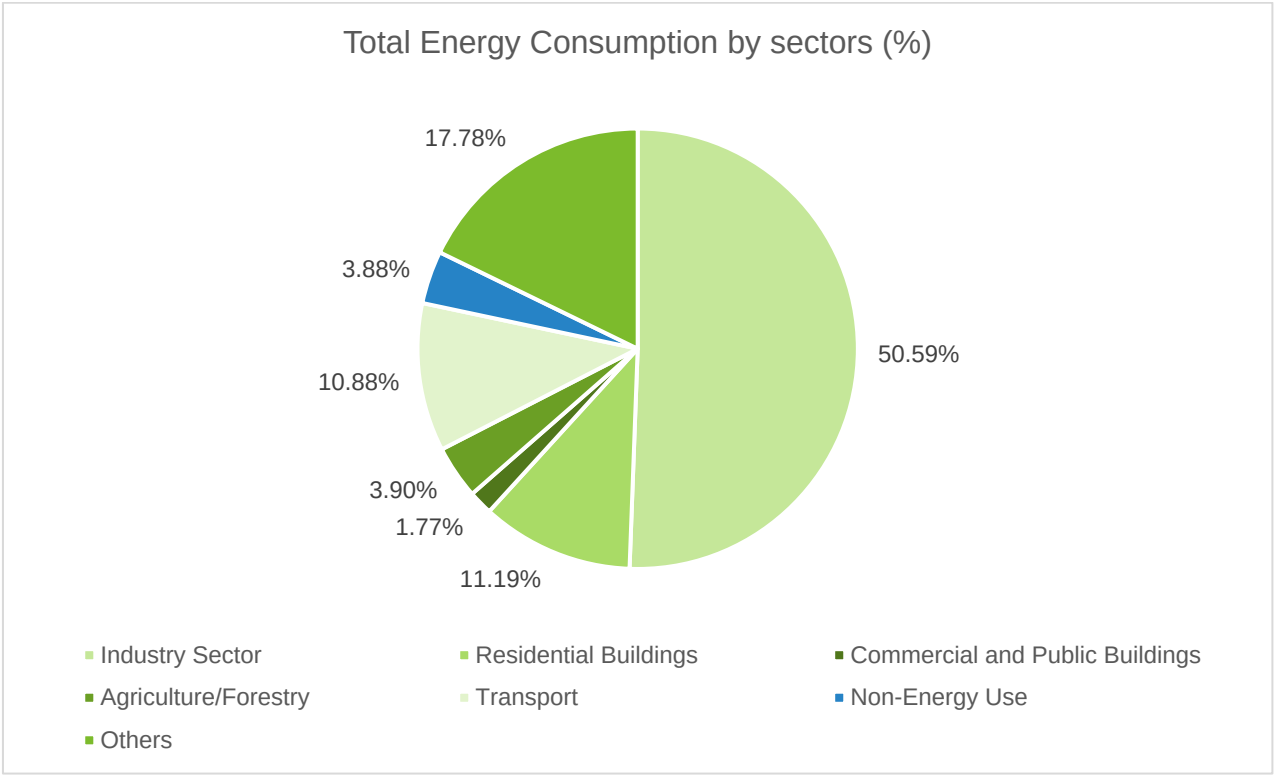


Figure 8: Total final energy consumption by major sectors in India Economy

Today, 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.

[11] Source: Energy Statistics 2023, MoSPI
[12] Source: MOSPI

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 Bureau of Energy efficiency (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 Perform, Achieve and Trade (PAT) scheme, ECBC for residential & commercial sector, Standards & Labeling programme for appliances, and conducive policies for clean transport (EVs) etc.

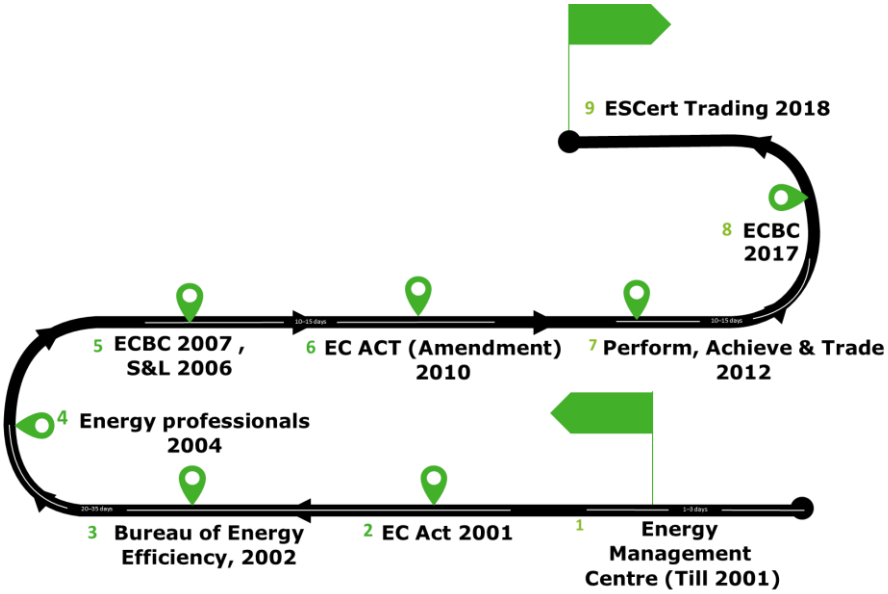


Figure 9: Chronograph of EE policies and programs in India

During the 31st National Energy Conservation Awards (NECA) held in December 2021, the **Standard and Labelling Programme for High-Energy Lithium-Ion Traction Battery Packs and Systems and Standard and Labelling Programme for Tyres** on voluntary basis was launched.

The EV battery accounts for about one-third of the total purchase price of an EV, bringing down battery costs through rapidly scaling production and standardizing battery components could be a key element of long-term success for India's electric mobility sector. The Tyre industry is dominated by the replacement market by vehicle owners, who are totally unaware of wastage of fuel on account of inefficient tires. To provide consumers an informed choice BEE has launched a Standard & labeling program covering tires for Passenger Cars (C1), Light-duty vehicles (C2) & Heavy-duty vehicles (C3), meant for manufactured, imported, and sold in India. Star label criteria are based on the Rolling Resistance Coefficient (RRC) of tires.

To widen the scope of Building Labelling Programme based on Energy Consumption, BEE has introduced Labelling programme for Net Zero Energy Buildings (NZEB) and Net Positive

Energy Buildings (NPEB). The programme was launched by Hon'ble Minister for Power and NRE on 14th December 2021 in NECA event.

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 3, along with their status in FY 2021-22.

Table 3: Status of major EE schemes and programmes

Sector/ Sub-sector	Schemes/ Programs	Status as on FY 2021-22
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-II 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 95 DCs have been completed. • PAT Cycle – IV commenced with effect from April 2018. A total of 109 DCs with a total reduction target of 0.6998 MTOE were notified under PAT cycle – IV. • PAT cycle – V had commenced with effect from April 2019. Under PAT cycle – V, 110 DCs from the existing sectors of PAT were notified. PAT cycle – V aims to achieve total energy savings of 0.5130 MTOE. • PAT cycle – VI had commenced with effect from 1st April 2020. Under PAT Cycle – VI, 135 DCs from six sectors were notified. With implementation of PAT cycle – VI, it is expected to achieve a total energy savings of 1.277 MTOE. • PAT cycle – VII was notified in October 2021 for the period 2022-23 to 2024-25 wherein 509 DCs have been notified. • The PAT scheme has covered 1104 units from 13 sectors for participation till 31st March 2022.
Industry-MSME	PRSF Program	• Total 6 MSME clusters (Hoshiyarpur, Faridabad, Mandi, Gobindgarh, Pune and Ropar) covering sector as Foundry, Forging & Heat Treatment, Re-rolling, pharma and chemical are part of the programme.

Sector/ Sub-sector	Schemes/ Programs	Status as on FY 2021-22
	BEE-GEF-UNIDO 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 2022
	GEF – EESL – BEE Programme	• 740 surveys, 78 detailed Energy Audits and more than 70 technology specific baseline studies have been completed. • More than 100 awareness / consultation / training workshops in 10 clusters for faster adoption of the technologies
Domestic-Lighting & appliances	Standards & Labeling (S&L)	• Total 32 appliances in this programme covered as on 31st March 2022. • 10 appliances under Mandatory regime. • 22 appliances under voluntary regime. • Introduction of Voluntary Energy performance standards for High Energy Li-Battery and Tires on 14 December, 2021
	UJALA	• 37 Crore LED bulbs were distributed till 31st March 2022. • 73 lakhs LED tube-lights and 25.92 EE fans were also distributed under UJALA programme till March 2022.
Domestic-Buildings	Eco Niwas Samhita	• As on 31st March 2022, Over 1.55 million sqm of the residential built-up area has been compliant with ENS part 1. Around 148 training and capacity building programs have been conducted which trained around 10000 stakeholders including Government and private sectors.
	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 2022, technical assistance has been provided to 465 buildings by the Building cells in all states. Over 575 training and capacity-building programs have been organized to train over 25000 various stakeholders including the government and private sector.
	BEE – Star Rating Programme	• Offices, Hospitals, Shopping malls, and BPOs are part of this program.

Sector/ Sub-sector	Schemes/ Programs	Status as on FY 2021-22
		• 80 existing commercial buildings across India have adopted BEE Star ratings as of 31st March 2022.
Agriculture-Appliances (Star Rated Pumps)	AgDSM- (Star Rated Pumps)	• As on 31st March 2022, 79,975 agricultural pumps have been installed.
Municipality - Lighting & Appliances	MuDSM- (SLNP)	• During the financial year 2021 – 22, total 8 lakh LED Street Lights have been installed which had led to cumulative achievement as on 31st March 2022 is 1.26 Crore.
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 • In the First Phase of the FAME Scheme about 2.8 lakh hybrid and electric vehicles are supported by way of demand incentive amounting to Rs 358Crore (Approx.) • Saving of 97 million liters of fuel and reduction of about 242 million Kg of CO2 as on 25th January, 2022. • Upgradation of Public EV charging infrastructure for faster adoption of EV. • FAME II was launched in 2019. As on 31st March 2022, 50 OEMs under Phase-II of FAME Scheme for availing benefit of demand incentives. • As on 31st March 2022 sale of Electric vehicles 220117 for availing benefit of demand incentives. • Under Phase II, the department of Heavy Industries (DHI) has already sanctioned 2,877 charging stations in 68 cities across 25 states/ UT's in the year 2021-22. • Further, the Ministry has sanctioned 1576 charging stations in 9 Expressways and 16 Highways and issued LOA to selected entities accordingly.
Transport-Railways	PAT and Non-PAT EE Initiatives	• Under PAT Cycle II, 16 Zonal Railways and 6 production units were included. • Indian railways have taken several steps such as - *Mission Electrification, HOG (Head-on-Generation) Trains, 3-phase regenerative locomotives etc.* - to reduce the energy consumption in the traction segment.

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

Towards this, BEE has hired the agency to undertake a comprehensive review of national and state level schemes initiated for the adoption of energy efficiency in 2021-22 across all the demand sectors. The coverage of national level schemes under the study is not only limited to BEE but also extends to energy efficiency 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 2021-22. 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 4 below:

Table 4: List of major Stakeholders

Stakeholder	Scheme/ Programme
BEE	PAT, S&L, ECBC, Star Rated Buildings, BEE SME Program, Residential labeling, Eco Niwas Samhita
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	Partial Risk Sharing Facility (PRSF) Programme
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 5.

Table 5 : 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 = 0.81 kg of carbon dioxide emission reduction[13]
Cost/toe[14] = INR 18,402
Cost/kWh[15] = INR 6.00
Net energy (Total) [16] consumption in 2021-22 = 553.97 Mtoe
Net energy supply [16] in 2021-22 = 888.52 Mtoe
Electricity (Total) [17] consumption in 2021-22= 1227 TWh
Emission factor for LPG[18] – 63.1 tonne of CO_2/ TJ

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 2021-22. Chapter 10 covers various initiatives undertaken in states by SDAs and other agencies. Finally, chapter 11 concludes along with the way forward.

[13] https://cea.nic.in/wp-content/uploads/baseline/2023/01/Approved_report_emission__2021_22.pdf

[14] https://beeindia.gov.in/sites/default/files/press_releases/Ministry%20of%20Power%20notifies%20price%20of%20one%20metric%20tonne%20of%20oil%20equivalent%20applicable%20for%20Designated%20Consumer%20of%20Second%20Cycle%20of%20Perform%2C%20Achieve%20and%20Trade%20%28PAT%29%20scheme..pdf

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

[16] Energy Statistics 2023, MoSPI Report.

[17] Energy Statistics 2023, MoSPI Report.

Chapter 2: Industries

2. *Industries*

The industry sector holds a prominent position in the Indian economy contributing major percent of total gross value added in the country. The manufacturing sector is also the largest consumer of commercial energy in India. In producing about a quarter of India's GDP, this sector consumes about half the commercial energy available in the country. This sector is particularly energy intensive, as it requires energy to extract natural resources, convert them into raw materials and then manufacture them to finished products. The industrial sector can be broadly defined as consisting of energy-intensive industries (e.g. iron and steel, chemicals, petroleum refining, cement, aluminium, pulp and paper) and light industries (e.g. food processing, textiles, wood products, printing and publishing, and metal processing). The most energy-intensive industries accounts for over majority of the energy consumed within this sector.

The major drivers for industrial energy demand are the increased demand for materials in buildings, transportation, capital goods and infrastructure. In the FY 2021-22, the total final Energy Consumption by the industrial sector was 5,25,708 ktoe[19]. The industrial sector was also the largest consumer of energy in the country with this sector itself using more than half, i.e., 50.59% of the total final energy consumption[20].

As depicted in the figure below, the most energy intensive industries within the industry sector were iron and steel, which accounted for 15.29% of the industrial energy use followed by Chemicals and petrochemicals 5.36 % and construction 2.09%.[21]

[19] Source: Energy Statistics India 2023, MoSPI
[20] Source: Energy Statistics India 2023, MoSPI
[21] Source: Energy Statistics India 2023, MoSPI

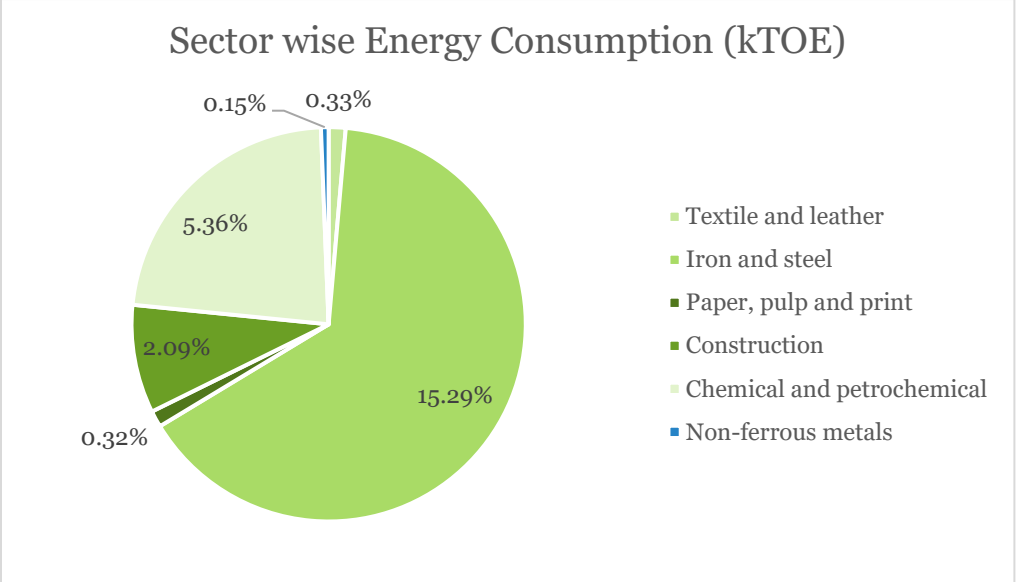


Figure 10:Energy Consumption by various industrial sectors in the FY 2021-22

At the 26th Conference of Parties (COP-26) in Glasgow, honorable Prime Minister has announced that India will achieve net-zero emissions by 2070 and has also committed to reduce 1 billion tonnes of projected emissions from now till 2030 and achieving carbon intensity reduction of 45 per cent over 2005 levels by 2030. 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.

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.

Today, Energy Efficiency 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 SIDBI etc. for a significant time now.

With an objective to accelerate Energy Transition in Industrial Sectors, BEE has also developed “User Manuals” for different stakeholders of PAT scheme. The User Manuals developed by Bureau of Energy Efficiency for key stakeholders will definitely be useful in providing necessary guidance for effective and efficient implementation of the PAT scheme

In order to gear towards the commitments made under the Nationally Determined Contributions (NDCs), related activities having climate benefits warranted consolidation and

alignment with the NDC goals. Thus, NMEEE has been revised to “Roadmap of Sustainable and Holistic Approach to National Energy Efficiency (ROSHANEE)” by BEE as a broader version of the Mission and includes all the current and potential areas of energy efficiency in each sector. Thus, through ROSHANEE, NMEEE is being strengthened with a review of existing approaches and planning a new portfolio of strategies to strengthen energy efficiency across all sectors in the country till 2030. As part of ROSHANEE, for continuation of NMEEE, an SFC proposal has been approved with an out lay of Rs. 167 Crores that include PAT scheme and certain activities under the energy efficiency financing.

2.1. Perform, Achieve and Trade (PAT) framework

The PAT scheme was designed with the goal of improving the energy efficiency of industrial units in a cost-effective manner. Even though the industrial sector is the largest energy consumer segment in the country, it was realized that the sector had not taken advantage of the benefits of increased energy efficiency due to problems in getting access to necessary capital to fund energy efficiency investments, and often a lack of necessary incentives towards such investments, and problems of long payback periods of such investments, coupled with inadequate information about the benefits of energy efficiency investments. The PAT scheme was designed to mitigate such inherent anomalies and offer a transparent, robust, and cost-effective mechanism to attain the desired energy efficiency goals in the large industrial sector.

As broadly brought out in the framework document on “National Mission on Enhanced Energy Efficiency”, the Energy Conservation Act, 2001 has identified 20 large Energy Intensive Sectors namely Aluminum, Buildings, Cement, Ceramics, Chlor-Alkali, Chemicals, Copper, DISCOMs, Fertilizer, Glass, Iron & Steel, Mines, Petroleum Refinery, Petrochemicals, Pulp & Paper, Railways, Sugar, Textile, Thermal Power Plants and Zinc for energy efficiency improvements.

PAT is a market-based mechanism to enhance cost effectiveness of improvements in energy efficiency in energy-intensive large industries and facilities, through certification of energy savings that could be traded. In this mechanism, an individual target will be set for the industries by the Government to reduce their Specific Energy Consumption (SEC).

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

Those industries that achieve and exceed the target would be issued Energy Saving Certificates (ESCerts) and those industries who could not

achieve the target have to either pay penalties or buy the ESCerts from the industries who have secured ESCerts by exceeding the target assigned to them. Some of the broad steps involved in commissioning and operationalizing typical PAT cycles in industries / industry sectors are presented in Figure 11:

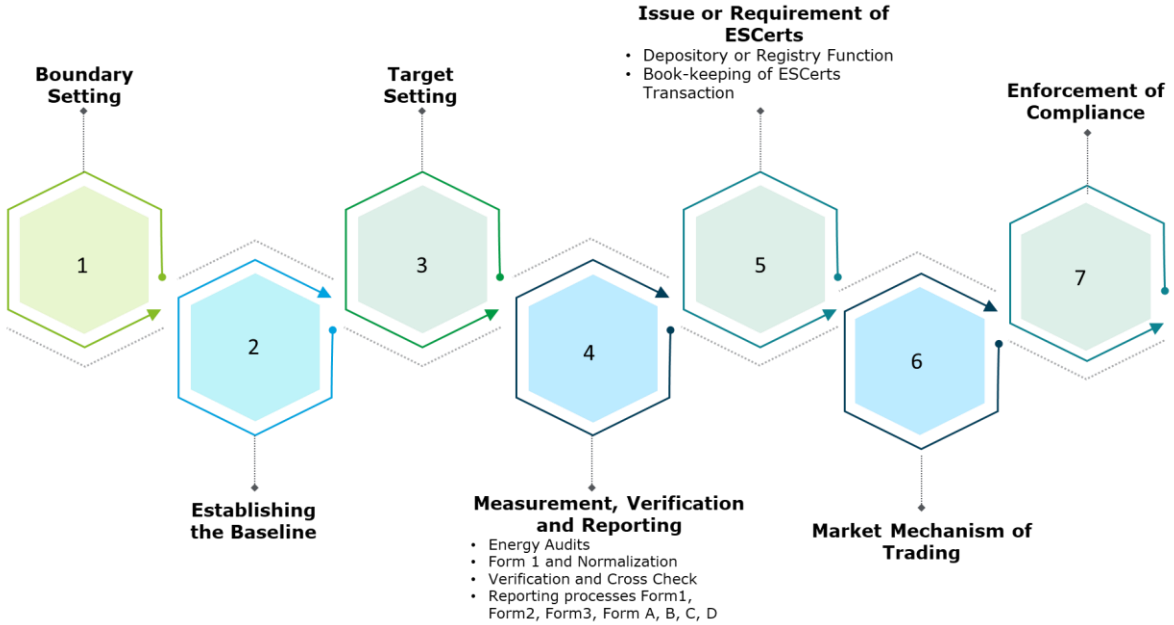


Figure 11: Design of the PAT framework

Table 6: PAT Stakeholders and responsibilities

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

2.1.1. PAT Overview:

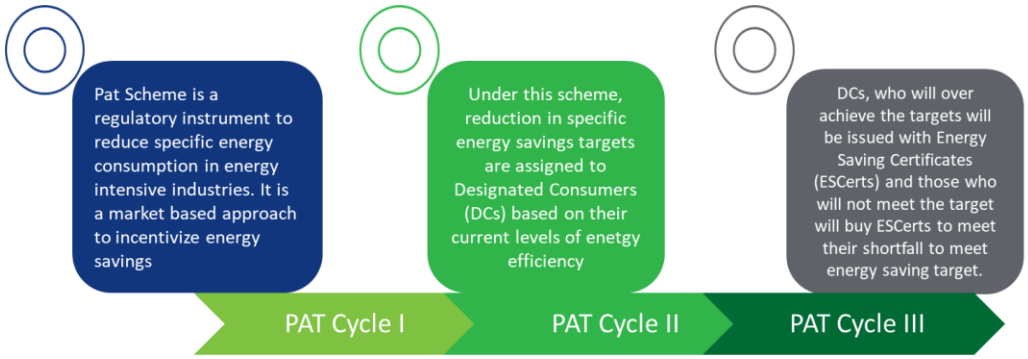
PAT cycle – I comprised of 478 industrial units from 8 sectors (Table 2) viz. Aluminum, Cement, Chlor- Alkali, Fertilizer, Iron & Steel, Paper & Pulp, Thermal Power Plant and Textile. PAT Cycle I was completed on 31st March, 2015. The energy savings achieved in PAT Cycle –I is 8.67 Mtoe which was excess of 30 percent against the target of 6.686 Mtoe. This energy saving also translates into avoiding about 31 million tonne of CO2 emission.

Considering the success of the PAT Cycle I, PAT Cycle II was launched in 2016 with addition of three sectors, namely, Petroleum Refineries, DISCOMs and Railways. With this widening of sectors and deepening among existing sectors, 173 DC were added during PAT Cycle II, taking the total number of DCs to 621 across 11 target sectors.

Table 7: PAT Sector Overview:

Sector	Threshold Energy Consumption for the DC (TOE)	No. of DCs	
		Cycle I	Cycle II
Thermal Power Plant	30,000	144	154
Iron and Steel	20,000	67	71
Cement			
a) Integrated Cement Unit	30,000	85	111
b) Cement Grinding Unit	10,000		
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
Petrochemical units having gas crackers or naphtha crackers or both	1,00,000	-	-
Railways			
a) All Zonal Railways (Traction)	70,000	-	16
b) Workshops	750	-	6
Commercial Buildings			
a) Hotels	500	-	-
b) Airports	500	-	-
DISCOMs	All licensed distribution companies BY SERC/JERC	-	44
	Total	**478**	**621**

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 6 target sectors. The timelines and energy saving targets under PAT Cycles I-III is showcased in the figure below:



Time line	2012-13 to 2014-15	2016 -17 to 2018-19	2017-18 to 2018-19
Industry Sectors	Aluminium, Cement, Chlor-Alkali, Fertilizer, Iron & Steel, Paper & Pulp, Thermal Power Plant and Textile.	Pat Cycle 1 + Railways, Electricity DISCOMs and Refineries	
Number of DCs	478 from eight sectors	621 from eleven sectors	737 from eleven sectors
Energy Savings Target	6.686 MTOE	8.869 MTOE	1.06 MTOE (for 116 DCs)

Figure 12:Timeline and energy savings targets for PAT Cycle I-III

PAT cycle –IV was notified in March 2018. A total of 109 DCs with a total reduction target of 0.6998 MTOE was notified under PAT cycle -IV. The DCs notified under PAT cycle -IV are from 8 sectors consisting of 6 existing sectors and two new sectors. The new sectors are Petrochemicals and Buildings.

PAT cycle –V (2019-2020 to 2021-22): PAT cycle –V had commenced with effect from 1st April 2019. Under PAT cycle –V, 110 DCs from the existing sectors of PAT i.e., Aluminum, Cement, Chlor-Alkali, Commercial Buildings (Hotels), Iron & Steel, Pulp & Paper, Textile and Thermal Power Plant were notified. Total energy savings of 0.5130 MTOE through the implementation of PAT cycle –V is expected to be achieved.

PAT cycle –VI (2020-21 to 2022-23) PAT Cycle-VI has commenced with effect from 1st April 2020. Under PAT Cycle-VI, 135 DCs from six sectors, i.e., Cement, Commercial buildings (hotels), Iron and Steel, Petroleum Refinery, Pulp and Paper and Textiles, have been notified. With implementation of PAT cycle –VI, it is expected to achieve a total energy savings of 1.277 MTOE.

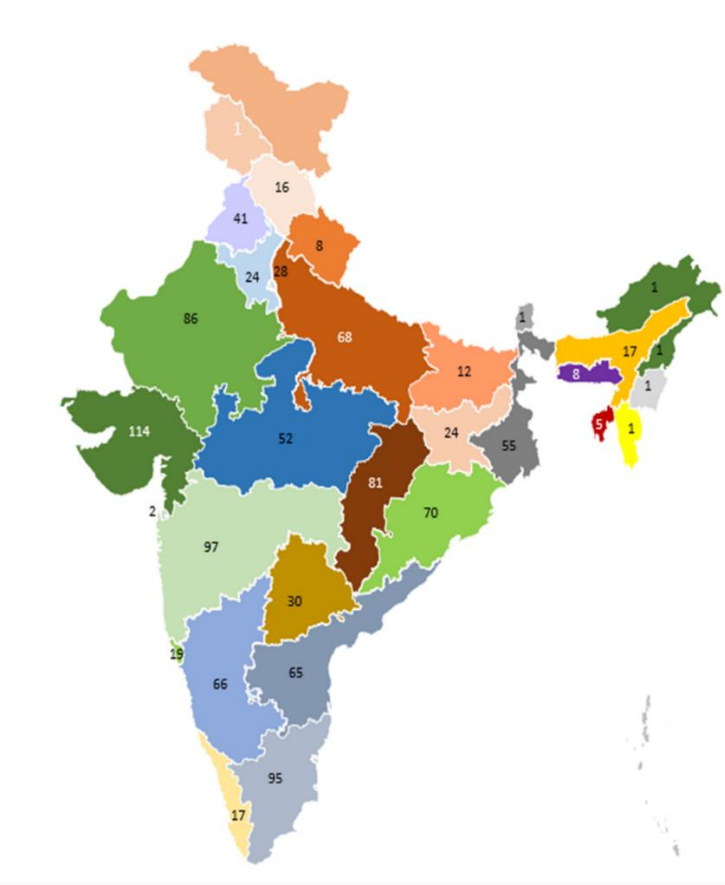
Today, PAT framework has come a long way in its seventh cycle, covering 13 Sectors and 1104 DCs. PAT cycle – VII was notified in October 2021 for the period 2022-23 to 2024-25 wherein 509 DCs have been notified with overall energy saving target of 6.627 MTOE.

Details are presented in the table below:

Table 8: PAT details till Cycle VI

Sector / No. of DCs	PAT Cycle I	PAT Cycle II	PAT Cycle-III	PAT Cycle-IV	PAT Cycle- V	PAT Cycle- VI	PAT Cycle-VII A	Total Notified DCs till VII A
Aluminium	10	12	1	-	1	-	11	14
Cement	85	111	14	1	12	37	106	174
Chlor- Alkali	22	24	-	2	2	-	24	28
Fertilizer	29	37	-	-	-	-	-	37
Iron & Steel	67	71	29	35	23	5	69	168
Paper & Pulp	31	29	1	2	8	2	23	48
Textile	90	99	34	7	16	7	90	168
Thermal Power Plant	144	154	37	17	17	-	119	238
Refinery	-	18	-	-	-	20		20
Railways	-	22	-	-	-	-	24	24
DISCOMs	-	44	-	-	-	-	43	44
Petrochemical	-	-	-	8	-	-	-	8
Buildings	-	-	-	37	31	64	-	133
Total	**478**	**621**	**116**	**109**	**110**	**135**	**509**	**1104**

The PAT cycles (till Cycle VII) has covered 1104 units from 13 sectors for participation till March 2023. The state wise distribution of these DCs is showcased in the figure below:



States / UTs	Number of DCs
Andhra Pradesh	65
Assam	17
Bihar	12
Chhattisgarh	81
Delhi	28
Dadra and Nagar Haveli	2
Goa	19
Gujarat	114
Himachal Pradesh	16
Haryana	24
Jharkhand	24
Jammu and Kashmir	1
Karnataka	66
Kerala	17
MG	1
Maharashtra	97
Meghalaya	8
Madhya Pradesh	52
Odisha	70
Punjab	41
Puducherry	2
Rajasthan	86
Tamil Nadu	95
Tripura	5
Telangana	30
Uttarakhand	8
Uttar Pradesh	68
West Bengal	55
Grand Total	1104

Figure 13: State-wise No. of DCs till PAT Cycle VII

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,

1. Generation of huge quantity of first-hand, measured and verified, industrial energy consumption data

2. 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 CO2. Summary of sector wise savings are presented in Table 9 below:

Table 9: Summary of energy saving and emission reduction PAT Cycle I

S No	Sector	Number of DC	Energy savings Achieved (Mtoe)	CO2 Emissions (Mn tonne of CO2 /year)
1	Aluminium	10	0.73	3.10
2	Cement	85	1.48	4.34
3	Chlor-Alkali	22	0.09	0.62
4	Fertilizer	29	0.78	0.93
5	Iron & Steel	67	2.10	6.51
6	Pulp & Paper	31	0.29	1.24
7	Textile	90	0.13	0.62
8	Thermal Power Plant	144	3.06	13.64
	Total	**478**	**8.67**	**31.00**

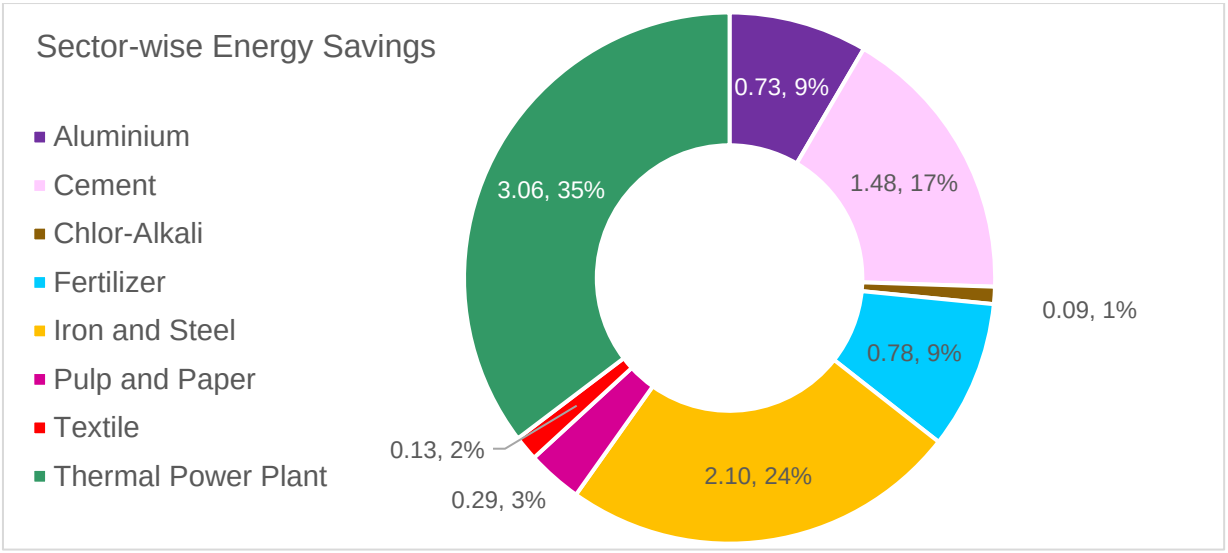


Figure 14: PAT Cycle I – Sector-wise Energy Savings

Outcome of PAT Cycle I is summarized in the figure below:

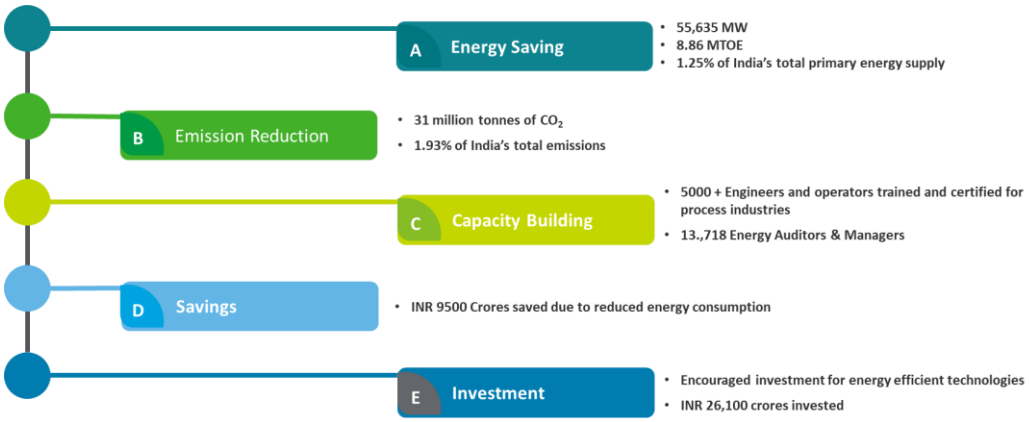


Figure 15: Outcome of PAT Cycle I

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 the table below:

Table 10: 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**

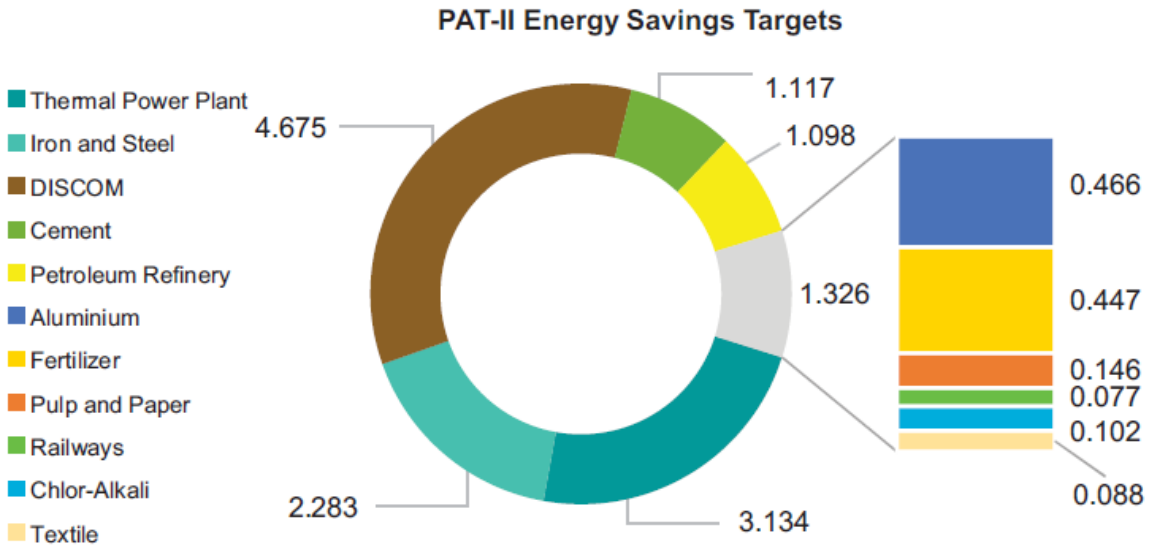


Figure 16: PAT Cycle II Energy Savings Targets

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 11 below:

Table 11: PAT Cycle II- Number of PAT DCs Analyzed for Monitoring and Verification

Sector	Total DC	Total Finalized DCs after M&V	Closed	Below Threshold	M&V Not Done
Aluminium	12	12	0		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	10	17*	9
Petroleum Refinery	18	18			
Railways	22	22			
DISCOM	44	43**		1	
Grand Total	621	548	22	29	21

Note:
*Out of 17 DCs, 1 was below threshold and 16 DCs were gas-based plant, so their PLF was below 40%. Therefore, target was not assigned to these DCs
**M&V of 2 DISCOMS (KESBL and TANGEDCO) was exempted due to Natural Calamity

In order to calculate the savings under the PAT scheme, the 548 DCs of PAT Cycle-II and their M&V data (Assessment year 2018-19) have been considered.

2.1.3.2. Impact of PAT Cycle II:

The impact under the PAT scheme for this report was calculated based on the data of 548 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 12 below:

Table 12: 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		12	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	18	1.43	10.2%	
	DISCOM	43	2.423	17.2%	
Grand Total		548	14.08	100%	

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 and 2021-22.

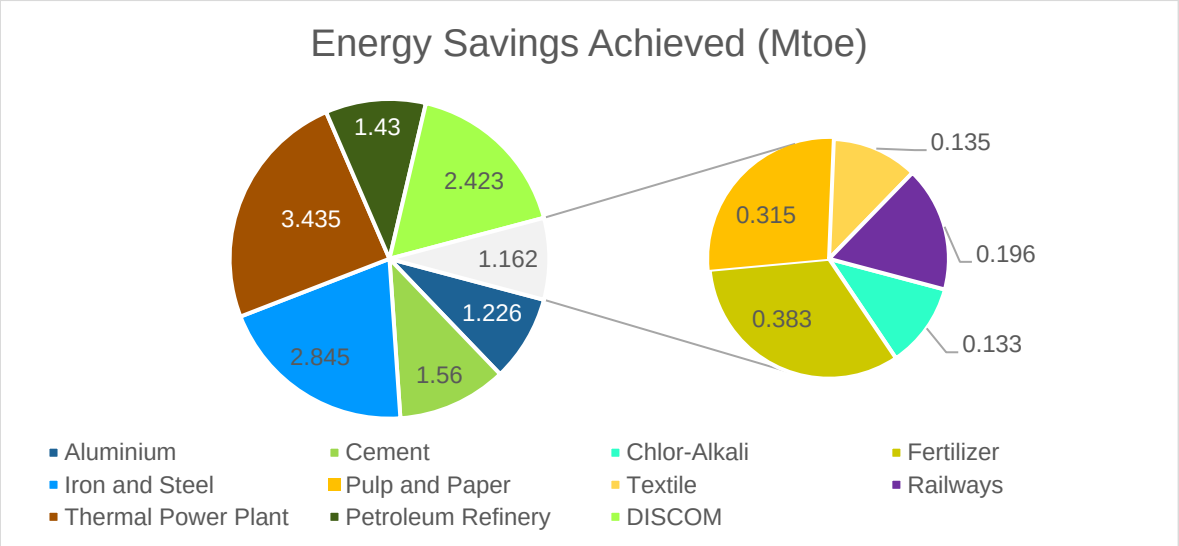


Figure 17: PAT Cycle II Energy Savings Achieved

Energy Savings- Target Vs Achieved

Data in below Table 13 shows that PAT II has overachieved its energy saving targets by almost more than 16.08%. Most of the sectors achieved the assigned targets with Aluminium, Pulp & Paper and Railways sector achieving more than twice of their assigned targets. However, sectors like Fertilizer and DISCOM were not able to meet the reduction targets which were set for them. The % Achievement over the energy saving targets of these 2 sectors are highlighted in red in the table below:

Table 13: 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	12	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	18	0.08	0.196	145%
DISCOM	43	3.73	2.423	(35%)
Grand Total	548	12.13	14.08	16%

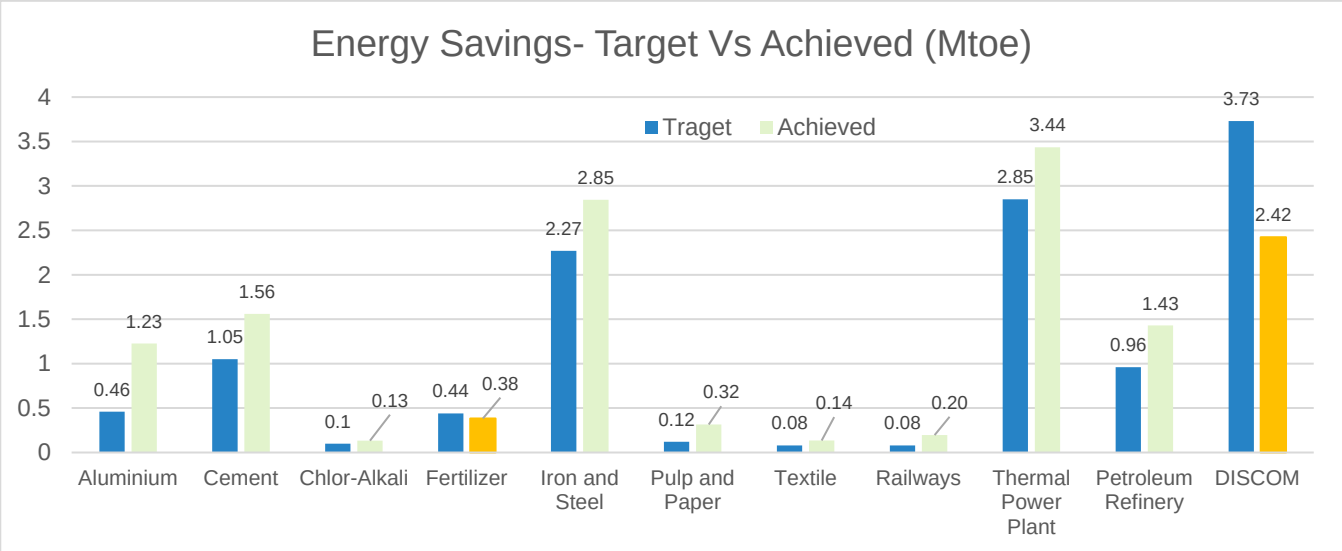


Figure 18: Energy Savings - Target Vs Achieved

2.1.3.2.1. 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 is identified as provided in Table 14.

Table 14: 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%

Post that conversion factor of 860 kcal/kWh is considered for calculation of electrical energy savings. Both thermal and electrical energy savings for each PAT sectors provided in Table 15.

Table 15: 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		12	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	18	1.293	1.598
	DISCOM	43	0.000	28.174
Grand Total		548	10.945	36.466

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

2.1.3.2.2. Estimation of reduction in CO_2 emission

In order to calculate the reduction in the total CO2 emission, Fuel-mix for each PAT sector is considered as per Table 14. Post those following assumptions were taken for calorific values, density of respective fuels and CO2 conversion factors as presented in Table 16.

Table 16: kcal value and CO2 conversion factors for various fuels

Gross Calorific Values	kcal/kg	kcal/kWh
Coal	4500	
Oil	10050	
Gas	9500	
LPG[22]	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[23]	2.89	
Electricity		0.81[24]

Overall, the energy savings of 10.945 Mtoe and 36.466 BU under PAT Cycle II has resulted in reduction of 71.47 MtCO2. Emission reduction due to PAT Cycle II is presented in Table 17.

Table 17: Share (Value) of reduction in CO2 emission by each sector

Sector	Total DCs	Evaluated DCs	Total Emission Reduction (Million tCO2)	% Share
Aluminium	12	12	4.20	6.14%
Cement	111	99	5.45	7.96%
Chlor-Alkali	24	24	0.55	0.80%
DISCOM	44	43	25.44	37.18%
Fertilizer	37	36	1.18	1.72%
Iron and Steel	71	67	11.85	17.32%
Petroleum Refinery	18	18	5.19	7.58%
Pulp and Paper	29	24	1.35	1.97%
Railways	22	22	1.00	1.46%
Textile	99	85	0.66	0.96%
Thermal Power Plant	154	118	11.57	16.91%
Grand Total	**621**	**548**	**68.43**	**100%**

[22] https://www.hindustanpetroleum.com/AboutLPG#:~:text=Properties%20of%20LPG,-LPG%20is%20twice&text=LPG%20can%20be%20compressed%20at,in%20high%20efficiency%20heat%20output.
[23] https://www.ipcc-nggip.iges.or.jp/public/gp/bgp/2_1_CO2_Stationary_Combustion.pdf- pro rata to 11900 kcal/kg
[24] Source: https://cea.nic.in/wp-content/uploads/baseline/2023/01/Approved_report_emission__2021_22.pdf

Summary:

Under the PAT scheme, overall summary of energy (thermal & electrical) savings, and corresponding reduction in CO2 emissions is presented in Table 18:

Table 18:PAT Cycle II emission and energy saving summary

Parameters	Values
No. M&V Analyzed PAT DCs	548
Total Energy Savings achieved under PAT II	14.08 Mtoe
Overall reduction in CO2 emission	68.43 MtCO2
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 19.

Table 19: PAT Cycle III- Energy savings targets:

S No	Sector	PAT-III (as per base year 2015-16)		
		Number of DC	Energy Consumption (Mtoe)	Energy savings targets (Mtoe)
1	Thermal Power Plant	37	23.86	0.406
2	Iron & Steel	29	7.65	0.457
3	Cement	14	1.74	0.094
4	Aluminium	1	1.02	0.061
5	Paper & Pulp	1	0.06	0.003
6	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:

i. Step I: Obtain the Specific Energy Consumption (SEC) for the base year 2015-16 = $SEC_{2015-16}$

ii. Step II: Obtain the Estimated SEC target for the year 2019-20= SEC_{target}

iii. Step III: $SEC_{2015-16}$ - SEC_{target} (Improvement in Energy Efficiency)

iv. 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 $Production_{2015-16}$

v. Step V: ΣES = $ES_{Plant\ 1}$ + $ES_{Plant\ 2}$+ $ES_{Plant\ 3}$ + $ES_{Plant\ 4}$ +----------+ $ES_{Plant\ N}$

2.1.4.2. Impact of PAT Cycle III

M&V Data for 100 DCs under PAT cycle III was analyzed and as per preliminary assessment it has been estimated that this will result into energy savings of 1.746 Mtoe (based on baseline year production data of FY 2015-16). The share of energy saved by each sector is presented in Table 20 below:

Table 20: 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	5.58%	54.58%
Cement		14	13	0.156	9.79%	
Iron and Steel		29	21	0.572	35.88%	
Pulp and Paper		1	1	0.005	0.31%	
Textile		34	28	0.048	3.01%	
	Thermal Power Plant	37	31	0.724	45.42%	45.42%
Grand Total		**116**	**95**	**1.594**	**100%**	

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 total energy savings of 0.870 Mtoe while the total energy savings for the supply side sectors amounts to 0.724 Mtoe for FY 2019-20.

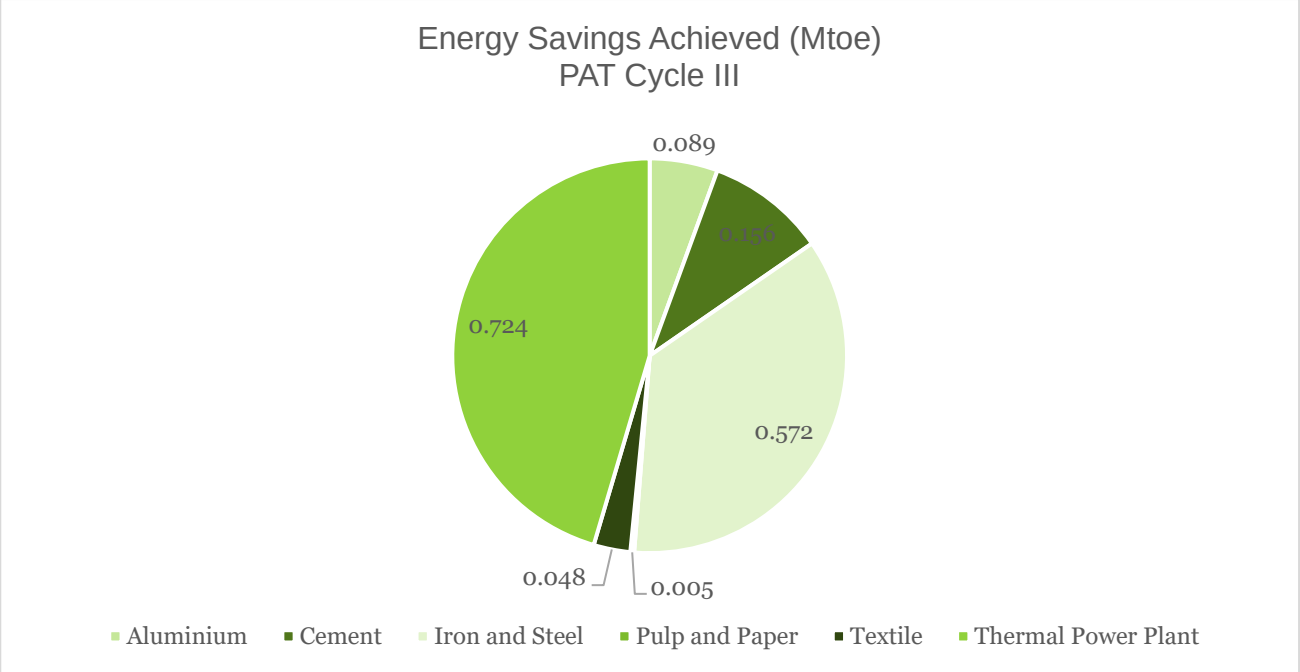


Figure 19: PAT Cycle III Energy Savings Achieved

The DCs, in each sector, under PAT Cycle III has overachieved its energy saving targets. The total target given to these sectors and the energy savings achieved under PAT Cycle III is showcased in the figure below:

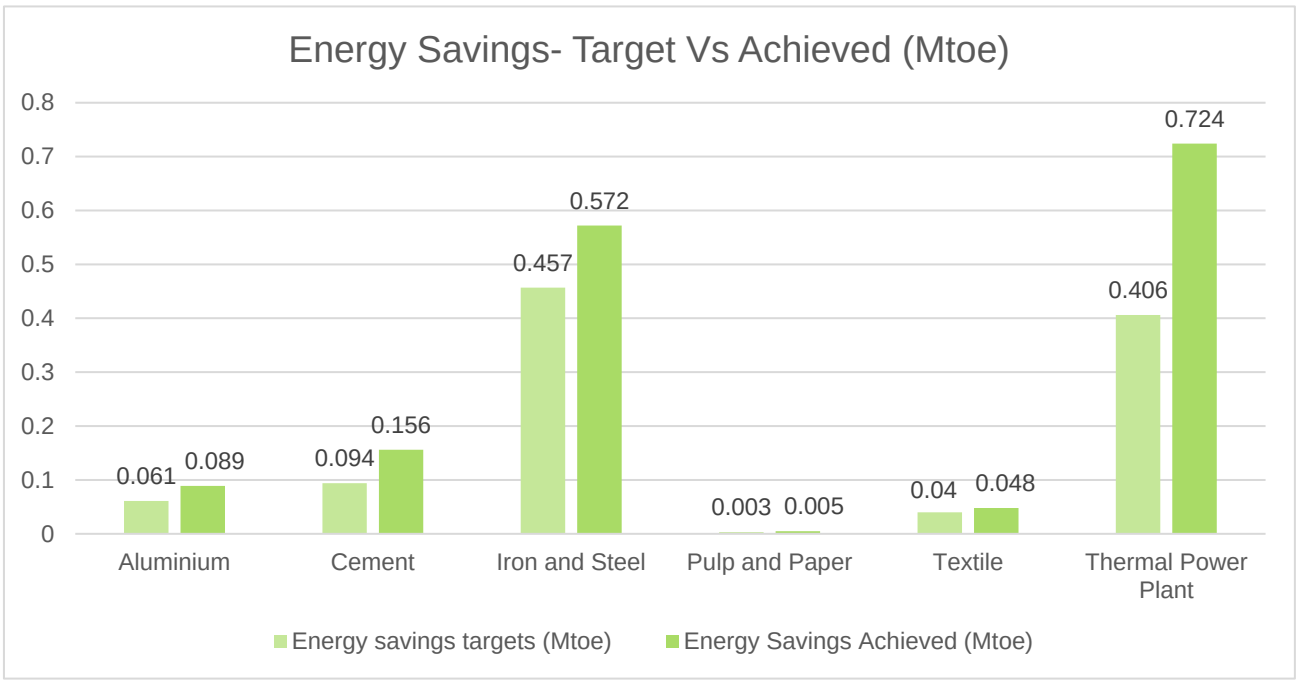


Figure 20: PAT Cycle III Energy Savings - Target Vs Achieved

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 14 is used for estimation of thermal and electrical saving, details are presented in Table 21.

Table 21: 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	0.088	0.002
Cement		13	0.136	0.237
Iron and Steel		21	0.555	0.203
Pulp and Paper		1	0.005	0.0
Textile		28	0.033	0.175
	Thermal Power Plant	31	0.724	0.0
Grand Total		**95**	**1.541**	**0.617**

The analysed data of sector under the consumption side demonstrates the total thermal **energy savings of 0.870 Mtoe and electrical energy savings of 0.617 BU**. While the sector under the **supply side demonstrates the total thermal energy savings of 0.724 Mtoe**.

2.1.4.2.2. Estimation of reduction in CO_2 emission

In order to calculate the reduction in the total CO2 emission, Fuel-mix for each PAT sector is considered as per Table 14. Post those following assumptions were taken for calorific values, density of respective fuels and CO2 conversion factors as presented in previous section in Table 16 are used for evaluation of the emission reduction. Overall, energy savings of 1.594 Mtoe and 0.617 BU under PAT Cycle III has resulted in reduction of 5.591 MtCO2. CO_2 emission reductions due to PAT Cycle III is presented in Table 22.

Table 22: Share (Value) of reduction in CO2 emission by each sector

Sector	No. of DCs	Emission Reduction ($MtCO_2$)	% Share in Total reduction
Aluminium	1	0.345	6.17%
Cement	13	0.339	6.06%
Iron and Steel	21	1.691	30.25%
Pulp and Paper	1	0.015	0.27%
Textile	28	0.261	4.67%
Thermal Power Plant	31	2.94	52.58%
Total	**95**	**5.591**	**100%**

Summary:

Under the PAT scheme III, overall summary of energy (thermal & electrical) savings, and corresponding reduction in CO2 emissions is presented in Table 23.

Table 23:PAT Cycle III emission and energy saving summary

Parameters	Values
No. of M&V Analyzed PAT DCs	95
Total Energy Savings achieved under PAT III	1.594 Mtoe
Overall reduction in CO2 emission	5.591 MtCO2
Energy (thermal) saved at consumption side	0.870 Mtoe
Energy (thermal) saved at supply side	0.724 Mtoe
Energy (electrical) saved at consumption side	0.617 BU
Energy (electrical) saved at supply side	0 BU

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 15.674 Mtoe (Thermal energy saving of 12.486 Mtoe and 37.083 BU of the electrical energy saving) under PAT cycle II, III. Sector wise energy saving is presented in Table 24.

Table 24: Total Energy saving Achieved from PAT cycle II and III

PAT Cycle	Total Energy Savings Achieved		
	Thermal (Mtoe)	Electrical (BU)	Total (Mtoe)
PAT II	10.945	36.466	14.08
PAT III[25]	1.541	0.617	1.594
Total	**12.486**	**37.083**	**15.674**

Note: M&V of PAT Cycle IV was postponed in the FY 2020-21 due to COVID pandemic and the activities related to M&V are in process in the FY 2021-22. Hence, the savings achieved from PAT Cycle IV is not considered in the energy and corresponding emission savings for the year 2021-22.

Feasibility Study for Identification of New Sectors: In order to widen the coverage of PAT scheme in 13 more sectors, feasibility study (Phase-1) was conducted and completed by BEE for the sectors namely Chemicals, Glass, Sugar, Ceramics, Zinc, Copper and Mining. The feasibility study in the Phase-1 provided outcomes in terms of threshold energy consumption of the new sector, energy consumption, percentage share in total energy consumption and probable number of Designated Consumers that could be notified from each sector based on the identified threshold.

The Phase-2 of the feasibility study by BEE in the sectors namely Port Trust, Dairy, Automobile Assembly Units, Tyre manufacturers, Forging, Foundry and Refractory.

Potential Assessment Study: Bureau of Energy Efficiency has undertaken potential assessment study in various sectors under PAT scheme namely Cement, Pulp & Paper, Textile, Chlor Alkali, Aluminum and Sponge Iron plants. The aim of such study was identification of further potential that the Designated Consumers possess to improve energy efficiency where the possible measures for energy efficiency have already been undertaken in the previous PAT cycles.

[25] Evaluation is done on basis of M&V data reported by 95 DCs to BEE

The basic objective behind carrying out this study was reaching measurable benchmarks in respective sectors in order to assess further potential of energy saving and consequent fixation of energy saving targets in subsequent PAT cycles. Based upon the study target for PAT cycle VII have been fixed.

Assessment of various industrial sectors of the economy to meet NDC targets: BEE has initiated a study in order to determine the targets based on India's Nationally Determined Contributions (NDCs) in industrial sectors and other establishments till 2030. The study is based on total energy consumption pattern / energy intensity / contribution of the industrial sector in GDP, etc. The study also reassesses the energy target gap of each industrial sector and other establishments with NDC based on realistic data of the sectors in line with the announcements in COP 26. The study was used to develop the 1 billion tonne of CO2 emission reduction goal.

Facilitating adoption of Industry 4.0 in PAT Industries: Industrial sectors continue to be the largest users of electricity. Internet of Things (IoT) and Industry 4.0 can aid in the conservation of energy and make industrial operations more energy efficient. It consists of a network of smart devices connected over the internet with access to a much larger network including sensors, smart phones, data management, report system and more. In a plant, an operator receives alerts from the hardware installed, and delivers live data on errors, malfunctions or deviations.

PAT scheme is the flagship program launched by BEE to reduce energy consumption and promote enhanced energy efficiency among specific energy intensive industries in the country. Adoption of IT, IoT (Internet of Things), smart equipment and industry 4.0 applications will facilitate the achievement of PAT targets also.

Further in this direction, capacity building programmes have been conducted by BEE for Designated Consumers already notified under PAT scheme. Further activities in order to fill the gaps are under process.

In an endeavour to continuously conserve and save energy, BEE envisages expansion of the PAT scheme to other sectors and development of a similar programme for Small and Medium Scale Enterprises in the future.

Chapter 3: MSME Sector

3. *MSME Sector*

The Micro, Small and Medium enterprise (MSME) sector accounts for a large share of world economic activity. The MSME sector contributes immensely towards economic growth, job creation, poverty alleviation and inequality reduction. For developing economies like India, the MSME sector assumes even greater importance due to its close linkages with socio-economic aspects; contribution in fostering entrepreneurship and generating employment opportunities at comparatively lower capital costs.

The Micro, Small and Medium Enterprises (MSME) sector has made a notable contribution to Indian economy since past few years. MSMEs contributes around 8% to India's GDP, playing an important role in strengthening country's economy. It also generates large employment opportunities incorporating more than 93 lakh people making their lives better by providing jobs, loans and other services through advanced technologies, infrastructure, quality trainings skill workshops and certification[26].

MSMEs accounted about 45.03% of India's total exports FY 2021-2022 which was found declining by ~4% compared to FY 2020-2021[27]. Also, with the growing economy, the energy demand also increases and thus making the industry and MSME sectors the largest consumers of energy[28]. The share of the MSME sector in India's total industrial energy consumption is also very high.

India's energy demand has increased by 10% in last 2 decades and to which the industrial segment contributes to more than 50% of energy consumption (56%) in India[29]. And from the total industrial consumption, the MSME sector takes the share of around 20-25%[30]. This immense quantum of energy consumed by the MSME sector signifies the immense potential for energy conservation across the sector.

[26] Source: Udyam Portal of the Ministry of MSMEs
[27] Source: Financial Express
[28] Source: Energy Statistics 2022, MoSPI
[29] https://powermin.gov.in/en/content/overview-2
[30] https://beeindia.gov.in/sites/default/files/UNNATEE_report_11.04.19.pdf

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

Micro, Small and Medium Enterprises (MSMEs) are strategically important part acknowledged across the world. MSMEs are the prime movers of employment and economic growth in both higher income and lower income countries making them an integral part of the manufacturing value chain and underpin the ability of large manufacturing enterprises to become competitive and successful. MSMEs form a critical part of the India's economy too. According to the annual report (2021-22) of the Ministry of MSME, there are about 633.88 Lakh MSMEs in India employing over 11.10 Crore people. The sector is the biggest employer in India after the agriculture sector.

As published by the Ministry of Micro, Small & Medium Enterprises Notification, 2020 the Micro, Small and Medium Enterprises (MSME) are classified as below[31]:

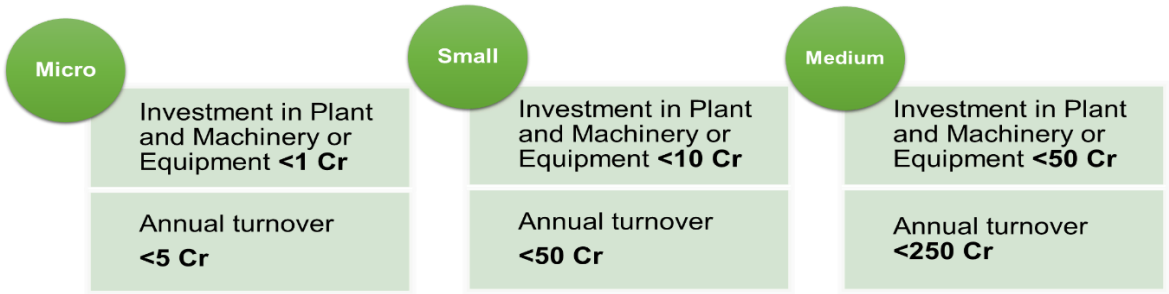
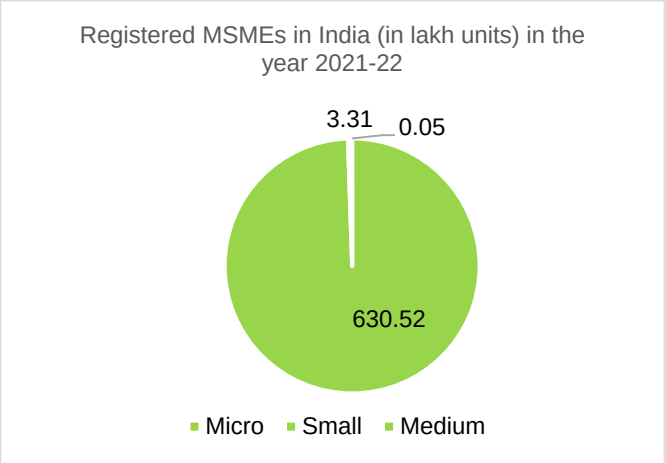


Figure 21: Definition of Micro, Small and Medium enterprises

According to an estimate by India Brand Equity Foundation, there are 633.9 lakh MSMEs from which micro enterprises cover more than 99% of the market share followed by small enterprises of 0.5% and medium enterprises of 0.01%. Micro sector with 630.52 lakh estimated enterprises accounts for more than 99% of total estimated number of MSMEs. Small sector with 3.31 lakh and Medium sector with 0.05 lakh estimated MSMEs accounted for 0.52% and 0.01% of total estimated MSMEs, respectively.

Out of 633.9 estimated number of MSMEs, 324.88 lakh MSMEs (51.25%) are in rural area and 309 lakh MSMEs (48.75%) are in the urban areas. Figure 2.1 shows the distribution of enterprises in rural and urban Areas.[32]

[31] Ministry of Micro, Small & Medium Enterprises Notification, The Gazette of India, 1st June 2020.
[32] Source: Ministry of MSME Annual Report 2021-22



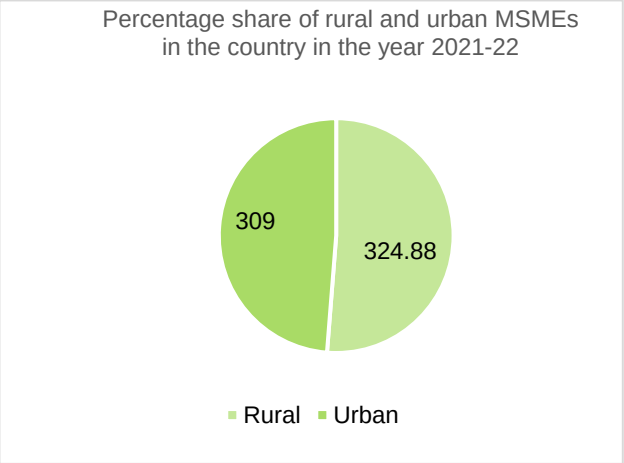


Figure 22: Number of MSMEs and distribution of enterprises in rural and urban areas 2021-22

Along with the economic progress, the sector is into development and production of 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.

Energy intensive industries, such as foundry, forging, textile, ceramics, refractory, glass, dairy, etc. are few important sectors falling under MSME. Several such Indian sectors are characterized by the presence of many geographical clusters with similar product offerings. A great deal of variation in technology and management practices within the MSME sector has been observed.

While at one end of the MSME spectrum, there are highly innovative and growth-oriented enterprises, on the other end there are unregistered units, and enterprises deploying obsolete technologies and practices. Due to wide variation in technology and operating practices, there is a wide variation in their energy performance and GHG emissions as well. There are many energy-intensive sectors where energy costs account for a major share of the operating costs. Thus, arise the need of energy saving and adoption of energy efficiency measures.

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

3.1.2. Programmatic interventions in the energy efficiency domain

Energy Efficiency (EE) is the centre of improving the competitiveness of the MSME sector and reducing carbon emissions. Adoption of Energy Efficient Technologies (EET) and best operating practices in industrial process is of vital importance for mitigating greenhouse gases (GHG) emissions and tackling climate change. The sector holds immense potential in fostering energy efficiency and upgradation of technologies.

To make Energy Efficient India and follow a path of sustainable development, it is important that the MSME sector adopt the green and efficient manufacturing processes. To proclaim the energy efficiency potential, the Indian government has undertaken several policies, strategies and programs targeted at promoting energy efficiency in the MSME sector at the national level. Various programme/schemes of Govt. of India and BEE remain a key driving force of energy conservation/uptake of energy efficiency among the SMEs. While these programmatic interventions have made an impact, there is a long way to go before majority of SMEs voluntarily increase their uptake of energy efficiency interventions.

In its endeavor to accelerate the uptake of energy efficiency in the MSME sector, BEE initiated an SME programme in the year 2009 with the objective to improve the energy performance of the MSME sector.

International organizations and agencies like World Bank, UNIDO, UNDP, JICA and GIZ etc. lays a focus on Energy Efficiency in the MSME sector that also remained on the programme agenda of several institutes and development. Some of the commercial banks have also been providing concessional energy efficiency loans to MSMEs under different Government schemes and bilateral lines of credit.

Table 25: 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 400 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 was 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 the adoption of EE technologies • Energy mapping of MSME clusters on pan India basis covering 8 sectors and 40 MSME clusters
GEF-World Bank BEE SIDBI Project Financing Energy Efficiency at MSMEs	• Program footprint to 25 MSME clusters till the third phase. • Reached out to 5000 MSME units through Capacity Building Workshops, and B2B Exhibitions • EE Implementations in more than 1250 MSME units • Resulted in emission reductions of 1.9 MTCo2 • 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

Programmatic Interventions	Achievements
	• Estimated EE saving potential of INR 900 lakh was identified from the implementation of ISO50001 and EnMS
GEF UNIDO BEE Program- Promoting EE and Renewable Energy in Selected MSME Clusters	• Focused 750 MSMEs units to 23 clusters in 5 sectors • Implemented around 1843 Energy Efficiency and Renewable Energy measures projects in SMEs • 301 Case studies • 300 Detail Project Reports • 21 Pilot Projects implemented • 7 International study tours organized • 230 SME stakeholders trained with National Productivity Council • 95 Capacity Building workshops were conducted • 603 EE and RE measures implemented • Benchmarking tool for 6 sectors developed • 12 Energy Management Centres established • 500 Local Service Providers were trained • Attracted investment of INR 244 Crores • Annual Energy savings of 24,102 TOE • Avoided 1,45,935 tonnes of CO_2 emissions per year.
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

Emerging innovations and technological upgradation like Energy 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 are supporting the development of MSMEs. In addition to these, automation by data acquisition and analysis, Artificial Intelligence, Internet of Things (IoT) and Industry 4.0 are gaining fame for improving efficiency, productivity and cost effectiveness.

Technologies, policies and financing schemes for promoting and encouraging energy savings measures on regular basis would lead MSME sector becoming more self-reliant and energy efficient.

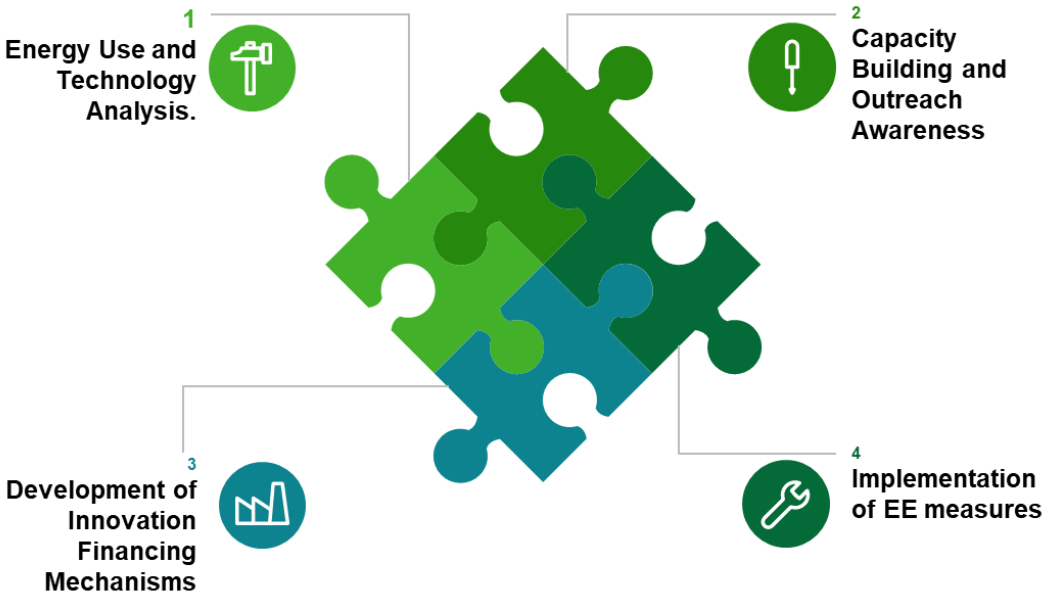
3.2. BEE – SME Programme

Objective of BEE-SME Programme

The objective of the scheme is to enhanced energy efficiency in India, accelerate adoption of energy efficiency measures and technologies to conserve energy in MSME sectors. Strengthen the MSMEs with appropriate hand-holding services by knowledge sharing, capacity building, demonstrations of efficient technologies and measures and, suitable financial mechanisms

Looking at the energy consumption MSME sector, the Bureau of Energy Efficiency noted need to develop, demonstrate and disseminate energy efficient technologies at the cluster level, through “National Programme on Energy Efficiency and Technology Upgradation in SMEs” to address the various challenges faced by MSMEs in India.

The scheme majorly focus on the challenges like savoir-faire faire of modern technologies, availability of finance for energy efficient equipment and technologies, lack of proven case studies, required set of technical skills, etc. The BEE-SME programme caters activities undertaken to encourage efficient energy consumption in the MSMEs since 2009. Few activities undertaken to encourage efficient energy consumption in the MSMEs in India are highlighted below:



Over 400 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 the implementation of Energy Efficiency Measures through the development of DPRs in 29 out of the 35 clusters for which baseline studies were undertaken.

BEE – SME Programme during the year 2017 - 2022

With the collective efforts of the Bureau towards improving the energy performance, the current state of awareness, perception and responsiveness towards energy efficiency programmes of the MSME segment in India, Energy Efficiency interventions in the SME sector are yet to become the mainstream across the country.

Although the energy saving potential is immense in this sector which BEE intends to unlock, there is quite a challenge faced by Indian MSME entrepreneurs which are risk averseness, cumbersome documentation and lack of awareness/motivation. Following are the key activities under implementation:

1. Technical Assistance and Capacity Building of energy intensive SME sectors
2. Promoting Energy Efficiency and Technology Upgradation in SMEs through the ESCO route
3. Energy mapping of SME clusters on pan India basis.

A large number of Small and Medium Enterprises (SMEs) like foundries, brass, textiles, refractories, brick, ceramics, glass, utensils, rice mills, and khandsari manufacturing units, etc., are said to have large potential for energy savings. Many of these units are in clusters located in various states of the countries.

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

United Nations Industrial Development Organization in collaboration with the 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". The 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 formulation of the energy baseline. Other components include technology identification and providing handholding support to SMEs for implementing energy efficiency. The programme also aims to build capacity on EE interventions across the cluster and to strengthen the vendor and local service provider network to ease the availability 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 a reduced cost due to economies of scale and also helps the technology provider with a business opportunity pipeline.

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

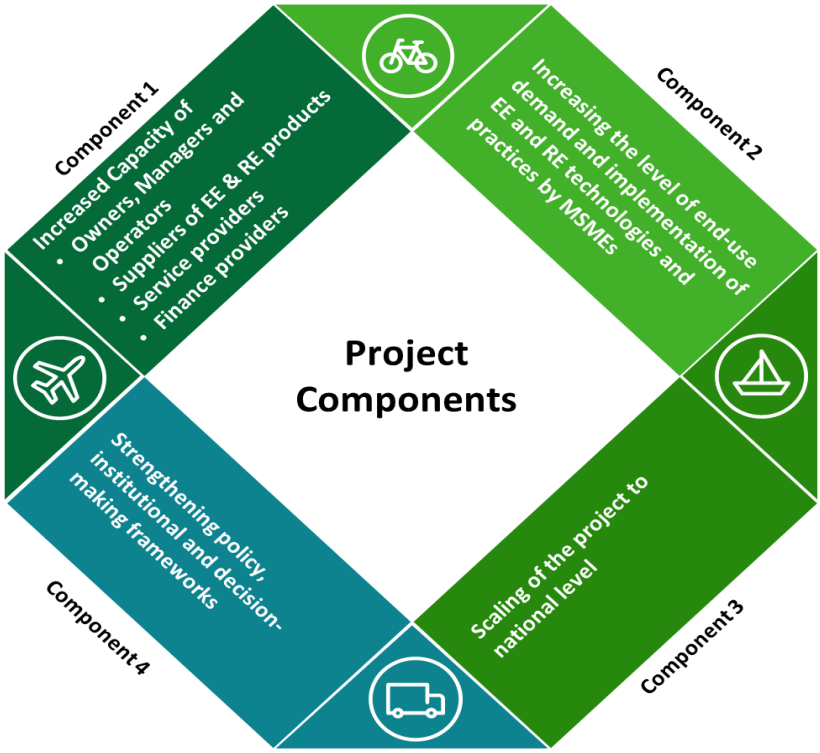


Figure 23:Project Components of BEE-GEF-UNIDO Project

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 (Jalandhar and Nagaur). Mixed Clusters in Indore (10 foundries, 20 Auto components, 30 Ready-made garments, 15 pharma, 25 food processing units), Sikkim (15 Pharma, 5 Beverage, 5 food processing units).

Methodology for estimation of the saving

$$Energy\ Saving = (Specific\ Energy\ consumption_{Baseline} - Specific\ Energy\ Consumption_{Post\ EE\ Interventions}) * Annual\ Production$$ [33]

Various energy efficiency interventions have been carried out in above-mentiooned MSME clusters. Energy saving obtained from BEE-GEF-UNIDO and BEE-SME Programme being implemented in Selected MSME Clusters in FY 21-22 is showcased in the Table 26 below:

[33] Baseline audits defines the present energy consumption and operational hours, Proposed energy consumption based on guaranteed energy saving by technology provider.

Table 26: Energy saving from BEE-GEF-UNIDO Programme and BEE-SME Programme in Selected MSME Clusters in FY 21-22

Sector	Cluster	Total Energy Savings (TOE)	CO_2 Reduction (Tonnes)	Monetary Savings (Crores ₹)	Investment (Crores ₹)
Ceramic	Thangadh	235.238	2443.11	1.85	6.56
	Morbi	1324.62	6888.75	9.13	15.04
	Ahmedabad	77.19	307.03	0.39	0.94
	Khurja	135.3	400.1	0.85	0.85
Hand Tool	Jalandhar	356.44	1384.63	2.05	4.81
	Nagaur	90.14	262.83	0.59	0.79
Dairy	Gujarat	453.18	5764.77	4.25	7.67
	Kerala	186.8	190.32	0.32	1.91
	AP & Telangana	97.8	820.4	0.54	1.86
	Maharashtra	138.05	1444.69	0.5	5.42
	Tamil Nadu	191.1	729.7	0.87	4.21
	Punjab	67.11	359.1	0.34	0.87
	Haryana	13.04	136.46	0.1	0.32
	Madhya Pradesh	81	524	0.3	1.15
Foundry	Coimbatore	728.68	7096.83	6.155	17.18
	Belgaum	256.45	2466.5	1.97	5.62
	Ahmedabad	167.02	616.79	0.66	1.85
	Eastern Zone	464.23	3814.02	2.35	3.43
Brass	Jamnagar	477.64	1264.71	2.02	5.25
Mixed Cluster	Indore	66.92	421.88	0.61	1.27
	Sikkim	90.02	837.3	0.89	0.86
Total		**5697.96**	**38173.92**	**36.72**	**87.83**

The energy savings and corresponding GHG Emission reduction from the BEE-GEF-UNIDO and BEE-SME Programme are showcased in the figure below:

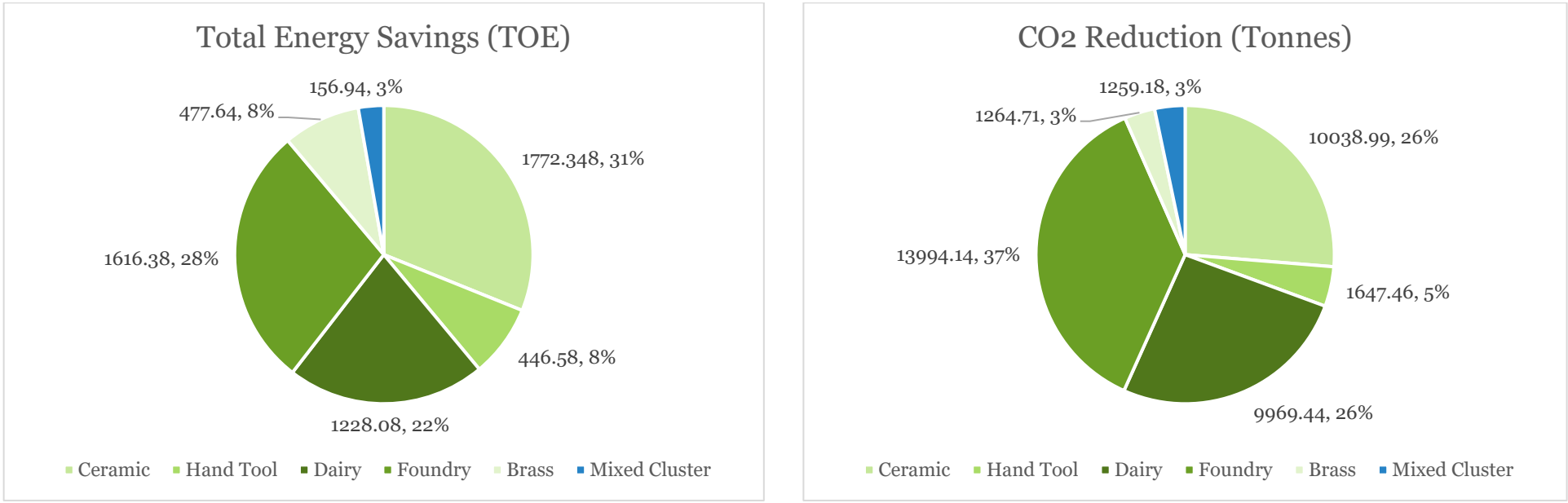


Figure 24: Energy Savings and GHG Emission Reduction from BEE-GEF-UNIDO Programme and BEE-SME Programme in FY 2021-22

Resource Mapping of MSME 45 CLUSTERS:

BEE, in an ongoing initiative titled '**Energy and resource mapping of MSME clusters'**, has intervened in nine energy-intensive MSME sub-sectors and has adopted an approach of deep-diving in these sub-sectors. The initiative aims at overcoming the lack of comprehensive and updated knowledge on various MSME clusters across the country —many of them in energy intensive sub-sectors— in regard to aspects such as production processes, technologies and fuels in use, energy saving potential, energy efficiency options, and so on.

The broad objective of this initiative is to develop sectoral benchmarks and prepare a roadmap for sustainable growth and make the intervening sub-sectors globally competitive.

Under the program, BEE has identified nine energy intensive MSME sub-sectors—brick, chemicals, dairy, forging, foundry, glass & refractory, paper, pharmaceuticals, and steel rerolling mills—for conducting a comprehensive energy and resource mapping exercise.

Studies were undertaken on each sub-sector, assisted by structured questionnaires and interactions with important stakeholders such as entrepreneurs and industry associations, R&D institutions, government agencies, and so on.

The studies and stakeholder interactions had assisted in developing a clear profile of each sub-sector including the important clusters, the diverse technologies and operating practices that are being used by MSMEs in different clusters, and market-related information for their products as well as for raw materials and services. The exercise helped in identifying the various entities that have linkages with the MSMEs at cluster/sector levels and outline the nature of support they provide to the MSMEs (materials, machinery/equipment, services, etc.).

These entities included local service providers (LSPs); equipment/machinery suppliers; technical/academic institutes; banks and NBFCs; technical consultancy organizations; government departments such as MSME Development Institute (MSME-DI), District Industries Centre (DIC), state pollution control board, and so on.

Five clusters per sub-sector were identified for detailed analysis. Detailed energy audits (DEAs) were conducted in ten units in each of these five clusters. Information and insights were gathered on the following key aspects:

- Current energy consumption scenario at the subsector and cluster levels, covering the various kinds of fuels used and the quantities consumed.
- Various raw materials used and consumption levels.
- The existing manufacturing processes, including the machinery and equipment used, and the potential for energy efficiency improvements.
- Possible EE technological options and best operating practices (BOPs)
- Readiness of the MSMEs and other cluster-level stakeholders to adopt the identified EE options.
- Market-related information on both supply and demand sides, including prospects.
- Relevant policy-level aspects.

Benchmarking

Based on the knowledge from the sub-sector/cluster level studies, key performance indicators (KPIs) will be determined for each energy intensive process and/or technology: for example, specific energy consumption (SEC) standards will be determined for each energy consuming technology/stage of the production process such as batch preparation, preheating, melting, reheating, drying, and so on.

By comparing these KPIs with the best KPI levels achieved by other industries within and outside India, benchmark standards will be set for energy efficiency for each process/technology. This exercise will also help assess and quantify the potential for bringing about energy efficiency improvements in each technology/process stage.

Roadmap

Based on the findings of the studies and the benchmarking exercise, a detailed road map will be prepared for an energy efficiency intervention in each sub-sector, in close consultation with the concerned industry stakeholders. The road map will set out an implementation plan covering technological, financing and capacity building aspects, and include policy recommendations (i.e., specific policy-level measures that could create an enabling policy and institutional level environment for the uptake of EE technologies). The road map will include information on the following key elements.

- Production
- Energy consumption pattern
- Existing technologies
- Energy saving potential.
- EE technologies that can be adopted
- Financial and other resources that might be required by MSMEs to adopt the EE technologies.
- Awareness and capacity building measures that might be required at unit/cluster levels.
- Existing institutional environment for supporting energy efficiency improvements
- Policy recommendations.

The findings of this study will further help BEE to formulate policies and prepare an implementation plan for pacing up the energy efficiency initiatives in the MSME clusters across India.

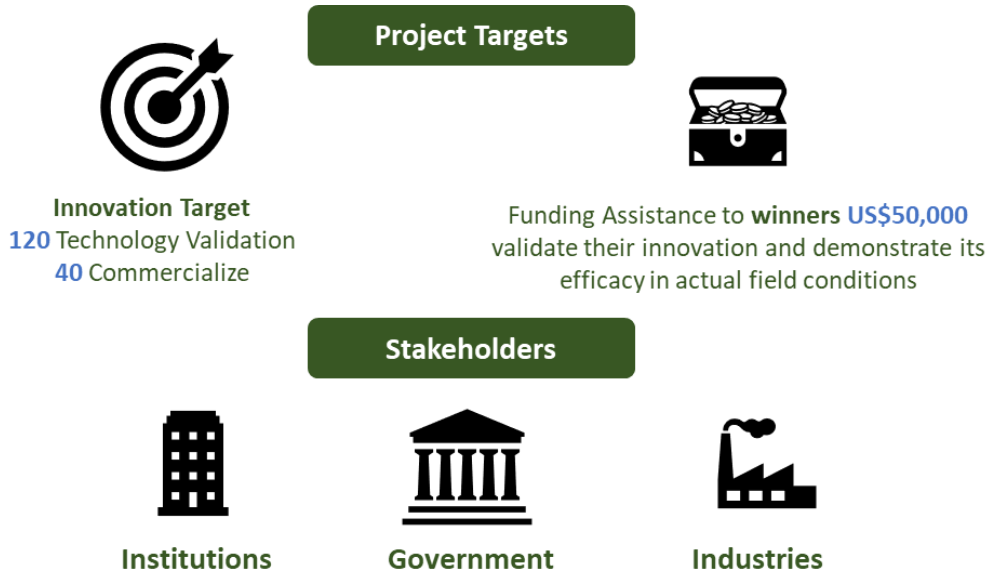
3.4. "Facility for Low Carbon Technology Deployment"

The Facility for Low Carbon Technology Deployment (FLCTD) project was initiated in 2016 aiming to promote innovation of low carbon technology solutions that address the existing technology gaps in Indian industrial and commercial sectors. The project is implemented by the United Nations Industrial Development Organization (UNIDO) in collaboration with the Bureau of Energy Efficiency (BEE) and funded by the Global Environment Facility (GEF)[34].

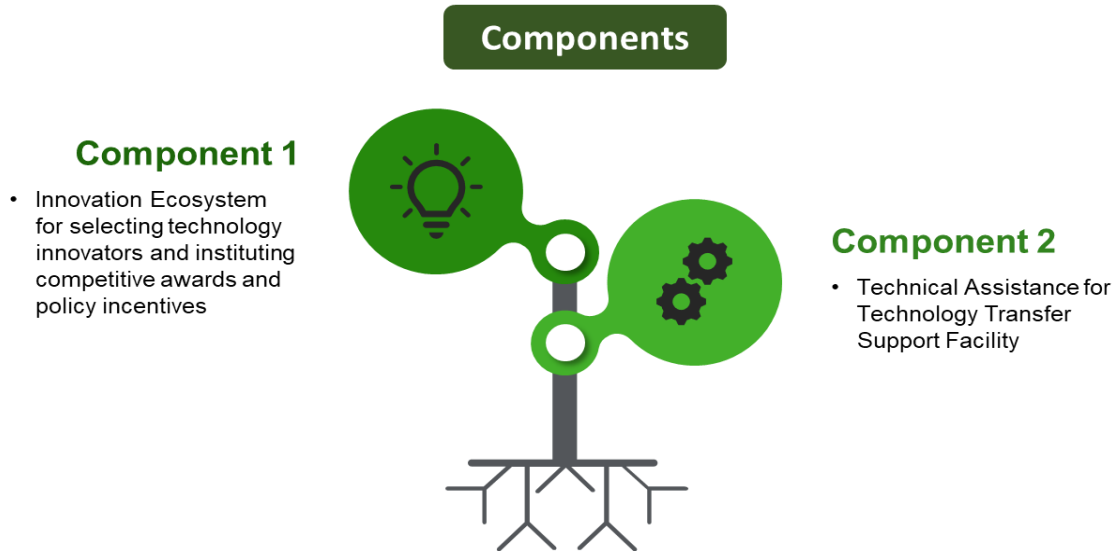
[34] Source: https://www.iea.org/policies/6197-facility-for-low-carbon-technology-development-flctd

To facilitate the validation of innovative low carbon technology thereby assist in scale up, deployment and scaling up of low-carbon technologies in India promoting innovation of low carbon technology solutions that address the existing technology gaps in Indian industrial and commercial sectors

The target of the project is to get 120 innovative technology validation ideas and 40 commercialize innovations. The project provides financial assistance of up to US$50,000 to the winners to validate their innovation and demonstrate its efficacy (performance) in actual field conditions[35]



The project is alienated into two components, of which one focus on the innovation ecosystem for selecting, awarding and policy interventions, while the other focuses on technical assistance for implementation of technology transfer support facility.



[35] https://www.low-carbon-innovation.org/the-project.html

Component 1 – Development of an awards methodology to identify and select competitive technology for project support

Under this component, the project has developed and evolved a mechanism to identify early-stage innovations that address the technology gap and have the potential for energy savings as well as replication. The "**Innovation Challenge"** is an open award competition aiming technology areas identified based on the various technical studies, consultations with industry experts and Bureau of Energy Efficiency. The challenge covers 6 technology areas covering heat, resource efficiency, pumping, IoT, space and energy storage as mentioned in the figure below:

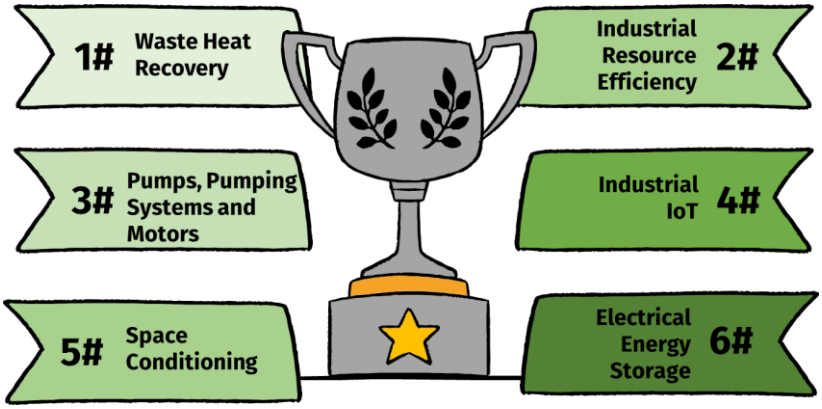


Figure 25: Open award competition for innovative solutions in 6 technology verticals

Each of the above technology vertical has panel of experts who defines the requirements of the Innovation Challenge and picks promising innovations that address the technology gaps, have the potential to reduce energy consumption and is scalable. A financial assistance up to **USD 50,000** would be awarded to the winners to validate the innovation and demonstrate its efficacy in the field conditions – a necessary pre-condition for commercialization under the project.

The project also focus on strengthening of the innovation ecosystem, comprising of knowledge-based institutions, government, industry and other stakeholders in the innovation arena apart from identifying low carbon technology innovations and nurturing their development deployment and validation for commercialization through technology challenges. The whole project is a seven-step process as explained in the figure below:

Figure 26: Innovation Challenge Cycle

Component 2 – Technical assistance for the Technology Transfer Support Facility

Under component 2 a dedicated support ecosystem for clean, low carbon and energy efficient technologies is provided. It is expected to support the creation of an innovation ecosystem for low-carbon and sustainable energy solution providers in India. It also includes capacity building activities through consultations/ workshops with international/ national experts, with documentation and dissemination of the facility. Efforts has also been made in direction to gather and disseminate good practices being undertaken by the project team for the same.

The Low Carbon Technology Accelerator Program was launched in 2019 under FLCTD, which was implemented by Sangam Capital Advisors Pvt. Ltd. It was designed to provide training and mentoring support to start-ups that are in the early stage of developing clean technology solutions and were unable to make up to the final round. It is a 4-month programme, collaborated with 'Start up India' where industry personnel and potential innovators are provided hands-on guidance to improve their business prospects[36].

Participation from Indian Technical Institutes/Universities, Research Institutes, Startups, Micro, Small & Medium Enterprises, Large Industries, Research and Development Units In Public Sector, Enterprises & Govt Labs are encouraged under the program[37].

The accelerator programme was developed based on the learning from the 2018 innovation challenge round in which it was found that many applicants with good innovations could not be shortlisted for the final round of the challenge as their applications lacked an understanding of the market, in terms of where the innovation would add value.

Key achievements of this program during FY 2021-2022 are as below:

1. Under the 4th Annual Innovation challenge, 19 innovative technologies were selected for providing financial support to perform the field demonstration.
2. 8 technologies from previous innovation challenges were validated after a thorough M&V process and are now in the process of commercialization.
3. 3rd Accelerator program was launched in partnership with Startup India on 11th August 2021 and received 206 applications by the closing deadline of 26th September 2021. Applications were scrutinized by Sangam AIC team and the PMU and thereafter 3rd cohort was launched with 23 start-ups and 15 mentors on 22nd October 2021. The startups underwent rigorous training for the next 3 months program was launched on 20th October 2021 virtually. The in-person presentations were conducted in New Delhi on 27th February 2022 and the winners were selected on 1st March 2022.
4. On the occasion of 20th Foundation Day, the National Innovation Conclave on Low Carbon Technologies was organised on 1st March 2022 at India Habitat Center, New Delhi. The event was graced by Shri R.K. Singh, Union Minister of Power and New and Renewable Energy, and Shri Krishan Pal Gurjar, Minister of State of Power and Heavy Industries. 34 winners of the FLCTD innovation challenge and start-ups from FLCTD Accelerator program participated in an exhibition to showcase their technology solutions.

[36] https://www.low-carbon-innovation.org/media/docs/compendium_april2022.pdf

[37] https://www.low-carbon-innovation.org/about-innovation-challenge.html

Interventions carried out under the project have led to total energy savings of 665.40 tonnes of oil equivalent and emission reduction of 1692.77 tCO2 during FY 2021-22. A summary of the energy savings and corresponding emission savings obtained by implementing the technologies through the FLCTD project in the FY 2021-22 is showcased in the table below:

Table 27: Energy Savings achieved under FLCTD Program in the FY 2021-22

Sl. No.	Implementation period	Name of the Winner	Technology	Savings from single pilot demonstration		No. of pilot demonstrations	Savings from all pilot demonstrations	
				Annual Energy Savings (coal / diesel / electricity)	Net annual CO_2 emissions avoided, tons of CO_2/annum		Annual Energy Savings (coal / diesel / electricity)	Net annual CO_2 emissions avoided, tons of CO_2/annum
Winners of 2019 (2nd Innovation Challenge)								
Waste Heat Recovery								
1	FY 2021	Promethean Energy	Waste Heat Recovery System for the Textile Dyeing unit Hot Effluent	453 tons of coal per WHR system	618	1	453 tons of coal per WHR system	618
2	FY 2020	ENCON	Development of regenerative burners single Pilot site: ENCON	22.320 tons of LPG per year in a 50,000 kcal test furnace	64	1	1.09,620 Sme of gas (NG) is saved annualy	230
3	FY 2022	Aspiration Energy	High temperature heat pump for industrial process heating	18.48 kL of Diesel is saved in the canteen	34.421	1	18480 liters of diesel	34.421
4	FY 2022	CEEP	Heat recovery from cotton textile dye effluent	215.8 tons of coal per WHR system	253.09	2	431.6 tons of coal savings	506.18
Pumps, Pumping systems, and motors								
5	FY 2022	Aquasub Engineering	Performance improvement of mixed flow centrifugal multistage pump	12.5 MWh per pump	9.8	10	125	98
6	FY 2021	Shakti Pumps	Micro Smart Pump	1.3 MWh per pump	1	17	22.1	17

Sl. No.	Implementation period	Name of the Winner	Technology	Savings from single pilot demonstration		No. of pilot demonstrations	Savings from all pilot demonstrations	
				Annual Energy Savings (coal / diesel / electricity)	Net annual CO_2 emissions avoided, tons of CO_2/annum		Annual Energy Savings (coal / diesel / electricity)	Net annual CO_2 emissions avoided, tons of CO_2/annum
7	FY 2022	Water Hand Limited	Pression irrigation algorithms and IoT unit.	157 kWh/crop cycle 1566 kL of water / crop cycle	0.124	16	2.512	1.984
8	FY 2022	Sense It out intelligent solutions Private Limited	Sensor Based Intelligent Crop Centric Automation (SICCA)	108 kWh/crop cycle 1081 kL of water / crop cycle	0.085	6	0.648	0.51
9	FY 2022	Scientific and Industrial Testing and Research Centre (Si'Tarc)	Smart Submersible Pump with high-speed permanent magnet motor	Submersible pump - 5hp @ 2.0 MWh annual savings Submersible pump - 7.5hp @ 2.12 MWh annual savings Submersible pump - 20hp@ 8.8 MWh annual savings	Submersible pump - 5hp - 1.5 tons of CO2/annum/pump Submersible pump - 7.5hp - 1.67 tons of CO2/annum/pump Submersible pump - 20hp - 6.9 tons of CO2/annum/pump	15	12.96 MWh of annual electrical savings	10.23
Space Conditioning								
10	FY 2022	Inficold India Private Limited	200 Lt Solar milk-cooler to provide instant chilling at the point of collection	610 litres of Diesel per milk chiller	5.2	12	7320	62.4
11	FY 2021	New Leaf Dynamics Private Limited	Refrigeration systems powered by farm waste using	5.4 MWh per GreenChill	0.039	1	5.4	0.039

Sl. No.	Implementation period	Name of the Winner	Technology	Savings from single pilot demonstration		No. of pilot demonstrations	Savings from all pilot demonstrations	
				Annual Energy Savings (coal / diesel / electricity)	Net annual CO_2 emissions avoided, tons of CO_2/annum		Annual Energy Savings (coal / diesel / electricity)	Net annual CO_2 emissions avoided, tons of CO_2/annum
			climate-friendly refrigerant provide on-farm cooling					
12	FY 2021	Promethean Spenta Tech. Private Limited	Milk-can cooling solution for chilling milk in the village with a thermal storage system	367 litres of diesel per milk chiller	0.8	11	4037	8.8
13	FY 2022	Zedbee Technologies	ZedBee – Automated HVAC control in buildings	13.3 MWh of electrical savings	10.5	5	18.62	14.7
14	FY 2022	Tan90 Thermal solutions Private Limited	Fast Charge Phase Change Material (PCM) based transport containers - Portable Cold Storages for first and last mile transport of perishables	121 kWh of electrical energy per PCM	0.09	600	72.6 MWh of electrical energy	54
			Sub Total 1	*19.457 kL/year of diesel 668.8 tons/year of coal 45.806 MWh/year electricity 22.320 tons/year of LPG*	*1007.211*	*698*		*1656.264*
Winners of 2020 (3rd Innovation Challenge)								
1	FY 2022	AFECO Heating Systems	Al-Thermos	46.212 MWh for each Althermos installation	36.507	1	46.212 MWh	36.507
			Sub Total 2	*46.212 MWh /year electricity*	*36.507*	*1*		*36.507*

Sl. No.	Implementation period	Name of the Winner	Technology	Savings from single pilot demonstration		No. of pilot demonstrations	Savings from all pilot demonstrations	
				Annual Energy Savings (coal / diesel / electricity)	Net annual CO_2 emissions avoided, tons of CO_2/annum		Annual Energy Savings (coal / diesel / electricity)	Net annual CO_2 emissions avoided, tons of CO_2/annum
	Grand Total			**19.457 kL/year of diesel 668.8 tons/year of coal 92.018 MWh/year electricity 22.320 tons/year of LPG**	**1043.718**	**699**		**1692.771**

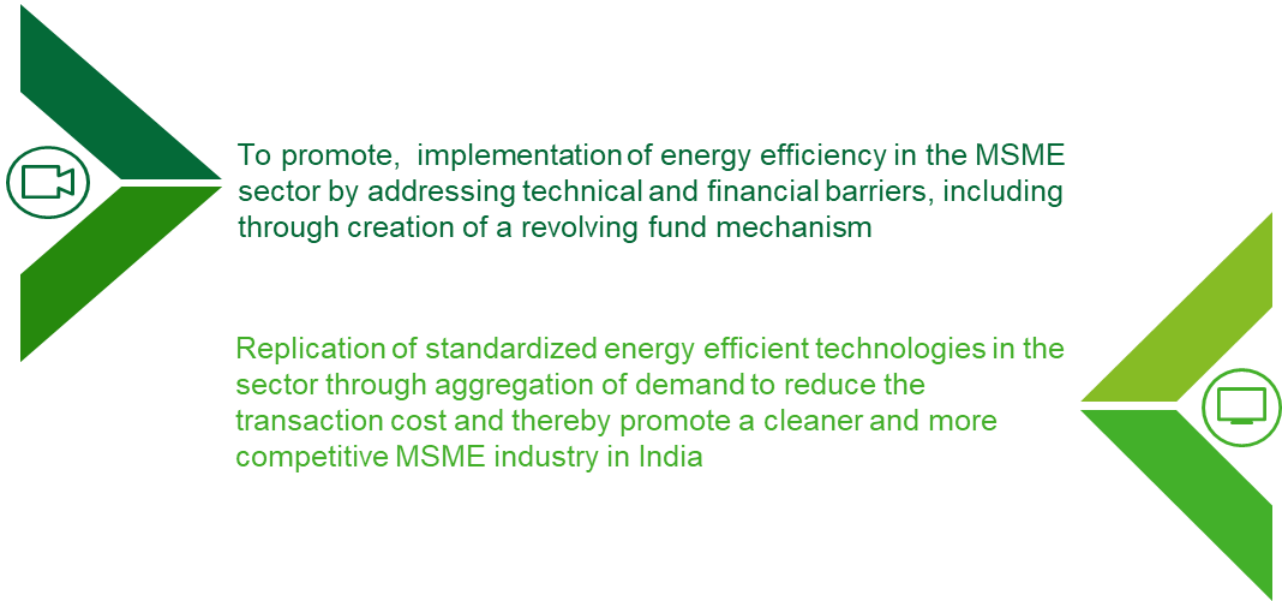
3.5. *"Promoting Market Transformation for Energy Efficiency in Micro, Small & Medium Enterprises" EESL-UNIDO –GEF-6 programme*

With the target to the implementation of energy efficiency in the Indian MSMEs, the project, "Promoting market transformation for energy effciency in Micro, Small & Medium Enterprises," a joint initiative conceptualized by the United Nations Industrial Development Organization (UNIDO) and office of the DC MSME was formed to create and sustain a revolving fund mechanism as a mode to ensure replication of energy efficiency measures in selected 10 industrial clusters.

The key Executing Partner for the project is Energy Efficiency Services Ltd (EESL). Small Industrial Development Bank of India (SIDBI) and Bureau of Energy Efficiency (BEE) are the guiding agencies for the project.

Programme Objective

The project aims to:



The project targets to accelerate the adoption of energy efficient technologies in the sector by removing its key barriers. The project aims to deploy 33-35 technologies in selective MSME clusters in the country which have the maximum possibility of replication and the potential to improve the energy baseline of fellow MSMEs units. Aiming at market transformation wherein the project will adopt various innovative business models of ESCO (Energy Servicing Company) based financing wherein the MSME units are expected to repay from their monetized energy saving in a stipulated period of time.

EESL is implementing this project in 10 MSME clusters (Surat, Ankleshwar, Jorhat, Vellore, Jalandhar & Batala, Varanashi, Sundargarh, Howrah, East Godavari, Muzafarnagar) in India. 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 2021-22[38]:

- 740 surveys, 78 detailed Energy Audits and more than 70 technology specific baseline studies have been completed.
- EESL has identified more than 30 energy efficient technologies for demonstration and has signed an agreement with more than 35 MSME units.
- Procurement for 19 technologies (with bulk procurement for 2 technologies) and demonstration of 14 technologies have successfully been completed.
- EESL has conducted more than 100 awareness / consultation / training workshops in 10 clusters for faster adoption of the technologies

The details of the above-mentioned clusters and the activities done under this programme in the FY 2021-22 is discussed below:

Surat Textile and Ankleshwar Chemical Cluster – One of the largest textile manufacturing clusters in India is located in Surat (Gujarat). The Surat cluster accounts for over 18% of the total manmade (synthetic) fibre exports and 40% of manmade fibre production in the country. The products primarily comprise synthetic sarees & dress materials and cotton dress materials. There are about 400 textile processing units in the cluster, operating over 600,000 power looms[39].

India's largest chemical industry cluster is located in Ankleshwar, in Bharuch district of Gujarat in Gujarat. This cluster hosts over 700 MSMEs manufacturing various kinds of chemicals: about 67% of the units produce dyes and pigments; 27% produce pharma and pharma intermediates; and the remaining 6% produce pesticides and chlor-alkalis. The production capacity of the units ranges from 100 tonnes to 1000 tonnes per annum.[40]

Under the project in FY 2021-22, several EE interventions were implemented in both the cluster. The implementations were carried out in 14 industries leading to energy savings of 1019 tonnes of oil equivalent and GHG emission savings of 5494 tCO2.

Jorhat Tea Cluster – The state of Assam is world-famous for its teas. A large cluster of tea gardens is located around the town of Jorhat, in upper Assam, spreading across Jorhat and Golaghat districts. Many of these tea gardens have their own in-house factories for processing the tea leaves. Jorhat tea cluster has been chosen under BEE-SME programme as the units there are traditionally very old which have not really progressed in pace with the technological advancements. During the FY 2021-22, EE implementations were implemented in 7 SME units

[38] https://eeslindia.org/wp-content/uploads/2021/06/Annual%20Report2021-22.pdf
[39] Source: http://sameeeksha.org/index.php?option=com_content&view=article&id=143&Itemid=499#:~:text=One%20of%20the%20largest%20textile,bre%20production%20in%20the%20country.
[40] Source: http://sameeeksha.org/index.php?option=com_content&view=article&id=131&Itemid=499#:~:text=This%20cluster%20hosts%20over%20700,produce%20pesticides%20and%20chlor%2Dalkalis.

which has led to saving of around 126 tonnes of oil equivalent and corresponding GHG emissions of 485 tCO2.

Howrah Forging Cluster – Howrah District is one of the 19 districts in West Bengal and known as the smallest district in West Bengal. One part of the district is fully engaged with industrial activities while other part is still going through the agricultural efforts. 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 five units which has resulted to energy savings of 597 tonnes of oil equivalent.

Vellore Rice Mill Cluster: Rice is the staple food of majority of Indians and specifically in Southern Indian. Paddy is one of the major crops cultivated in the Southern states, especially in the state of Tamil Nadu. The Rice comes out of the milling of paddy. Hence rice milling is an important activity in the state. Rice mills are the lifeline for the economic development of rural India. The rice mills are generally located in rural areas and near paddy growing areas. There are about 340 rice mills in the Vellore rice mills cluster covering Arni, Arcot and Vellore areas. Considering the potential in the sector, several interventions for energy efficiency improvements were carried out in units leading to energy savings of 33 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 2021-22, due to the implementation of EE interventions is showcased in the table below:

Table 28: Energy saving from the EESL-UNIDO-GEF 6 programme in FY 21-22

State	Cluster	Sector	No. of Units	Total Investment (INR Lakhs)	Energy Saved (TOE/yr)	Monetary Savings (INR Lakhs)	Reduction in CO2 emission (tCO2/yr)
Gujarat	Chemical	Ankleshwar	9	96.62	141	37	913
Punjab	Forging	BJL	2	64	181	58	335
W. Bengal	Mixed	Howrah	5	96	597	143	2604
Assam	TEA	Jorhat	8	117	126	53	486
Gujarat	Textile	Surat	8	126	840	127	4093
Tamil Nadu	Rice	Vellore	2	56	33	31	158
Uttar Pradesh	Textile	Varanasi	1	3	0.31	0.45	3
Total			**35**	**558.62**	**1918.31**	**449.45**	**8592**

The energy savings and corresponding GHG emissions reductions due to the implementation consultation/training another EE interventions in the mentioned clusters under this programme in FY 2021-22 are showcased in the figure below:

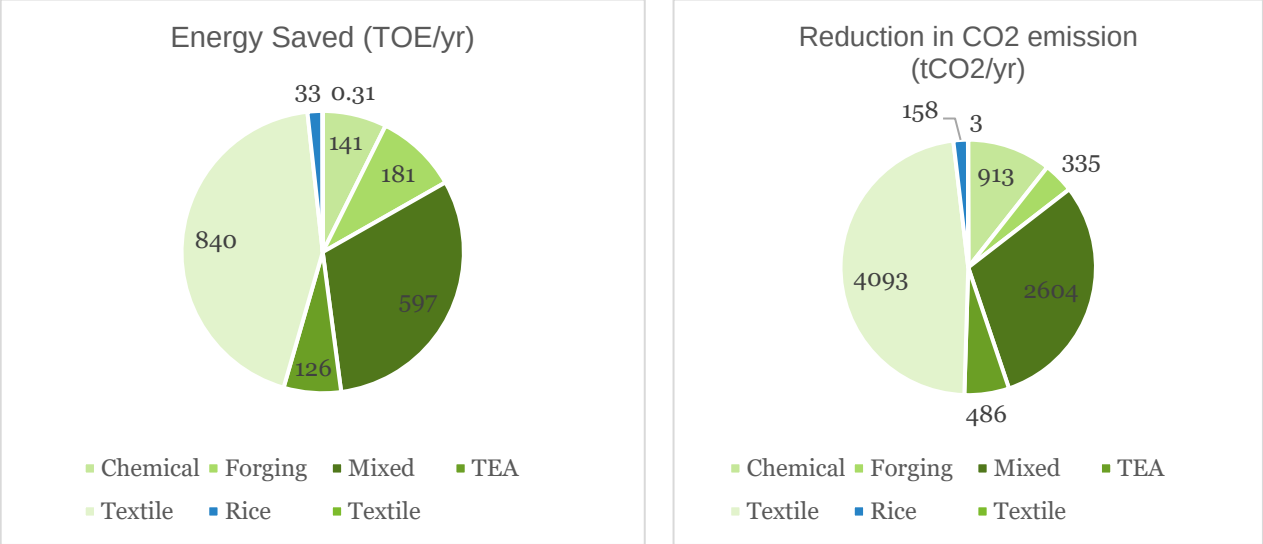


Figure 27: Energy and emission reduction across the five clusters

3.6. "Partial Risk Sharing Facility for Energy Efficiency" – WB-SIDBI-GEF project

"Partial Risk Sharing Facility for Energy Efficiency" project was initiated by Government of India partnering with World Bank to promote an increased level of investments in energy efficient projects, particularly through energy service performance contracting delivered through energy service companies ("ESCOs").

Objective

To transform the energy efficiency (EE) market in India by promoting increased level of EE investments, particularly through energy service performance contracting (ESPC) delivered through Energy Service Companies (ESCOs).

The programme is implemented by Global Environment Facility("GEF") and the Clean Technology Fund ("CTF"). It is supporting the loans granted by various PFIs and by SIDBI as lender (in such capacity, “SIDBI as Lender”), who are empaneled with the PEA Division to either ESCOs or the Host who are implementing energy saving projects, by providing risk coverage for repayment of such loans.

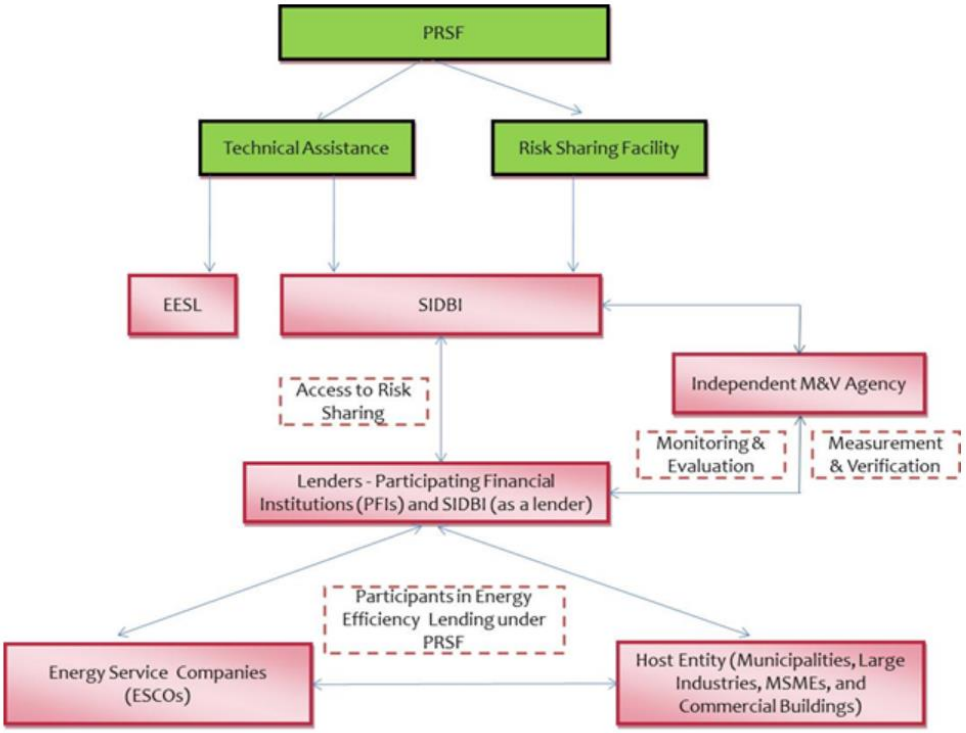


Figure 28: *Management Hierarchy of the PRSF programme*

The ESCOs are important drivers to achieve energy-efficiency potential and the business model they use, energy performance contracting, helps overcome several market barriers. Financing for the EE equipment/technology investment can either be provided by the ESCO from its internal funds or by the customer, or by a third-party funding (TPF), in which a financial institution allows a credit either to the ESCO or directly to Host entity where the energy savings project is being implemented; the loan may or may not be backed by a guarantee for the projected energy or cost savings given by the ESCO.

The above objective can be accomplished through:

The procedure to obtain a loan under the PRSF scheme for EE technology is showcased in the figure below:

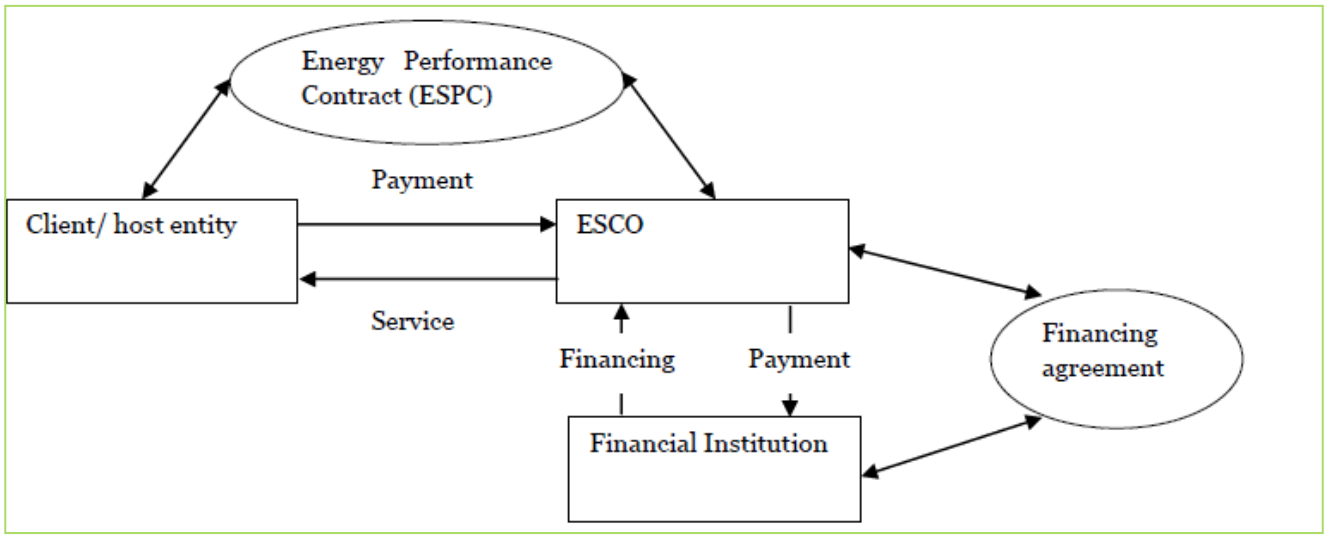


Figure 29: Functioning of PRSF Scheme

There are two main models for energy performance contracting: the "shared savings" model and the "guaranteed savings" model.

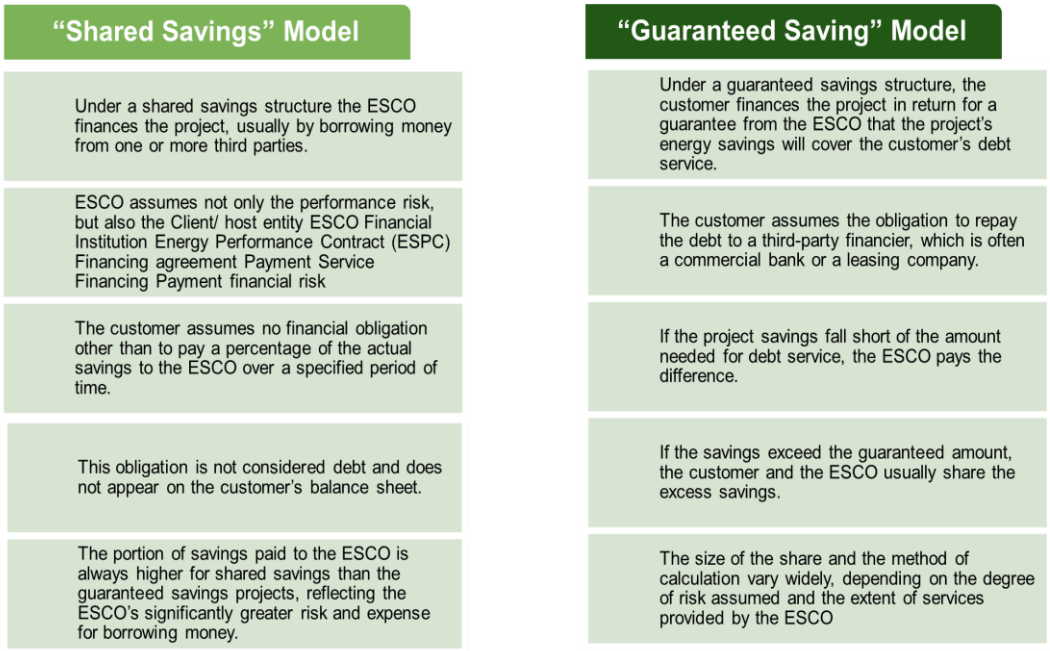


Figure 30: Energy Performance Contracting Models under PRSF Scheme

Project components

Total expenditure of the project was USD 43 million consisting of the "Partial Risk Sharing Facility for Energy Efficiency" component of USD 37 million and technical assistance component of USD 6 million. SIDBI managed the entire "Risk Sharing Facility" component of USD 37 million providing a cover share of default risk faced by Participating Financial Institutions (PFI) in extending loans to eligible EE projects implemented through ESCOs[41].

The table below showcases the energy and emission savings obtained under SIDBI's PRSF scheme for the FY 2021-22:

Table 29: Cluster wise energy savings obtained under SIDBI- PRSF Programme in FY 21-22

Cluster	No. of Units	Total Investment (INR Lakh)	Energy Saved (MWh)	Total Energy Saved (TOE)	Reduction in CO2 emission (tCO2)
Kozhikode, Kerala	1	500	6271	539	5142
Bokaro, Jharkhand	1	531	9948	856	8157
Gujarat	1	288	250	22	197
Hisar, Haryana	1	445	892	77	731
Chennai, Tamil Nadu	1	452	190	16	156
Mysuru, Karnataka	1	979	22292	1917	20508
Bhopal, Madhya Pradesh	1	220	10	1	9
Bellari, Karnataka	1	225	4140	356	3395
Chennai, Tamil Nadu	1	259	147	13	116
Adityapur, Jharkhand	1	670	825	71	652
Satara, Maharashtra	1	1400	2942	253	1689
Total	**11**	**5969**	**47907**	**4120**	**40752**

[41] https://www.sidbi.in/en/prsf-project

Methodology for estimation of energy savings

Energy Saving = (Specific Energy consumption $_{Baseline}$ – Specific Energy Consumption $_{Post\ EE\ Interventions}$) Annual Production* [42]

The WB-GEF project has also created a revolving fund to promote the financing of energy efficiency projects in the 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 have led to total energy savings of 6915.90 tonnes of oil equivalent[43] during FY 2021-22.

3.7. 4E (End to End Energy Efficiency) Scheme

4E (End to End Energy Efficiency) is a sustainable finance scheme launched by the SIDBI (Small Industries Development Bank of India) on the occasion "World Environment Day" i.e., 5th June 2014. This scheme intends to provide technical backstopping and help MSME clients to reduce their labour and expenditures and fulfil their financial needs. It also provides loans to MSMEs for implementation of energy efficiency measures, the latest technologies, etc.

The main objectives of the scheme are explained in the figure below:

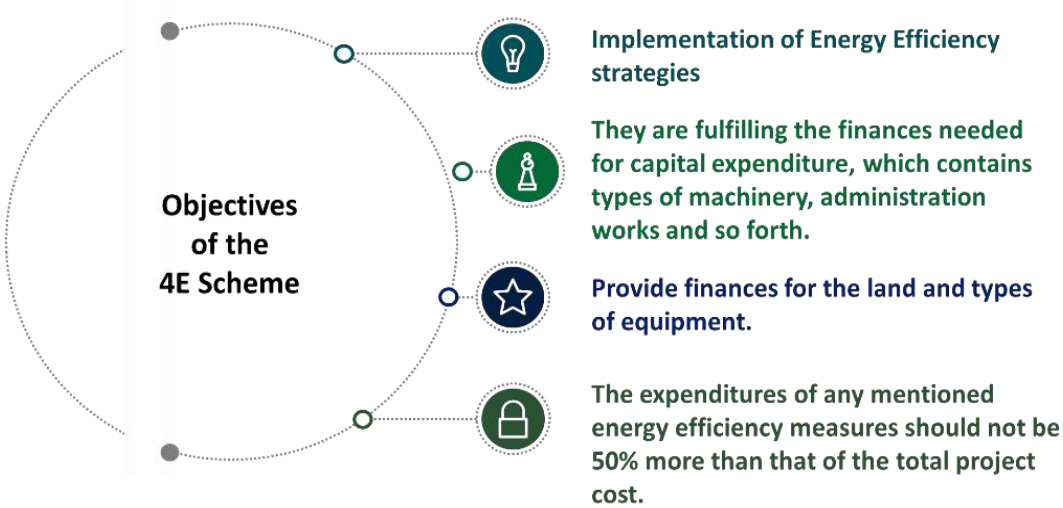


Figure 31: Objectives of the 4E scheme[44]

[42] Energy savings estimated based on annual production details collected during year of EE implementation, at respective MSME unit for each implemented measure.
[43] 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
[44] https://www.startupindia.gov.in/content/sih/en/government-schemes/end-to-end-energy-efficiency.html

The scheme provides multiple benefits to the stakeholders mentioned in the figure below:

Figure 32:Benefits of SIDBI's 4E Scheme

The table below showcases the energy and emission savings obtained under SIDBI's 4E scheme for the FY 2021-22:

Table 30: Cluster-wise energy savings obtained under SIDBI- 4E Scheme in FY 21-22

Cluster/Location	Sector	No. of Units	Total Investment (INR crore)	Electrical Energy Saved (kWh)	Total Energy Saved (TOE)	Reduction in CO2 emission (tCO2)
Ahmedabad	Chemical	1	0.62	183966	15.82	145.33
Gandhidham	Engineering (Cutting & Shaping)	1	1.28	379800	32.66	300.04
	Textiles	1	1.06	364000	31.30	287.56
Vadodara	Food Processing	1	0.23	78981	6.79	62.40
Rajkot	Engineering (Cutting & Shaping)	1	0.46	157962	13.58	124.79
	Foundary & Forging	1	1.48	392000	33.71	309.68
	Plastics & Polymers	1	3.00	1050000	90.30	829.50
	Steel	1	2.03	522000	44.89	412.38
Jamnagar	Engineering (Cutting & Shaping)	1	1.45	14723	1.27	11.63
Bengaluru	Packaging	1	0.57	27930	2.40	22.06
	Metal	1	5.00	128909	11.09	101.84
	Plastic & Polymer	1	1.83	159437	13.71	125.96
	Engineering (Cutting & Shaping)	9	11.46	419923	36.11	332.00
Panji	Plastic & Polymers	1	2.01	46080	34.24	99.69
Mysuru	Manufacturing	1	1.11	322541	27.74	254.81
	Engineering (Cutting & Shaping)	1	4.48	73728	6.34	58.25
	Automobile	1	2.45	34376	2.96	27.16
	Pulp & Paper	1	7.50	41472	3.57	32.76

Cluster/Location	Sector	No. of Units	Total Investment (INR crore)	Electrical Energy Saved (kWh)	Total Energy Saved (TOE)	Reduction in CO2 emission (tCO2)
Kochi	Engineering	1	5.00	172800	14.86	136.51
	Engineering (Cutting & Shaping)	1	0.25	24170	2.08	19.09
	Construction	1	0.20	19440	1.67	15.36
Chandigarh	Foundary & Forging	4	14.37	1600	0.14	1.27
	Pharmaceutical	1	0.30	70	0.01	0.06
	Service	1	0.33	20160	1.73	15.93
	Engineering (Cutting & Shaping)	2	2.61	167760	14.42	132.53
	Chemical	1	2.33	207360	17.83	163.81
	Metal	1	0.65	40320	3.47	31.85
	Auto Components	1	5.06	27496	24.72	227.12
	Steel	1	5.25	53280	4.58	42.09
	Iron & Steel	1	1.32	165888	14.27	131.05
	Castings & Forging	2	9.00	1050000	90.30	829.50
Jalandhar	Forging	1	5.00	429483	36.94	339.29
	Engineering	1	0.96	19440	1.67	15.36
Ludhiana	Textiles	2	1.02	20655	1.77	16.32
	Plastics & Polymers	1	0.71	187663	16.14	148.25
	Iron & Steel	2	7.30	121821	10.48	96.24
	Engineering (Cutting & Shaping)	3	4.55	75930	6.53	59.98
	Pulp & Paper, Iron & Steel	1	2.44	40718	3.50	32.17
	Service	1	1.81	30205	2.60	23.86
Ambattur	Machine Manufacturing	1	1.00	34848	3.00	27.53
	Steel	1	0.58	190080	16.35	150.16

Cluster/Location	Sector	No. of Units	Total Investment (INR crore)	Electrical Energy Saved (kWh)	Total Energy Saved (TOE)	Reduction in CO2 emission (tCO2)
	Engineering (Cutting & Shaping)	15	14.18	521510	44.87	411.93
	Iron and Steel	1	1.50	365000	31.39	288.35
	Food processing	1	0.74	43718	3.76	34.54
	Agriculture Machinery	1	0.74	43718	3.76	34.54
	Chemical Industries	2	2.30	78624	6.76	62.11
	Service	2	3.65	124936	10.74	98.69
	Engineering (Cutting & Shaping)	12	14.59	546691	47.02	431.89
	Auto Components	1	2.55	12960	1.11	10.24
	Packaging	1	1.00	10957	0.94	8.66
	Auto Parts	2	12.18	160128	13.78	126.50
	Construction	1	1.05	6912	0.59	5.46
	Pulp & Paper	1	0.12	790	0.07	0.62
Coimbatore	Textiles	1	3.00	1280	0.11	1.01
	Engineering (Cutting & Shaping)	3	8.87	28903	2.48	22.83
	Plastic & Polymers	2	2.20	224496	19.31	177.35
	Textile	4	7.00	2340000	201.24	1848.60
Erode	Engineering (Cutting & Shaping)	2	3.39	36120	3.11	28.53
	Textiles	2	9.50	487728	41.94	385.31
	Electronic	1	4.25	229600	19.75	181.38
	Plastic and Polymers	1	1.76	429069	36.90	338.96
Hosur	Engineering (Cutting & Shaping)	10	7.33	277056	23.82	218.88

Cluster/Location	Sector	No. of Units	Total Investment (INR crore)	Electrical Energy Saved (kWh)	Total Energy Saved (TOE)	Reduction in CO2 emission (tCO2)
Kanchipuram	Engineering	1	3.14	26856	2.31	21.22
Puducherry	Packaging	1	4.13	423360	36.41	334.45
	Plastics & Polymers	1	1.92	105494	9.07	83.34
	Construction	1	1.04	315	0.03	0.25
	Metal	1	1.21	60157	5.17	47.52
	Engineering (Cutting & Shaping)	1	0.54	26847	2.31	21.21
Tirupur	Textiles	1	1.50	115200	9.91	91.01
Madurai	Textiles	1	0.61	168000	14.45	132.72
BHUBANESWAR	Textile	1	3.00	1296	0.11	1.02
	Glass	1	0.21	5184	0.45	4.10
Kolkata	Engineering (Cutting & Shaping)	1	0.15	3703	0.32	2.93
Faridabad	Engineering (Cutting & Shaping)	3	2.93	187068	16.08	147.78
	Metal	2	1.47	347600	29.89	274.60
	Leather & Tannery	1	0.89	33264	2.86	26.28
	Plastics & Polymers	1	1.00	6048	0.52	4.78
	Forging and Foundary	1	0.27	12960	1.11	10.24
	Textile	1	0.15	7200	0.62	5.69
	Pulp & Paper2	1	1.40	67200	5.76	53.10
	Service	1	3.00	144000	12.33	113.78
Gurugram	Plastic & Polymer	1	0.40	30240	2.60	23.89
	Rubber	1	0.92	223442	19.22	176.52
Kundali	Cosmetics	1	1.16	103496	8.90	81.76
Bahadurgarh	Automotive	1	4.00	43200	3.72	34.13

Cluster/Location	Sector	No. of Units	Total Investment (INR crore)	Electrical Energy Saved (kWh)	Total Energy Saved (TOE)	Reduction in CO2 emission (tCO2)
Yamunanagar	Engineering	1	0.72	190080	16.35	150.16
	Engineering (Cutting & Shaping)	1	1.69	446160	38.38	352.46
Vishakhapattanam	Textiles	2	6.00	1584000	136.25	1251.33
Vijaywada	Engineering (Cutting & Shaping)	1	0.74	195360	16.80	154.33
Hyderabad	Plastics & Polymers	3	4.57	74519	6.41	58.87
	Engineering (Cutting & Shaping)	5	14.60	225605	19.41	178.23
	Stone	1	2.16	682490	58.69	539.17
Jodhpur	Construction	1	0.48	94250	8.11	74.46
	Engineering	1	2.45	481068	41.39	380.06
Kishangarh	Construction	1	1.01	198318	17.06	156.68
	Granites	1	1.12	219917	18.92	173.74
	Engineering	1	0.96	375000	32.25	296.25
	Stone	1	0.75	128909	11.09	101.84
	Pulp & Paper Engineering (Cutting & Shaping)	1	1.42	244068	21.00	192.82
Bhilwara	Engineering (Cutting & Shaping)	2	3.50	1121687	22.88	210.14
Udaipur	Chemical	1	1.19	92385	7.95	72.98
	Engineering	1	7.40	56160	4.83	44.37
	Pulp & Paper Engineering (Cutting & Shaping)	1	0.70	5312	0.46	4.20
Jaipur	Leather & Tannery	1	1.18	300000	25.80	237.00
Noida	Engineering (Cutting & Shaping)	1	0.82	208475	17.93	164.69

Cluster/Location	Sector	No. of Units	Total Investment (INR crore)	Electrical Energy Saved (kWh)	Total Energy Saved (TOE)	Reduction in CO2 emission (tCO2)
	Leather	1	1.06	269492	23.18	212.90
Varanasi	Chemical	1	0.66	183024	15.74	144.59
	Food Processing	1	1.93	584000	50.22	461.36
	Chemical	1	1.95	585200	50.33	462.31
Bhopal	Engineering (Cutting & Shaping)	1	0.65	23760	2.04	18.77
Dehradun	Engineering	1	0.59	186336	16.02	147.21
Haridwar	Omega Printopacks	1	4.31	1361200	117.03	1075.38
New Delhi	Plastics & Polymers	1	0.65	33120	2.85	26.16
	Packaging	1	0.50	140000	12.04	110.60
	Textile	1	0.61	170800	14.69	134.93
	Engineering (Cutting & Shaping)	2	1.92	109440	9.41	86.45
ADITYAPUR	Engineering (Cutting & Shaping)	1	2.43	27720	2.38	21.90
	Castings & Forging	1	5.00	57037	4.90	45.06
Andheri (Mumbai)	Financial	1	1.40	16900	1.45	13.35
Chinchwad	Engineering (Cutting & Shaping)	2	4.05	171648	14.76	135.60
	Electrical products	1	0.49	15840	1.36	12.51
Indore	Engineering (Cutting & Shaping)	1	17.18	625680	53.81	494.29
	Auto Components	1	0.31	15840	1.36	12.51
Aurangabad	Pulp & Paper	1	1.76	250560	21.55	197.94
	Engineering	1	0.54	43200	3.72	34.13
	Textile	1	0.43	34400	2.96	27.18

Cluster/Location	Sector	No. of Units	Total Investment (INR crore)	Electrical Energy Saved (kWh)	Total Energy Saved (TOE)	Reduction in CO2 emission (tCO2)
Kolhapur	Engineering (Cutting & Shaping)	1	6.00	164448	14.14	129.91
	Metal	1	3.21	125568	10.80	99.19
Nasik	Engineering	1	4.00	149069	12.82	117.76
Nagpur	Engineering (Cutting & Shaping)	3	3.97	675594	58.08	533.72
	Wood	1	0.48	159500	13.72	126.01
	Plastics & Polymers	1	0.68	129341	11.12	102.18
	Food Processing	1	0.79	150264	12.92	118.71
	Pulp & Paper	1	1.15	218738	18.81	172.80
Pune	Engineering (Cutting & Shaping)	3	6.51	173088	14.88	136.74
	Foundary and Forging	1	3.81	276480	23.78	218.42
	Automotive	1	4.94	237600	20.43	187.70
	Total	**216**	**394**	**29899990**	**2550**	**23214**

3.8. Green Finance Scheme (GFS)

Sustainable development of the MSME sector is one of the core agenda in SIDBI's vision and it has been promoting this through a series of schemes which not only provide adequate and affordable energy efficiency / green finance, but also enhancing awareness of benefits of climate control amongst MSE clusters. SIDBI's focused lending schemes promote investment in clean production and energy efficient technologies / production processes under bilateral lines of credit from international agencies such as JICA, AFD and KfW.

Objective

The objective of these financing scheme is to provide financial products that enable climate and environment friendly investments to:

- Promote energy saving in MSMEs in India
- Reduce the emission of greenhouse gases, especially Carbon Dioxide (CO2) to contribute towards climate change mitigation and achieve a reduction or avoidance of emissions and pollution through the introduction of financial products
- Support MSMEs towards development, up-scaling, demonstration and commercialization of innovative technology based project.

The table below showcases the energy and emission savings obtained under SIDBI's Green Finance scheme for the FY 2021-22:

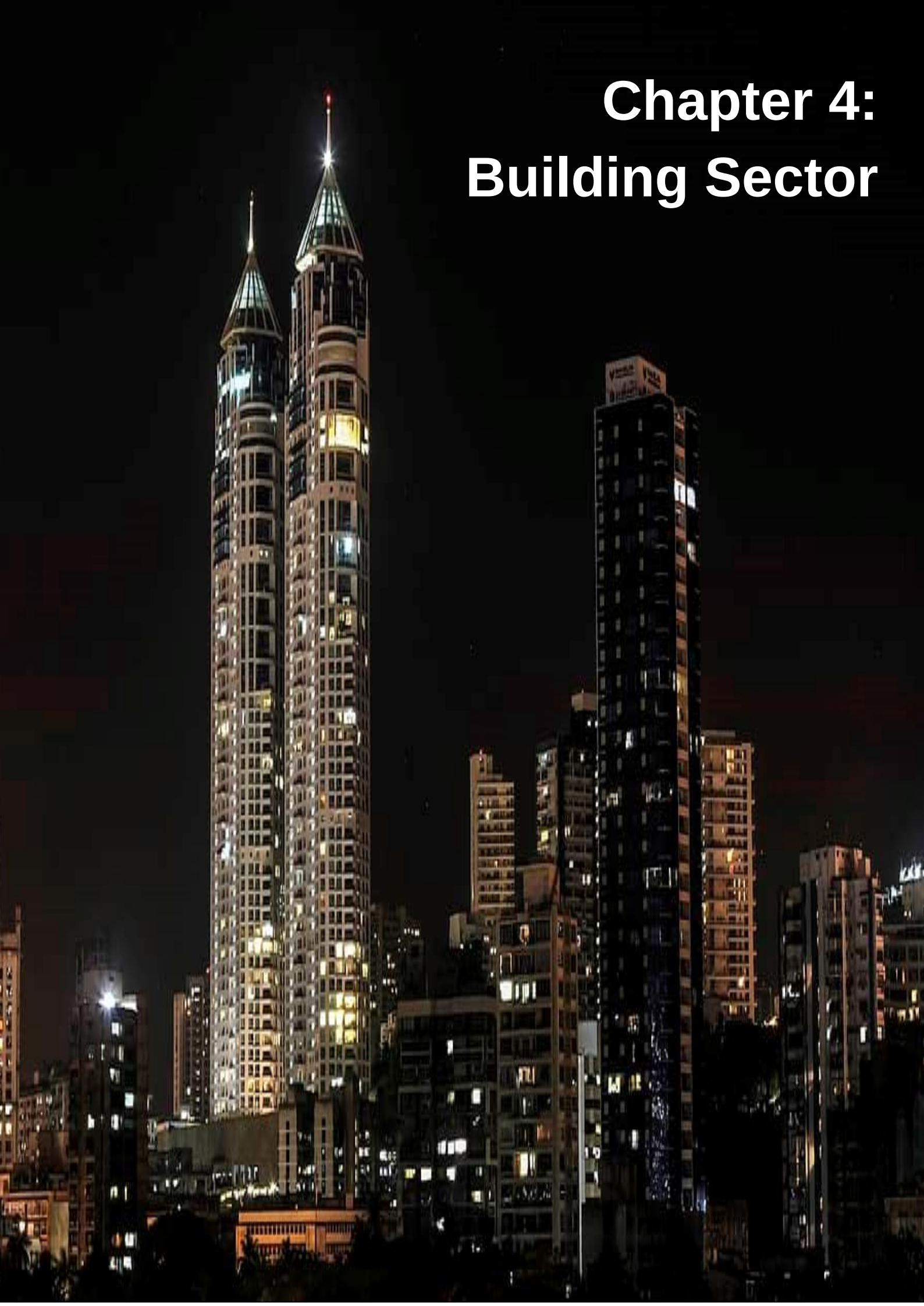
Table 31: Cluster-wise energy savings obtained under SIDBI-GFS Scheme in FY 21-22

Cluster/ Location	Sector	No. of Units	Total Investment (INR lakhs)	Total Investment (INR crore)	kWh Saved	Total Energy Saved (TOE)	Reduction in CO2 emission (tCO2)
Changodar	Chemical	1	755	7.55	2124067	182.65	1678.00
Rajkot	Engineering (Cutting & Shaping)	1	135	1.35	379800	32.66	300.04
	Textiles	1	495	4.95	364000	31.30	287.56
Bengaluru	Food Processing	1	500	5.00	367677	31.62	290.46
	Engineering (Cutting & Shaping)	1	35	0.35	25737	2.21	20.33
Panji	Foundary & Forging	1	44	0.44	392000	33.71	309.68
Mysuru	Plastics & Polymers	1	500	5.00	1050000	90.30	829.50
	Steel	1	1100	11.00	522000	44.89	412.38
	Engineering (Cutting & Shaping)	1	488	4.88	14723	1.27	11.63
Ludhiana	Packaging	1	285	2.85	27930	2.40	22.06
	Metal	1	114	1.14	128909	11.09	101.84
Chennai	Plastic & Polymer	1	825	8.25	159437	13.71	125.96

Cluster/ Location	Sector	No. of Units	Total Investment (INR lakhs)	Total Investment (INR crore)	kWh Saved	Total Energy Saved (TOE)	Reduction in CO2 emission (tCO2)
	Engineerign(Cutting & Shaping)	1	450	4.50	419923	36.11	332.00
	Plastic & Polymers	1	1447	14.47	46080	34.24	99.69
	Manufacturing	1	500	5.00	322541	27.74	254.81
Coimbatore	Engineering (Cutting & Shaping)	1	400	4.00	73728	6.34	58.25
	Automobile	1	575	5.75	34376	2.96	27.16
	Pulp & Paper	1	357	3.57	41472	3.57	32.76
	Textiles	1	600	6.00	172800	14.86	136.51
Tirupur	Engineeing (Cutting & Shaping)	1	600	6.00	24170	2.08	19.09
Madurai	Construction	1	1200	12.00	19440	1.67	15.36
	Foundary & Forging	1	800	8.00	1600	0.14	1.27
Bhubaneswar	Pharmaceutical	1	800	8.00	70	0.01	0.06
Faridabad	Service	1	1350	13.50	20160	1.73	15.93
Gurugram	Engineering (Cutting & Shaping)	1	800	8.00	167760	14.42	132.53
Hyderabad	Chemical	1	1000	10.00	207360	17.83	163.81
Jaipur	*Metal*	1	39	0.39	40320	3.47	31.85
	Auto Components	1	500	5.00	27496	24.72	227.12

Cluster/ Location	Sector	No. of Units	Total Investment (INR lakhs)	Total Investment (INR crore)	kWh Saved	Total Energy Saved (TOE)	Reduction in CO2 emission (tCO2)
Noida	Steel	1	365	3.65	53280	4.58	42.09
Adityapur	Iron & Steel	1	170	1.70	165888	14.27	131.05
Chinchwad	Castings & Forging	1	420	4.20	1050000	90.30	829.50
	Forging	1	1400	14.00	429483	36.94	339.29
	Engineering	1	297	2.97	19440	1.67	15.36
Aurangabad	Textiles	1	625	6.25	40909	3.51	32.32
Nasik	Plastics & Polymers	1	1495	14.95	187663	16.14	148.25
	Iron & Steel	1	500	5.00	121821	10.48	96.24
Pune	Engineering (Cutting & Shaping)	1	1000	10.00	243643	20.96	192.47
	Total	**37**	**22966**	**230**	**9487703**	**869**	**7764**

Chapter 4: Building Sector



4. *Buildings*

India is home to 1.2 billion people, and approximately 31% of whom now live in urban areas[45]. India has witnessed rapid economic growth in the past few years, on average of 7.6% annually since 2000[46]. The number of Indians living in urban areas is expected to reach 525 million by 2025, which will also create demand for building 35 billion square meters of residential and commercial spaces by 2050[47]. This also translates into increased energy demand and consumption.

Building sector (residential and commercial) in India constitutes 33% of total electricity consumption, and it is predicted that electricity demand will rise from 414 TWh/year to 4,697 TWh/year and buildings will demand 55% of total electricity generated by 2047. Electricity demand in residential and commercial buildings sectors is predicted to rise by 5 folds and 3 folds respectively by 2032[48].

Commercial buildings consume about 8-9% of total electricity consumption. Commercial buildings include offices, hospitals, hotels, retail outlets, educational buildings, government offices, etc. The total built-up area of commercial buildings is expected to touch 1.9 billion m2 by 2030. The rate of growth in commercial buildings sector is amongst the highest, and hence, this sector needs to be moderated in its energy consumption.

The key driver for the rapid increase of energy consumption in the buildings sector has been rising ownership levels for appliances such as air conditioners to provide comfortable indoor temperatures in urban areas in the recent years.

Increased use of decentralized room based air-conditioning units in homes and commercial spaces for thermal comfort is an important reason contributing to this rapid increase in the electricity use. The demand for air conditioning will continue at an exponential growth with improvement in household incomes and will become the dominant contributor of GHG emissions.

Details of the national electricity consumption including the share of commercial and domestic buildings sectors are presented in Out of the total consumption of electricity in 2021-22(P), industry sector accounted for the largest share (41.16%), followed by domestic (25.77%), agriculture (17.67%) and commercial sectors (8.29%). The Domestic sector has experienced the highest CAGR of 6.87 between FY:2012-13 to FY:2021-22.[49]

[45] Source: World Bank
[46] Source: https://smartnet.niua.org/sites/default/files/resources/06.eiu_india_casestudy.pdf
[47] Source: https://dste.py.gov.in/PCCC/pdf/Reports/Energy%20Benchmark%20Report.pdf
[48] Source: https://dste.py.gov.in/PCCC/pdf/Reports/Energy%20Benchmark%20Report.pdf; Pg-12
[49] Source: Energy Statistics 2023, Ministry of Statistics and Program Implementation; Pg- 75

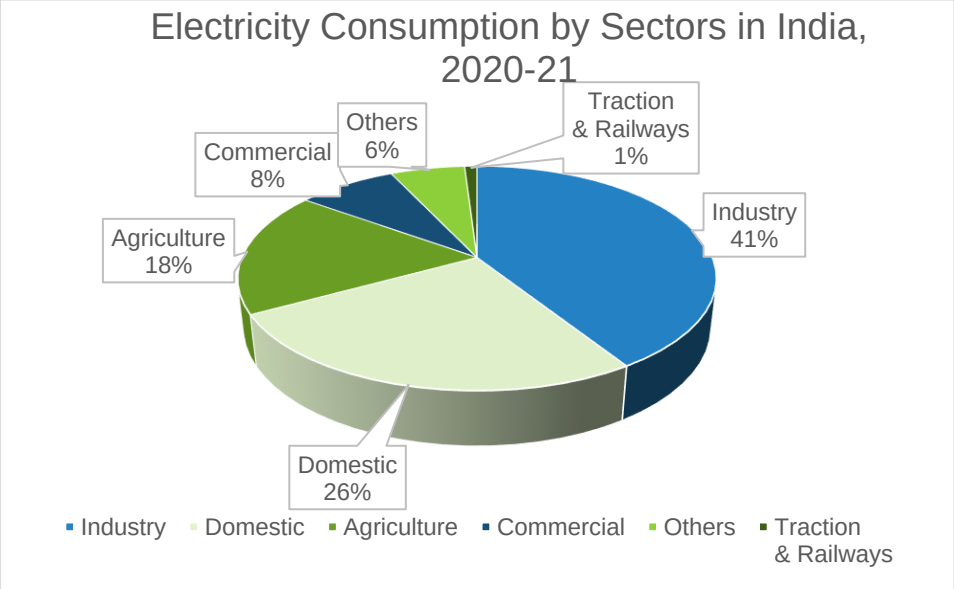


Figure 33: Electricity Consumption by Sectors in India, 2020-21

There are primarily two typologies of buildings in India, commercial and residential. As per Energy Conservation Building Code (ECBC), commercial buildings include offices, hospitals, hotels, retail outlets, educational buildings, government offices, etc. The factors affecting energy demand in both domestic and commercial buildings sector have been divided into categories:

Building envelope optimization: The building envelope is the exterior skin of the building which acts as a thermal barrier between the outside and the enclosed conditioned space through which the thermal energy is transferred. An energy-efficient building envelope is amalgamation of passive design technologies which minimizes the heat gain in the building subsequently reducing the load of cooling and heating, hence consuming less energy. A well-designed envelope with appropriate wall window ratio could also reduce lighting load making the building more energy efficient.

Lighting and Electromechanical equipment: Energy consuming equipment in the commercial sector include lighting, heating, ventilation and air conditioning (HVAC), and other office auxiliary equipment. Heating and cooling demand is responsible for major energy consumption in any given building across all the climatic zones in India.

Government of India, Ministry of Power and BEE have introduced multiple energy efficiency programs for the buildings sector (both commercial and residential) to optimize the energy consumption in buildings. The various initiatives and programs undertaken by various ministries and institutions in India for the building sector are presented in figure –

-.

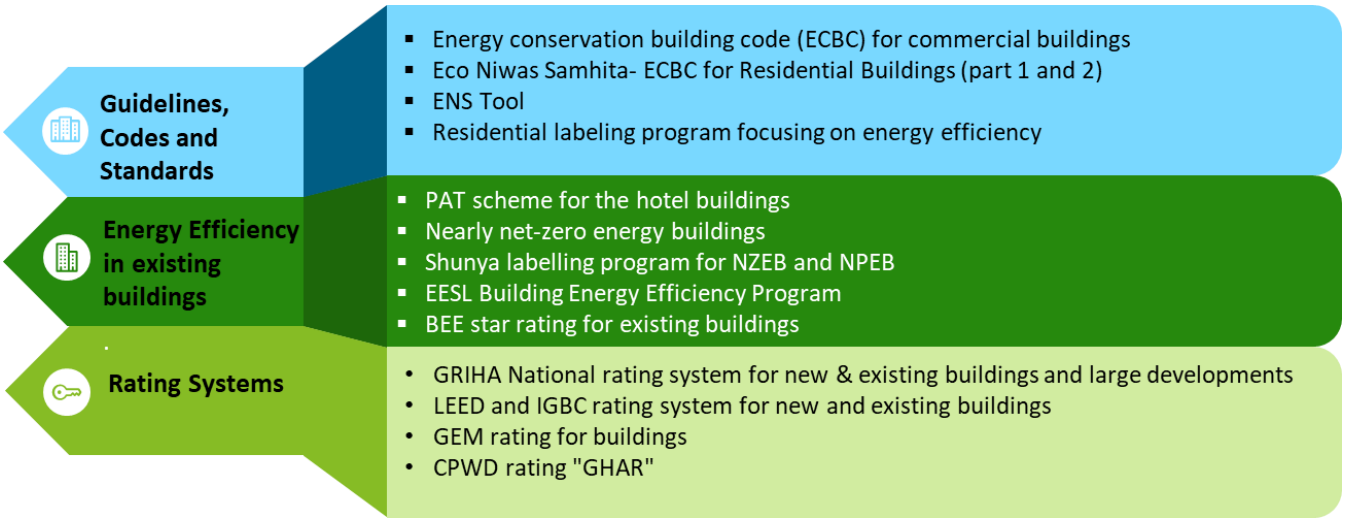


Figure 34: Program initiatives in the building sector

4.1. Energy Conservation Building Code (ECBC) 2017

The Energy Conservation Building Code (ECBC) is a regulatory tool to capture and administer the energy footprint in commercial buildings in India. The code was developed to efficiently design and operate a commercial building to reduce its demand and consumption of energy. Hence, a specific energy conservation code is required for each building type depending on its energy use. The Bureau of Energy Efficiency (BEE) launched Energy Conservation Building Code (ECBC) in 2007 to establish minimum energy performance standards for buildings in India the implementation of the code lies with the State/UT governments. The major components of the building which are being addressed through the code are: envelope (walls, roofs, windows), lighting systems, HVAC systems, water heating, water pumping and electrical power system.

Image Source: https://www.gettyimages.in/detail/photo/mumbai-skyline-royalty-free-image/979238792

Building energy codes are updated in regular intervals to match up the latest innovation in energy efficient technologies and GHG mitigation measures. The updating of the codes also caters to establishing ideal user case scenarios and benchmarks for future developments.

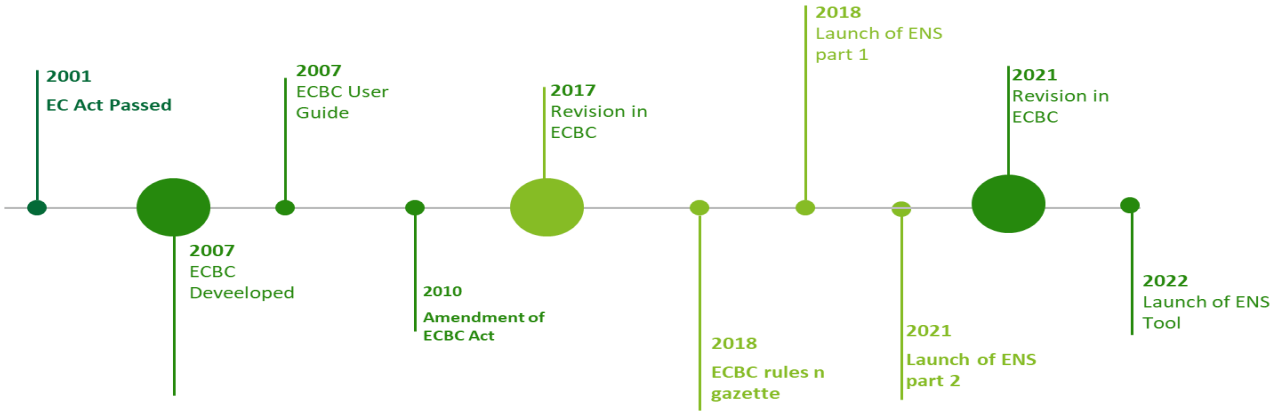


Figure 35: ECBC and ENS development and revision timeline

The first version of the Energy Conservation Building Code (ECBC) was launched by the Government of India in 2007. The BEE also launched the Star rating of commercial buildings scheme in India in 2009. EC Act was amended in 2010 with a further update of Commercial ECBC in 2017.

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.

ECBC 2017 supports many of the Government of India's objectives for achieving energy security, economic growth, and environmental sustainability. As a primary policy driver for guiding building construction, it is a forward-looking code and will push the building sector towards near zero energy targets.

BEE has launched a new version of code ECBC 2017 on 19th June 2017[50]. The newly developed code is futuristic, pragmatic, and easy to implement. The new version of Code is geared to encourage public and private sectors to not only meet the basic ECBC criteria, but to exceed them as well. Long-term success of the ECBC will depend heavily on the collaborative roles that various stakeholder would play towards the development, adoption, and implementation of building code.

4.1.1. Program Overview

Based on the anticipated urban growth of India, it is projected that if the future building stock is made in compliance with this code, about 300BU electricity will be saved by 2030[51]. It will translate to peak demand reduction of 15 GW and about 250 million tonnes of CO_2. It is estimated that INR. 35,000 crores will be saved by implementing ECBC compliant buildings[52].

The Energy Conservation Building Code (ECBC) sets minimum energy standards for new commercial buildings having a connected load of 100 kW or more, or contract demand of 120 kVA or more. The effective implementation of code provides comfort to occupants by adopting passive design strategies & day light Integration. It is technologically neutral, promotes renewable energy and also emphasizes on life cycle cost of building. The updated code has additional priorities of renewable energy integration, ease of compliance, inclusion of passive building design strategies and, flexibility for the designers. As per EC Act 2001, section 15, the code, and rules are suitably modified, as per the local requirements and then the process of integration with the present building approval process is undertaken, which subsequently paves way for enforcement and implementation of the code in the said jurisdiction. There are 6 types of buildings classified under ECBC:

[50] Source: www.bee.gov.in
[51] Source: Annual Report 2021-22– Ministry of Power; Pg 60
[52] Source: BEE Annual Report 2021-22; Pg- 22

	Healthcare	• Hospital • Out-patient Healthcare
	Hospitality	• Star Hotel • No Star Hotel • Resort
	Educational	• College • University • Institution • School
	Shopping Complex	• Shopping Mall • Stand-alone Retails • Open Gallery Malls • Super Markets
	Business Centers	• Large Office (>30,000 m^2) • Medium Office (10,000m^2-30,000m^2) • Small Office (<10,000 m^2)
	Assembly	• Multiplex • Theatre • Building used for Transport Services

Figure 36: Types of buildings classified under ECBC

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. Passive design strategies like daylight and shading are promoted in the code. Additional parameters include lighting, electrical and renewable energy offering flexibility to the designers to design buildings efficiently for various components.

In the FY 2021-22, 25 building cells have been functional covering all States/UTs[53]. ECBC Rules and code notified by Madhya Pradesh and Manipur. Implementation of ECBC has committed in Andhra Pradesh, Assam, Andaman & Nicobar Island, Haryana, Karnataka, Kerala, Punjab, Sikkim, Telangana, Uttarakhand, Madhya Pradesh, Uttar Pradesh. About 270 ULBs have covered under these states[54].

A total of 1443 buildings are approved by ULB/SDA at design stage and these buildings are at different stages of construction. In 2021-22, 622 number of buildings have been approved by ULB/SDA in 7 states namely[55]:

Table 32: State wise no. of buildings approved by ULB/SDA in FY 2021-22

S.No.	State /UTs	No. of ECBC Compliant Buildings
1.	Andhra Pradesh	414
2.	Haryana	57
3.	Kerala	18
4.	Punjab	350
5.	Telangana	410
6.	Uttar Pradesh	185
7.	Uttarakhand	9
	Total	**1443**

[53] Source: BEE Annual Report 2021-22; Pg- 21
[54] Source: BEE Annual Report 2021-22; Pg- 22
[55] Source: BEE Annual Report 2021-22; Pg- 22

Training and capacity building

The National Training Program on ECBC and ENS was conducted on 19th July 2021 for architects, building professionals, field officials and other stakeholders. Total 11,191 participants attended the training program in the FY 2021-22.

Detail of the training programs conducted in 2021-22 (State wise) is showcased in the table below:

Table 33: Training/capacity building programs conducted in 2021-22 (State wise)

S.No.	State	Code	Total	Participants
1	Andhra Pradesh	AP	19	896
2	Bihar	BR	12	733
3	Chhattisgarh	CG	14	554
4	Delhi	DL	0	0
5	Gujarat	GJ	0	0
6	Haryana	HR	14	1182
7	Himachal Pradesh	HP	6	309
8	Ladakh	LA	9	242
9	Jammu & Kashmir	JK	4	137
10	Jharkhand	JH	9	277
11	Karnataka	KA	11	458
12	Kerala	KL	9	474
13	Maharashtra	MH	13	955
14	Madhya Pradesh	MP	1	39
15	Odisha	OD	12	506
16	Punjab	PB	12	579
17	Rajasthan	RJ	11	366
18	Tamil Nadu	TN	10	532
19	Telangana	TS	14	492
20	Uttar Pradesh	UP	8	360
21	Uttarakhand	UK	9	455
22	West Bengal	WB	11	334
23	Arunachal Pradesh,	AR	3	92
24	Assam	AS	2	107
25	Meghalaya	ML	1	45
26	Sikkim	SK	2	57
27	Manipur,	MN	2	118
28	Nagaland,	NL	1	74
29	Mizoram	MZ	4	196
30	Tripura	TR	1	80
31	Andaman and Nicobar Islands	AN	4	189
32	Daman and Diu,	DN&DD	2	60
33	Lakshadweep,	LD	0	0

S.No.	State	Code	Total	Participants
34	Puducherry	PY	2	70
35	Goa,	GA	2	81
36	Chandigarh	CH	3	142
Total			**237**	**11191**

4.1.2 Level of compliance of buildings:

It is imperative to recognize performance beyond the mandatory code requirements. ECBC 2017 introduced a major update that acknowledges the voluntary measures and their impact on the overall energy efficiency of the building. 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). The ECBC compliance is checked on basis of the EPI ratio. The EPI Ratio of a building is the ratio of the EPI of the Proposed Building to the EPI of the Standard Building. To Show ECBC compliance, the EPI ratio should be less than or equal to 1.

The buildings that fall within the scope of ECBC shall comply with the code by meeting all mandatory requirements of the code. Further, it can follow any of the compliance paths for compliance the EPI ratio shall be calculated based on either of the below approaches:

- Prescriptive Methods
    - Prescriptive Method
    - Whole Building Performance Method
- Whole building performance method
    - A building complies with the Code using the Whole Building Performance (WBP) Method when the estimated annual energy use of the Proposed Design is less than that of the Standard Design, even though it may not comply with the specific provisions of the prescriptive requirements. The mandatory requirements shall be met when using the WBP Method.
    - The EPI Ratio of a building that uses the Whole Building Performance Method to show compliance, should be less than or equal to the EPI Ratio for the applicable building type and climate zone, mentioned in the code.

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

ECBC compliance

- Shall demonstrate compliance by adopting all the mandatory and prescriptive requirements
- Or by following the provisions of the Whole Building Performance (WBP) Method, including compliance with all mandatory requirements

ECBC+ compliance

- Shall demonstrate compliance by adopting all the mandatory and prescriptive requirements
- Or by following the provisions of the Whole Building Performance (WBP) Method, including compliance with all mandatory requirements.
- An ECBC+ building is 30-35% more efficient than a conventional building

Super ECBC compliance

- Shall demonstrate compliance by adopting all the mandatory and prescriptive requirements
- Or by following the provisions of the Whole Building Performance (WBP) Method, including compliance with all mandatory requirements.
- A Super ECBC building is 40-45% more efficient than a conventional building

Figure 37: Three level of energy performance standards

4.1.1.1. Minimum energy efficiency requirements

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

1. **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
2. **Comfort system and controls-** Ventilation, space conditioning equipment efficiencies, controls, piping and ductwork, system balancing, condensers, service water heating
3. **Lighting and controls –** Lighting controls, and exit signs
4. **Electrical power and motors-** Efficiency and losses for transformers, motors, DG sets, metering and monitoring, power correction factor, power distribution system, UPS, and 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.

4.1.1.2. ECBC Compliance in FY 2021-22

Technical assistance has been provided for ECBC demonstration projects. About 173 building projects for different categories of buildings in different climatic zones were supported to showcase ECBC compliance across the country in the FY 2021-22.

Design and Construction of super ECBC Buildings taken up in 5 more states: Arunachal Pradesh, Chhattisgarh, Puducherry, Sikkim, Uttarakhand. Total 10 states initiated Super ECBC Building Development project[56].

4.1.3 Methodology adopted to calculate the savings

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 a total of 173 buildings across India that are either in the construction or under construction stage as per ECBC guidelines across various states in India. The details are presented in table 3 below:

Table 34: Details of buildings covered under ECBC in FY 2021-22

Construction Stage	No. of Buildings	Total Area in Mn. Sqm
Completed	41	0.66
Design stage	132	1.54
Grand Total	**173**	**2.20**

4.1.1.3. Estimation of Energy Savings

To calculate the energy (electrical) savings, the difference between the conventional EPI and proposed EPI of the respective buildings is 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 the ECBC program and conventional EPIs are calculated using % Saving of ECBC[57] over and above the baseline EPI.

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

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

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, to calculate the energy savings for buildings compliant during FY 2021-22, 50% of total energy savings are considered.

To calculate the reduction in the total CO_2 emission, the conversion factor of 0.81 kg CO_2/kWh for electricity is considered. The total energy (electrical) saved under the ECBC program is 0.0199 BU and the total reduction in CO_2 emission is 0.016 MtCO_2 for year 2021-22.

[56] Source: BEE Annual Report 2021-22; Pg 23
[57] 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.

Table 35: Energy Saving for ECBC compliant completed buildings FY 18-22

Financial Year	No. of Buildings	Energy Savings in MU	Total Area in Mn. Sqm
2018-20	192	59.3	3.29
2021-22	173	19.89	2.22
Total	**365**	**79.19**	**5.51**

Some of the electrical energy savings obtained under this scheme are due to the replacement of inefficient electrical & mechanical appliances with BEE star-rated appliances. Therefore, to avoid this duplication, only 90% of total energy savings have been considered for the ECBC program. **Therefore, total electricity savings for the ECBC program in FY 2021-22 is considered as 0.018 BU and the total reduction in CO2 emission is 0.0144 MtCO2.**

4.1.1.4. Green Rating Integrated Habitat Assessment[58]

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 that helps people assesses the performance of their building against certain nationally acceptable benchmarks. It evaluates the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'. The rating system, based on accepted energy and environmental principles, will seek to strike a balance between the established practices and emerging concepts, both national and international[59].

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

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

Table 36: Star rating index with threshold value

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

For the financial year 2021-22, state wise energy savings for GRIHA rated buildings is presented below:

[58] 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
[59] Source: https://www.grihaindia.org/about-griha

Table 37: State wise energy savings of GRIHA rated Buildings for 2021-22

State	Number of GRIHA rated buildings	Built up area (Sq mt)	Energy savings in MU
Andhra Pradesh	1	30237	1.58
Bihar	1	10306	0.89
Delhi	4	158240	5.89
Gujrat	3	40337	5.83
Haryana	17	1553889	35.77
Jharkhand	1	11469	0.47
Karnataka	2	25270	0.44
Kerala	1	13741	2.16
Madhya Pradesh	2	35960	2.23
Maharashtra	12	508434	5.86
Orissa	1	9590	0.56
Punjab	2	99072	3.96
Rajasthan	1	58700	1.48
Tamil Nadu	4	55989	9.05
Uttar Pradesh	8	352929	9.05
WB	1	30825	2.99
Total	**61**	**2994988**	**88.20**

As on 31st March 2022, 61 Buildings have been rated by GRIHA and these buildings have contributed in energy saving of 88.20 MU (0.082 BU). The energy savings for the GRIHA rated building is calculated on annual basis to account for seasonal factors, and this saving cannot be broken-down on monthly basis. Therefore, to calculate the energy savings for buildings compliant during FY 20-21, 50% of total energy savings are considered.

4.2. Star Rating of Commercial Buildings

Having regard to the fact that the rate of growth in commercial building sector is amongst the highest, and that, this sector needs to be moderated in its energy consumption BEE introduced the Star Rating for existing buildings as a voluntary policy measure to reduce the adverse impact of buildings on the environment. This programme is based on the energy usage in the building over its area expressed in kWh/sqm/year. This program rates buildings on 1-5 scale, with 5 star labelled buildings being most efficient.

Recently, BEE has revised the EPI band for Star Rating for Office Buildings and BPOs. The revision of the scheme is effective from January 2022. Till the end of March 2022, total 264 buildings[60] have been awarded Star Rating under this programme.

4.2.1. Shunya Labelling Programme for Net Zero and Net Positive Energy Buildings

To widen the scope of Building Labelling Programme based on Energy Consumption, BEE has introduced Labelling programme for Net Zero Energy Buildings (NZEB) and Net Positive

[60] Source: BEE Annual report 2021-22; Pg -23

Energy Buildings (NPEB). The programme was launched by Hon'ble Minister for Power and NRE on 14th December 2021 in NECA event.

The programme is named as "Shunya" Labelling Programme. Shunya is the Hindi meaning of Zero (0) thus making it suitable to label the NZEB and NPEB buildings as Shunya. Two types are Labels are proposed, one is the Shunya Label for NZEBs while another is for NPEBs i.e., Shunya+ (Shunya Plus). For this programme the buildings having 10 < EPI < 0 kWh/m2/year, will be awarded by Shunya Label, while the buildings having EPI < 0 kWh/m2/year will be awarded by Shunya+ label. The programme will encourage the building owners and promotors to make energy efficient buildings and further making improvements to make it net zero or net positive energy buildings.

4.2.2. Energy efficiency in the residential sector in India

The residential industry of India is one of the fastest growing sectors. A large population base, rising income level and rapid urbanization are major factors of growth in this sector. The residential real estate market in India witnessed astounding progress in 2022, setting new sales records of 68% YoY[61], further demonstrating the industry's prominence residential sector as one of India's fastest-growing sectors. The real estate sector in India is expected to reach US$ 1 trillion in market size by 2030, up from US$ 200 billion in 2021 and shall contribute 13% to the country's GDP by 2025[62].

Image Source: https://www.skyscrapercenter.com/city/hyderabad

The economic importance of the residential sector in India can be judged by the estimate that for every Indian rupee (INR) invested in housing and construction, INR 0.78 is added to the gross domestic product[63] of the country. Thus, it is imperative to provide a firm boost to the

[61] Source: https://www.livemint.com/money/personal-finance/future-of-real-estate-market-in-india-in-2023-11676368024008.html
[62] Source: https://www.ibef.org/industry/real-estate.
[63] Source: https://economictimes.indiatimes.com/news/economy/indicators/economic-survey-housing-sectors-share-in-gdp-of-india-to-rise-to-6/articleshow/12276533.cms

Indian housing sector. Growth in the residential sector, will also increase the demand for energy consumption, and the residential electricity demand is projected to reach 646–758 TWh in 2030[64], growing roughly at the same rate of growth as that of the overall economy.

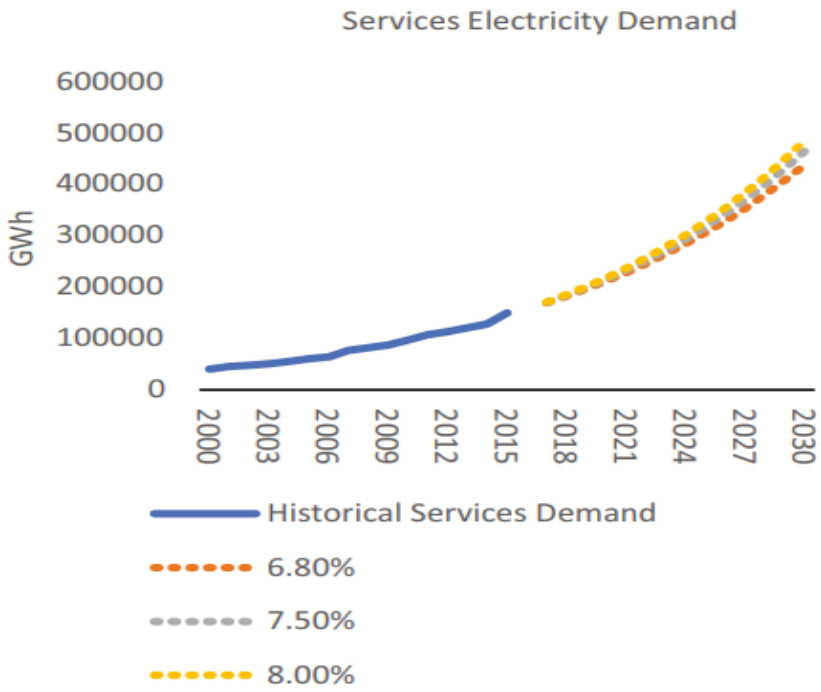


Figure 38: Forecast of residential space electricity demand

4.2.3. About Eco Niwas Samhita (ENS) – Scope and Requirement

Out of the total electricity consumed in the building sector, about 75% is used in residential buildings. The gross electricity consumption in residential buildings has been rising sharply over the years. For instance, the consumption figure rose to about 414 TWh in 2019-20 from about 98 TWh in 2000-01 that is an increase by more than four times in 20 years. Projections shows it rising to anywhere between 630 and 940 TWh by 2032[65]. The key driver for the rapid increase of energy consumption in the buildings sector has been rising ownership levels for appliances such as air conditioners to provide comfortable indoor temperatures in urban areas in the recent years

The upcoming building stock provides us with an opportunity to ensure sustainable and comfortable living conditions, incorporating strategies and interventions to optimize building design and efficient resource consumption. Recognizing a massive potential for energy savings in the new construction of residential buildings, the Bureau of Energy Efficiency launched the Residential Energy Conservation Building Code in 2018, Eco Niwas Samhita (ENS), to enhance thermal performance and reduce energy consumption.

The purpose of any residential unit is to provide comfort which comes from appropriate thermal comfort and lighting in the unit, so as to ensure health and well-being of the occupants. Thus,

[64] Source: https://www.teriin.org/sites/default/files/2019-02/Analysing%20and%20Projecting%20Indian%20Electricity%20Demand%20to%202030.pdf
[65] Source: https://dste.py.gov.in/PCCC/pdf/Reports/Energy%20Benchmark%20Report.pdf

BEE envisaged a focused performance standard for residential sector to ensure adoption of energy efficiency measures.

The Eco Niwas Samhita (ENS), Part – I Building Envelope (Energy Conservation Building Code for Residential Sector) was developed and launched in 2018 on the occasion of National Energy Conservation Day by Hon'ble speaker of Lok Sabha and Hon'ble Minister of Power, New & Renewable Energy. ECO Niwas Samhita 2018 is an Energy Conservation Building Code for Residential Buildings (ECBC-R). It has been developed to set minimum building envelope performance standards to limit heat gains (for cooling dominated climates) and to limit heat loss (for heating dominated climate) while ensuring adequate natural ventilation and day lighting. The code is applicable to all residential use building projects built on plot area more than 500 m2. 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.

4.2.4. Building components covered under ENS

Eco Niwas Samhita (ENS), Part -1

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

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

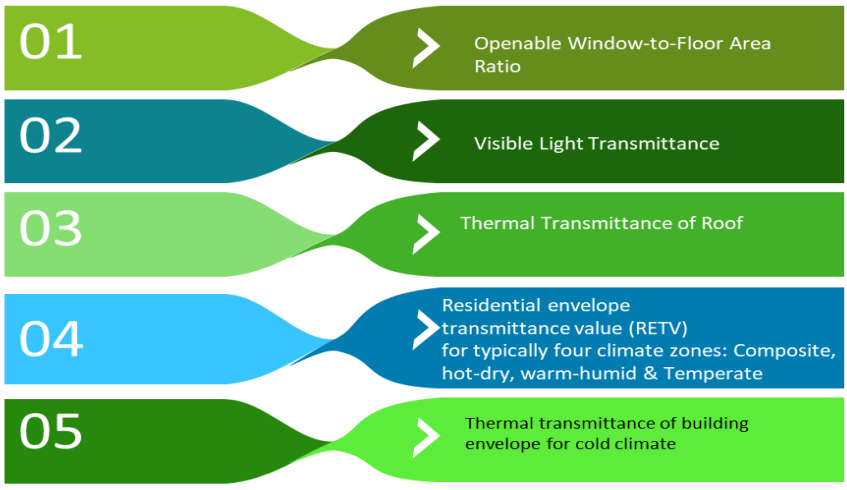


Figure 39: Key components of ENS part-1 building envelope

Eco Niwas Samhita (ENS), Part -2

The purpose of Eco Niwas Samhita 2021 (Code Compliance and Part-II: Electromechanical and Renewable Energy Systems) is for code compliance and to provide the minimum requirement(s) for building services. The code applies to –Residential buildings built on a plot area of ≥ 500 m2 and for Residential part of Mixed land-use building projects, built on a plot area of ≥ 500 m2. The ENS-C&2 sets minimum requirements for renewable energy systems (Solar hot water requirements and Solar Photovoltaic) integration and for electro-mechanical systems used in building services (i.e., common area and exterior lighting, elevators, pumps, basement ventilation, transformers, power distribution losses, power factor correction, electrical vehicle supply equipment etc.) and indoor electrical end-use (i.e., indoor lighting, comfort systems, service hot water etc.).

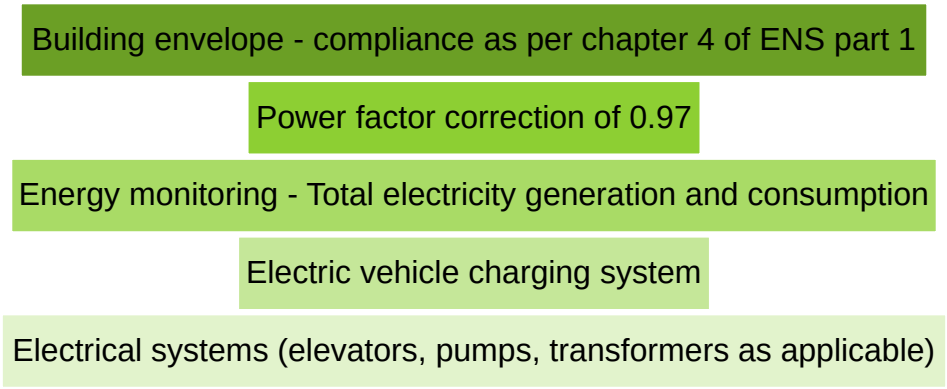


Figure 40: Key components of ENS part 2

Eco-Niwas Samhita Compliance (ENS) Tool:

Under the initiative, BEE has developed online tools for quick evaluation of design for homeowners, contractors, and builders on energy efficiency parameters. The BEE has developed three tools basic, advanced, and optimization tools.

The Basic tool has various categories of options from building envelope (wall, roof & window), Air-conditioning and Ventilation techniques to check the project performance. **An advanced tool** is for the professionals (Architects, Engineers, MEP consultants, project developers, and Industry professionals) who wish to perform a detailed analysis of the project design features in terms of energy efficiency and economic feasibility. The tool has the provision of various inputs of building design parameter options ranging from Building Geometry, Envelope, Lighting, Equipment, HVAC, and Economics to check the project performance. **The optimization tool** is a quick evaluation module to compute the most optimized set of envelope parameters (best wall, best roof, and best window) for the selected location based on the life cycle cost of the envelope options. Just input the cost of the most common envelope assemblies available at the project site and the tool will indicate which envelope will be the best for a site. Eco-Niwas Samhita Compliance (ENS) Tool PART 2 of ENS Compliance Tool is presently in final stage of development.

Other initiatives taken by BEE under the ENS are –

- The National Training Programme on ECBC and ENS was conducted on 19th July 2021 for architects, building professionals, field officials and other stakeholders.1113 participants attended the training programme[66].
- Webinar to provide training on the navigation of Replicable Design Web tool developed under "Replicable Designs for Energy Efficient Residential Buildings" project was conducted on 17th September 2021.
- Technical assistance has been provided for ENS demonstration projects for 70[67] residential building projects in different climatic zones were supported to showcase ENS compliance across the Country.

ENS Cell: In FY 2021-22, ENS cells were established as pilot cells in a few states Punjab, Delhi, UP, Maharashtra, Karnataka, Haryana, Gujarat, Rajasthan, and Andhra Pradesh. Till June 2022 1,443 training programmes have been conducted and 55,658 professionals have been trained.

Level of compliance of buildings

To demonstrate compliance with the code, the building shall comply with all of the mandatory requirements stated in Chapter 4 (of ENS part 2) along with either of the two approaches which are prescriptive approach or a point-based system.
The code defines the minimum ENS score required for low-rise buildings, affordable housing, and high-rise residential buildings. The code also defines the compliance mechanisms for mixed-mode buildings. The minimum ENS score required is presented next:

Table 38: Minimum score required for different categories of ENS compliance building

Project Category	Definition	Minimum ENS score
Low rise buildings	A building equal to or below 4 stories, and/or a building up to 15 meters in height (without stilt) and up to 17.5 meters (including stilt).	47
Affordable housing	Affordable houses are Dwelling Units (DUs) with a Carpet area of less than 60 sqm. It also includes the Economically Weaker Section (EWS) category and Lower Income Group (LIG) category (LIG-A: 28-40 sq. m. and LIG-B 41-60 Sq.m.)	70
High rise buildings	A building above 4 stories, and/or a building exceeding 15 meters or more in height (without stilt) and 17.5 meters (including stilt).	100

The code provides liberty to the user to opt for the prescriptive method or point-based method after compliance with mandatory requirements.

[66] Source: BEE Annual Report 2021-22; Pg -25
[67] Source: BEE Annual Report 2021-22; Pg -23

Methodology adopted to calculate the savings

ENS part 1 was launched in December 2018. ENS cells were established in 2019 in Delhi, Uttar Pradesh, Punjab, Karnataka, and Maharashtra to implement the residential code for one year.

The methodology adopted for estimating savings is based on RETV calculations. Residential envelope heat transmittance (RETV) is the net heat gain rate (over the cooling period) through the building envelope (excluding the roof) of the dwelling units divided by the area of the building envelope (excluding the roof) of the dwelling units. Its unit is W/m2.

RETV characterizes the thermal performance of the building envelope (except the roof). Limiting the RETV value helps in reducing heat gains from the building envelope, thereby improving the thermal comfort, and reducing the electricity required for cooling.

As per ENS part 1, the RETV for the building envelope (except the roof) for four climate zones, namely, Composite Climate, Hot-Dry Climate, Warm-Humid Climate, and Temperate Climate, shall comply with the maximum RETV[68] of 15 W/m^2.

The demonstration projects in the states (where ENS cell was established) have complied with the minimum RETV requirements (as stated in ENS part 1). The energy savings is calculated by creating a baseline case and proposed case. Baseline case developed to achieve minimum RETV requirements where the proposed case is developed to achieve energy efficiency in building envelope with improved RETV.

Estimation of Energy Savings

Technical assistance has been provided for ENS demonstration projects. About __ residential building projects in different climatic zones were supported to showcase ENS compliance across the Country.

To calculate the energy (electrical) savings, the difference between the conventional RETV (baseline) and proposed RETV of the respective residential buildings is considered.

Table 39: Energy savings by the adoption of ENS in selected states

Year	Number of buildings	Total built-up area (million sqm)	Energy savings (MU)
2021-22	54	1.55	2.42

To calculate the reduction in the total CO_2 emission, the conversion factor of 0.82 kg CO_2/kWh for electricity is considered. The total energy (electrical) saved under the ENS program is 0.0024 BU and the total reduction in CO_2 emission is 0.00021 MtCO_2. This is expected to grow exponentially in the coming years with much aggressive adoption o(f ENS in all states of India.

[68] BEE plans to improve the RETV norm to 12 W/m2 in the near future and the building industry and regulating agencies are encouraged to aim for it.

Building Energy Efficiency Project (BEEP)

Indo-Swiss Building Energy Efficiency Project (BEEP) is a bilateral cooperation project between the Ministry of Power, Government of India, and the Federal Department of Foreign Affairs (FDFA) of the Swiss Confederation. Started in 2011, the project's central focus is to help India mainstream Energy-Efficient and Thermally Comfortable (EETC) Building Design for both commercial and residential buildings. BEEP works with building industry, policy makers, and building owners to catalyze adoption of EETC building design and technologies. The Bureau of Energy Efficiency is BEEP's implementing agency for the Ministry of Power, while the Swiss Agency for Development and Cooperation oversees the project for FDFA. During the financial year 2021 – 22, EESL has retrofitted 1112 nos. of buildings where cumulative achievement as on 31st March 2022 is 11,581 nos. of buildings[69]

4.2.5. Residential Labeling Program

Residential segment of India has been facing soaring energy consumption from the past few decades. It has become imperative to build houses which are more energy efficient to avoid 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 launched EcoNiwas Samhita 2018 on 14th December 2018, which prescribed the minimum energy performance through an energy-efficient envelope 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.

Objective of the labeling program

The objective of the Program is to introduce the Energy Efficiency Label as an instrument to provide information to users about the energy performance of a residential building and constitute an additional decision tool when carrying out a real estate operation, evaluating a new project or carrying out interventions in existing buildings. The objectives of the proposed labeling program are to provide:

1. Information to consumers on the energy efficiency standard of the Homes
2. A benchmark to compare one home over the other on the energy efficiency standards
3. A consumer-driven market transformation business model solution for Energy Efficiency in the housing sector
4. Steering the construction activities of India towards international best practices norms

Scope of the program

The 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 mandatory in any real estate transaction/ leasing.

[69] Source: EESL Annual Report 2021-22; Pg 10

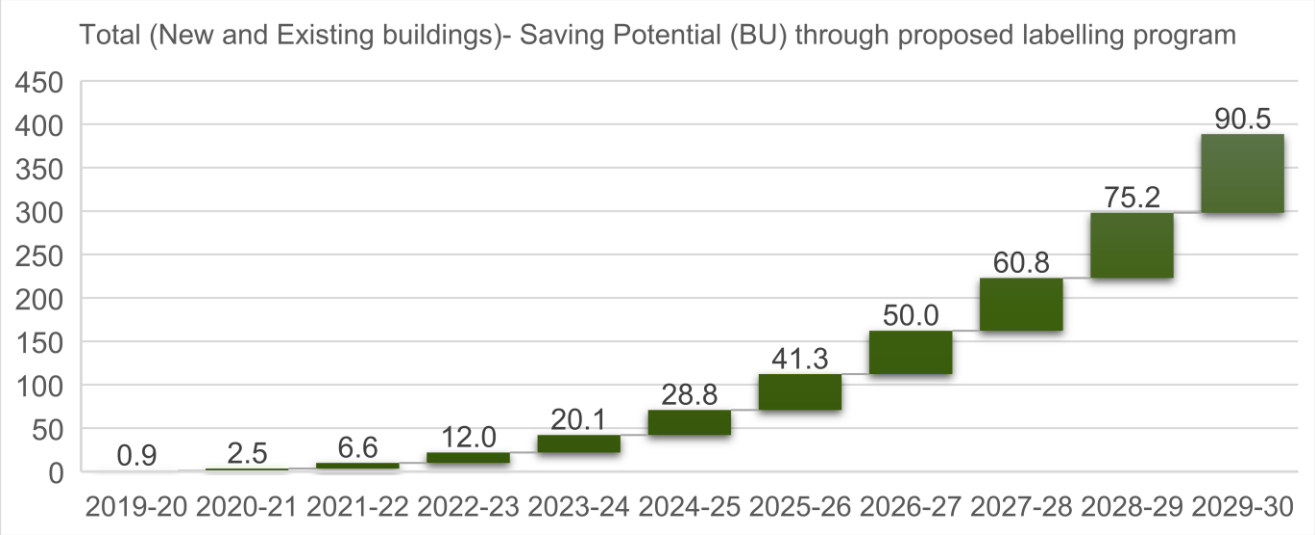


Figure 41:Energy saving potential in buildings through labeling program

Benefits of the program

The proposed labeling program is expected to save a large amount of energy by implementation of energy efficiency measures to residential sector across the nation. The estimated energy-saving potential through the proposed labeling program is around 388 BU by the year 2030 which is greater than the energy consumption in 2016 (250 BU).

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

1. The labelling program will create awareness among end users to not use energy efficient appliances but also incorporate energy efficient technology and sustainable building material in their homes which shall create the demand in the market and give enough impetus to suppliers to produce the same.
2. Labeling mechanism and energy efficient technology implementation requires sector expertise in the entire value chain of housing industry and hence labeling regime shall also be a stimulant to the Indian job market.
3. The proposed labeling program also is in sync with “Make in India” policy. As the demand of energy efficient materials will rise, manufacturers will be motivated to invest in sustainable material manufacturing in India
4. Labeling mechanism shall cause a 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.
5. It helps the nation in working towards the fulfillment of Global Sustainable Development Goals 7 of United Nations: Affordable and Clean Energy The 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 launched the Star rating of commercial buildings scheme in 2009. The star rating program is based on the actual performance of a building in terms of its specific energy usage in kWh/sqm/year. This program rates office buildings on a 1-5 Star scale, with 5 Star labeled buildings being the most efficient. The scheme is propagated voluntarily, and the label provided under it is applicable for 5 years from the date of issue.

Under this program, 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 a rating of office buildings, a standardized format is developed for the collection of actual energy consumption: data required includes the 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 a total of 264 buildings have been star rated under different categories of buildings as on date (since the start of the program in 2009). BEE had launched the Star rating program for Offices (February 2009), BPOs (December 2009), shopping malls (January 2011), and Hospitals (July 2014). A Memorandum of Understanding (MoU) is also signed between BEE and CPWD on 10th January 2019 for “Energy Efficiency in CPWD managed Buildings”.

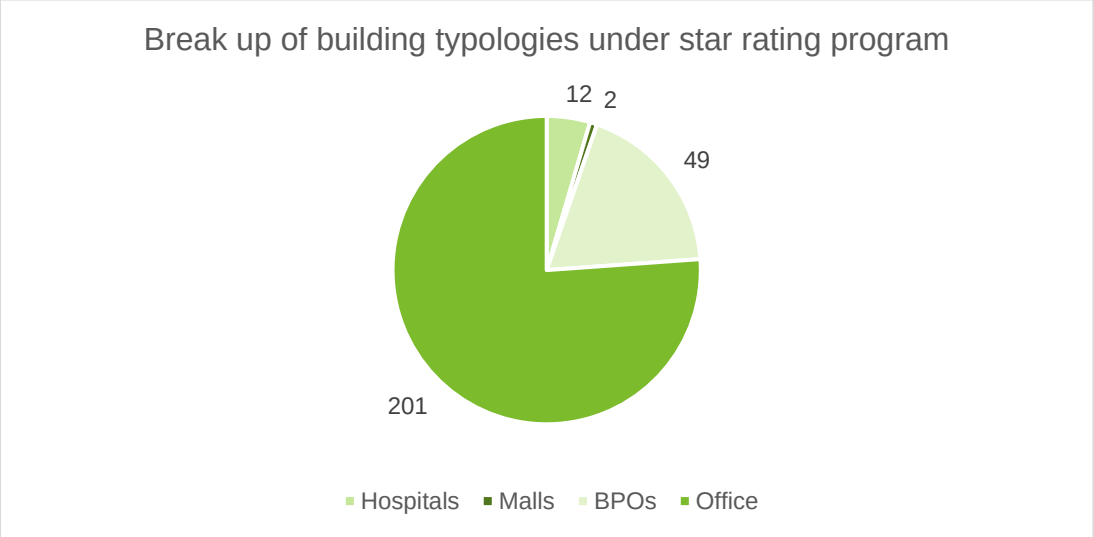


Figure 42: Break up of building typologies since the inception of the program

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 is provided in the below sections for reference- For buildings having an air-conditioned area greater than 50% of their built-up area & for buildings having an airconditioned area less than 50% of their built-up area. Details are presented below:

Table 40: Baseline EPI for Star rated buildings in 2021-22

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

Under this program, 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 BEE 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 the comparative assessment and target setting in existing buildings.

4.3.2. 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.

The 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 buildings, multiplied by the total built-up area. The bandwidths considered for building energy star rating programs are provided for office buildings in the above section. Similarly, bandwidths for other typology of buildings (hospital, BOP, shopping malls) is considered for the calculation of energy savings.

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

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

Type of Buildings and Climate Zones

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

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

There are a total of four types of commercial establishments that are part of this report, viz. Offices, Hospitals, BPOs, and shopping malls.

1. ***Office Buildings:*** BEE Star Rating Scheme for Office Buildings is notified in the year 2009. The baseline EPIs considered for the star rating program in more than 50 % of air-conditioned built-up areas and less than 50 % of air-conditioned built-up areas are given in the table below:

Table 41: EPI for star label office buildings

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

2. ***BPO Buildings*:** Star Rating Scheme for BPO buildings was notified in December 2009. Average Annual hourly Energy Performance Index 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 is presented in table below:

Table 42: 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

3. ***Shopping Malls:*** BEE Star Rating Scheme for shopping malls is notified in the 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 below:

Table 43: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

4. Hospitals: BEE 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.

4.3.3. Impact of BEE Star Rated Program

As the star rating is valid for 5 years and 80 buildings had received a star rating from 2017-18 to 2021-22; so, it has been assumed that these buildings have been sustaining the energy savings post the star rating certification.

Out of these buildings, a total of 2 commercial establishments have received BEE star ratings in FY 2021-22.

On account of the total number of star-rated buildings in the last 5 years, the total energy (electrical) saved by these commercial establishments in the year 2021-22 is 261.57 MU. This has led to a reduction of 0.2065 Tonnes of CO_2. Details are presented in table below:

Table 44: Energy-saving summary of Star rated scheme

Building Type	Energy Savings in MU					Total	CO_2 Emission Reductions (MntCO2)
	2017-18	2018-19	2019-20	2020-21	2021-22		
Offices	6.2	7.9	51.5	14.3	12.8	92.77	0.0732
BPO	28.6	40.8	86.2	0.0	0.0	155.6	0.1229

Building Type	Energy Savings in MU					Total	CO_2 Emission Reductions (MntCO2)
	2017-18	2018-19	2019-20	2020-21	2021-22		
Hospital	0.0	3.5	0.9	0.0	0.0	4.4	0.0034
Mall	0.0	8.9	0.0	0.0	0.0	8.9	0.0070
Total	**34.8**	**61.0**	**138.6**	**14.3**	**12.8**	261.57	0.2065

As the electrical energy savings obtained under this program is mainly due to the replacement of inefficient electrical & mechanical appliances with BEE star-rated electrical & mechanical appliances, therefore, to avoid any duplication, the energy savings of the Star Rating Programme has been already considered under the S&L program. The savings are not counted for the assessment year 2021-22 as the above-mentioned savings have been included in the previous report.

4.3.4. Building Sector under PAT Scheme

Buildings are identified as one of the most Energy Intensive Sector in India. There is a huge scope of energy saving from Building sector. ECBC are limited to new buildings only and can be implemented at design and construction phase only. However, existing buildings can also save a lot of energy. In order to conserve energy and to promote energy efficiency in existing buildings, Commercial Buildings Sector has been covered under the PAT Cycle –IV and subsequent cycles there forth;

1. To start with in PAT Cycle-IV, 37 Hotels were notified as Designated Consumers (DC) under Commercial Building having energy consumption more than 1000 TOE (Tons of oil equivalents).
2. While in PAT Cycle -V and forthcoming cycles of PAT threshold consumption has been revised to 500 TOE to qualify a hotel as a DC under commercial building sector. In PAT cycle V, 31 more Hotels were added as DCs with the saving potential of 1360 TOE till 2022.
3. Similarly in PAT cycle VI, 64 more Hotels were notified as a designated consumer with the target saving of 4154 TOE till 2023. Now, cumulatively 132 Hotels as DCs are covered under the PAT Scheme.
4. Airports are added as a new sub-sector under the Commercial Building Sector to be included under PAT Scheme. As per the gazette notification, Airports - having energy consumption of 500 metric tonne of oil equivalent (mTOE) per year and above will be considered as a Designated Consumer under PAT Scheme.

Chapter 5:
Standards & Labeling

5. *Standards and Labeling*

India's final energy consumption increased by 36% from 2010 to 2021,[70] with growth across all sectors, but with the largest increases in the industrial and transport sectors. It has seen the highest growth of primary energy among G20 countries, but still has the lowest GDP per capita. The Government of India has made impressive progress in recent years in increasing citizens' access to electricity and clean cooking. The priority is now shifting towards energy security and affordability as demonstrated by India's successful energy market reforms. Energy efficiency will remain important to realize these priorities as India continues to develop economically.

Due to the growth of the Indian economy, energy use has continued to increase. Structural factors such as movement towards more energy-intensive transport modes, increased appliance ownership and building floor areas have added to increased energy use between 2010 and 2022.

The implementation of clean energy systems is gaining momentum worldwide, including in India, due to policy interventions. However, one of the most cost-effective options available is to adopt an energy-efficient lifestyle. Energy efficiency is increasingly becoming a critical aspect of energy transformation policies globally. Implementing robust energy efficiency measures results in reduced air pollution, decarbonization, improved energy access, better utilization of resources, and enhanced energy security. The transition to clean energy can be accelerated and made more affordable through the adoption of energy efficiency measures.

In this regard, the Bureau of Energy Efficiency (BEE) introduced the Standards and Labeling (S&L) program in 2006 with the aim of providing consumers with information on energy consumtpion and the cost-saving potential of labeled appliances. The program distinguishes between high-energy-consuming and efficient end-use equipment and appliances, creating competitive dynamics for the domestic market to shift towards more efficient appliances and equipment. The program not only applies to specific appliances but also controls the quality of information, particularly at the point-of-sale of energy-intensive appliances. The S&L program has gained widespread acceptance worldwide and is now a common tool for energy efficiency.

There are two components under the Standards and Labeling programme.

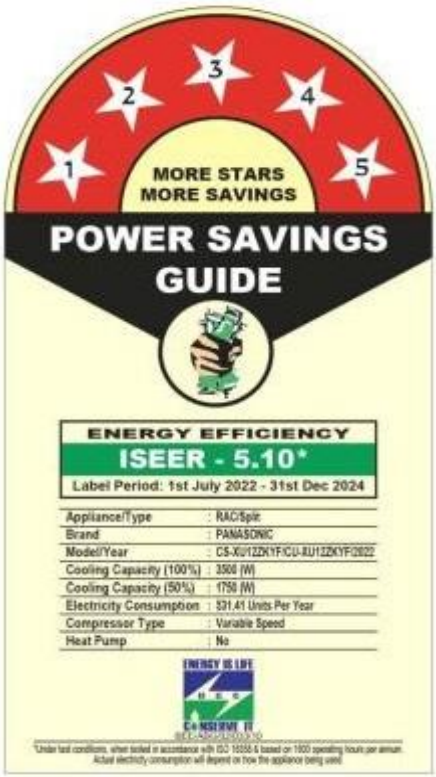
Standards: Standards prescribe limits on the energy consumption (or minimum levels of energy efficiency) of manufactured products. Based on the standard, a prescribed energy performance of the manufactured products can be set, sometimes prohibiting the sale of products that are less efficient than a 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.

[70] Source: IEA

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

There are two types of labels that are issued by BEE for the various appliances. First is a comparative label which allows consumers to compare the energy consumption of similar products, and factor lifetime running cost into their purchasing decision. The other is the 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 the figure below:

Comparative Label



Endorsement Label

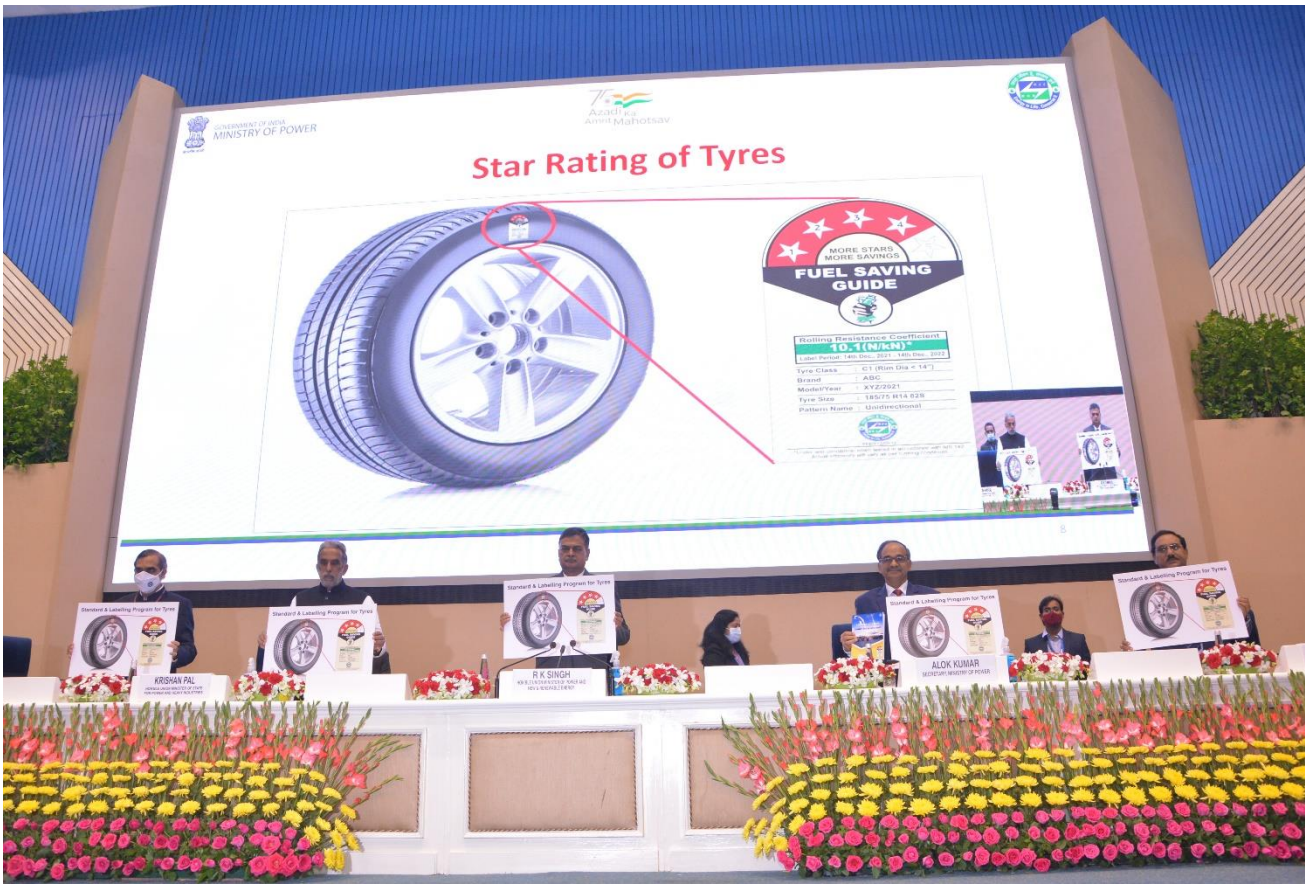
Figure 43: Energy efficiency labels

The S&L programme was started with voluntary labels for refrigerators and Tubular fluorescent lamps. Since its inception, several appliances have been added year after year under this programme. In January 2009 affixing labels on appliances namely *"Room Air Conditioners, Tubular Fluorescent lamps, Frost Free Refrigerators and Distribution Transformers".* was made mandatory. To date, thirty appliances are covered under the scheme, out of which, ten are under the mandatory labelling regime and the remaining twenty are under the voluntary regime of labelling.

S&L in India works on a model in which the permittee provides information related to the 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. The energy performance standards get updated every two-three years; old inefficient products are replaced with more energy-efficient products. For example, the 5-star air conditioner of the year 2009 was having an ISEER of 3.5 which has drastically improved over years. Presently, in accordance with norms applicable 5-star RAC has an ISEER of 4.5 or more.

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.

Two new appliances were added during 2021-22 under the S&L Programme. During the 31th National Energy Conservation Awards (NECA), celebrated on 14th December 2021, the Standards and Labelling Programme for High-Energy Lithium-Ion Traction Battery Packs and Systems and Tyres on a voluntary basis were launched.



The scheme as of 31st March 2022, covers 30 appliances under the S&L programme (10 mandatory and 20 voluntary). Details of the appliances are presented in the section below:

5.1 Appliances under S&L

The appliances covered[71] are presented in Table 45 below:

Table 45: List of appliances covered under the S&L program as on 31st March 2022[72]

S.No	Appliance Name	Category
1.	Frost Free Refrigerator	Mandatory
2.	Tubular Florescent Lamp	Mandatory
3.	Room Air Conditioners (Fixed Speed)	Mandatory
4.	Direct Cool Refrigerator	Mandatory
5.	Distribution Transformer	Mandatory
6.	Color TV	Mandatory
7.	Electric Geysers	Mandatory
8.	Room Air Conditioners (Cassette, Floor Standing)	Mandatory
9.	LED Lamps	Mandatory
10.	Room Air Conditioner (Variable Speed)	Mandatory
11.	Light Commercial AC Fixed Speed	Voluntary
12.	Ceiling Fans	Voluntary
13.	Deep freezer	Voluntary
14.	UHD Color Television	Voluntary
15.	Pump Sets	Voluntary
16.	Induction Motors	Voluntary
17.	Washing Machine	Voluntary
18.	Computer (Notebook/Laptops)	Voluntary
19.	Ballast (Electronic/Magnetic)	Voluntary
20.	Solid State Inverter	Voluntary
21.	Office Equipment's	Voluntary
22.	LPG-Stoves	Voluntary
23.	DG Sets	Voluntary
24.	Diesel Engine Mono-set Pumps	Voluntary
25.	Chillers	Voluntary
26.	Microwave Oven	Voluntary
27.	Solar Water heater	Voluntary
28.	Air Compressor	Voluntary
29.	High-Energy Lithium-Ion Traction Battery Packs and Systems	Voluntary
30.	Tires	Voluntary

71 Source: https://www.beestarlabel.com/SearchCompare.

5.1. Methodology adopted for saving

The Methodology adopted for the evaluation of the impact of the S&L programme is shown in Figure 44[73]

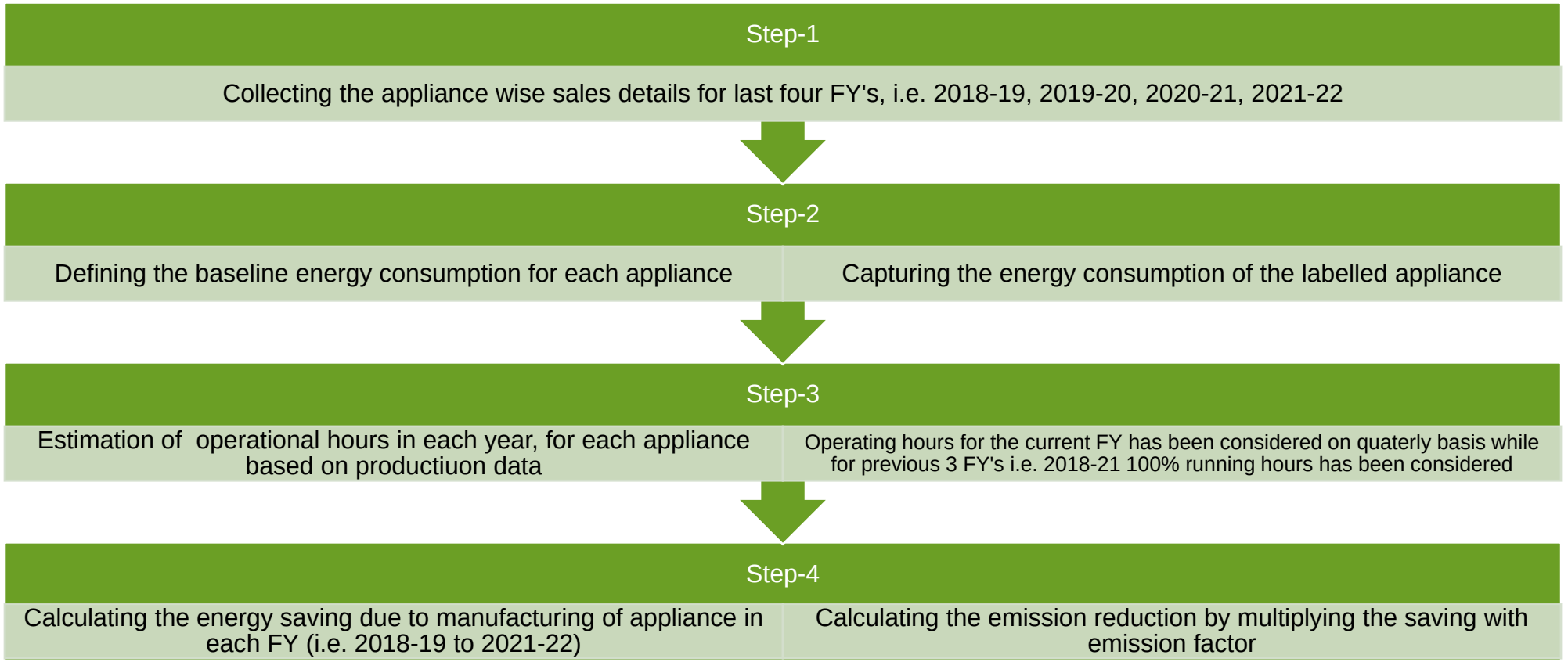


Figure 44: Methodology for impact assessment

[73] Average life of the appliances in considered as four years, hence energy savings due to the sales of Star labeled appliances from FY 2018-19 to FY 2021-22 are considered while evaluating the impact of the scheme for FY 2021-22 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).

5.2. Estimation of impact from S&L

Step-1: Production Volumes of Star-Labeled Appliances

5.2.1.1. Appliances considered for S&L impact assessment

To evaluate the impact of the S&L programme the production data must be captured for the registered appliances under the S&L program. Till 31st March 2022; 30 appliances were registered under the programme, out of which 19 have significant production volume based on data reported under the programme. For the other 11 appliances, the recorded production volume is presently low, and consequently, the savings accrued due to these appliances is not significant. These appliances are presently included under the voluntary category. A list of the 19 appliances being considered for impact assessment is presented in Table 46:

Table 46: List of appliances covered under the S&L programme for impact assessment[74]

S. No.	Appliance
Mandatory Appliances	
1.	Frost Free Refrigerator
2.	Tubular Florescent Lamp
3.	Room Air Conditioners
4.	Direct Cool Refrigerator
5.	Distribution Transformer
6.	Colour TV
7.	Electric Geysers
8.	Room Air Conditioners (Cassette, Floor Standing)
9.	Inverter Air Conditioners
10.	LED Lamps
Voluntary Appliances	
11.	Pump Set (Submersible)
12.	Deep Freezers
13.	Ceiling Fans
14.	Washing Machine
15.	Computer (Notebook/Laptops)
16.	Light Commercial Air Conditioners
17.	LPG-Stoves
18.	Diesel Engine Mono-set Pumps
19.	Chillers

5.2.1.2. Production Volumes of the appliances for the respective FY (2018-19 to 2021-22)

The star-wise production figures of both mandatory and voluntary appliances, which are considered for the study, for the current FY 2021-22 is showcased in the table below:

[74] 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

Table 47: Star-wise production figures of appliances (FY 2021 – 22)

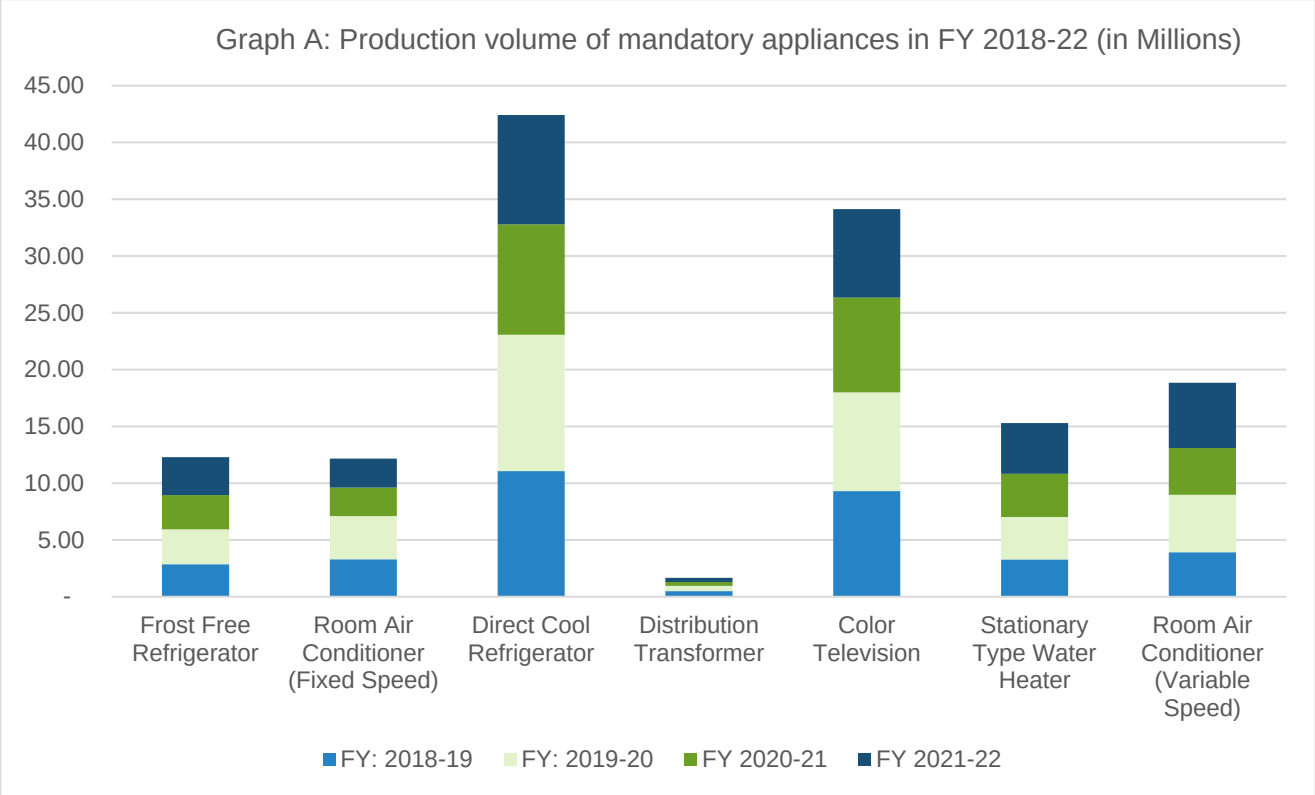
S.No	Appliance	5 Star	4 Star	3 Star	2 Star	1 Star	Total
1	Frost Free Refrigerator	-	4,018	1,053,457	2,240,680	36,308	3,334,463
2	Tubular Fluorescent Lamps	-	-	1,322,595	32,000	27,160,783	28,515,378
3	Room Air Conditioners (RAC) Fixed Speed	192,946	25,920	2,155,478	135,564	34,089	2,543,997
4	Direct Cool Refrigerator	559,570	852,020	3,530,429	2,799,352	1,877,968	9,619,339
5	Distribution Transformer (DT)	21,573	4	35	128,727	205,611	355,950
6	Color Television	66,363	1,508,785	2,664,404	3,063,547	486,579	7,789,678
7	Stationary Storage Type Electric Water Heater (Geyser)	1,868,604	1,807,875	746,236	42,181	3,035	4,467,931
8	Air Conditioners Variable Speed	1,939,753	703,928	3,076,556	29,627	50	5,749,914
9	LED Lamps	4,560	1,937,705	289,128,034	182,705,592	-	473,775,891
10	Submersible Pump sets	165,955	151,300	242,011	67,703	13,139	640,108
11	Open-well pump sets	152,751	49,846	28,510	19,282	3,978	254,367
12	Ceiling Fans	2,037,743	-	97,546	300,634	839,288	3,275,211
13	Washing Machine (Semi / Top Load / Front Load)	8,181,032	121,669	487,354	-	-	8,790,055
14	Computer	-	-	-	-	-	-
15	Domestic Liquefied Petroleum Gas (LPG) Stoves	-	-	-	-	990,824	990,824
16	Monoset Pumps	11,346	619	41,132	11,188	1,005	65,290
17	Deep Freezer	3	-	6	-	-	9
18	Light Commercial AC	24,475	21,692	40,587		-	86,754
19	Chillers	2,428	94	1,862	1,440	-	5,824
	Total	**15,229,102**	**7,185,475**	**304,616,232**	**191,577,517**	**31,652,657**	**550,260,983**

The consolidated production data of the appliances for the FY 2018-22, is presented in the table below:

Table 48: Production figures for appliances (FY 2018 – 22)

S.No	Appliance	FY: 2018-19	FY: 2019-20	FY 2020-21	FY 2021-22	Total in Million
			Mandatory Appliances			
1	*Frost Free Refrigerator*	2,861,285	3,074,275	3,017,997	3,334,463	12.29
2	*TFL*	63,187,569	52,775,743	48,189,268	28,515,378	192.67
3	*Room Air Conditioner (Fixed Speed)*	3,304,280	3,797,043	2,511,348	2,543,997	12.16
4	*Direct Cool Refrigerator*	11,067,110	11,998,899	9,732,127	9,619,339	42.42
5	*Distribution Transformer*	500,544	464,389	338,115	355,950	1.66
6	*Color Television*	9,298,819	8,703,395	8,335,140	7,789,678	34.13
7	*Stationary Type Water Heater*	3,287,462	3,736,438	3,800,519	4,467,931	15.29
8	*Room Air Conditioner (Variable Speed)*	3,924,884	5,050,951	4,113,958	5,749,914	18.84
9	*LED Lamps**	243,974,600	505,633,490	465,096,423	473,775,891	1,688.48
	Total In Million	**341.41**	**595.23**	**545.13**	**536.15**	**2,017.93**
			Voluntary Appliances			
1	*Submersible Pump set & Open well pumps*	1,326,818	1,037,081	415,943	894,475	3.67
2	*Ceiling Fan*	2,353,916	1,795,718	3,323,670	3,275,211	10.75
3	*Washing Machine*	-	1,791,020	6,681,960	8,790,055	17.26
4	*Computer*	-	-	330	-	0.00
5	*Domestic LPG Stoves*	821,804	1,326,632	1,213,959	990,824	4.35
6	*Monoset Pump*	72,768	70,835	48,200	65,290	0.26
7	*Chiller*		18	5	9	0.00
8	*Deep Freezer*	-	-	-	86,754	0.09
9	*Light Commercial AC*	-		-	5,824	0.01
	Total In Million	**4.58**	**6.02**	**11.68**	**14.11**	**36.39**

With reference to the data provided in the above table, the production figures for each mandatory and voluntary appliance for the FY 2018-22 are showcased in the figures below:



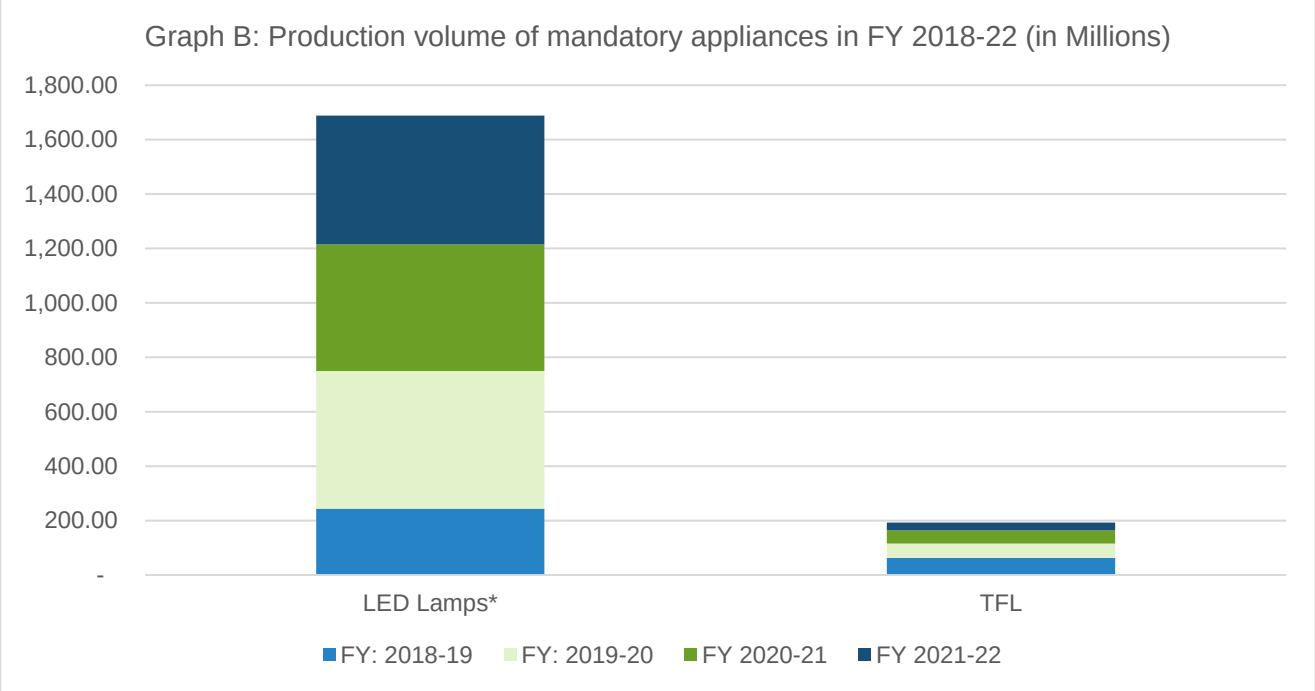
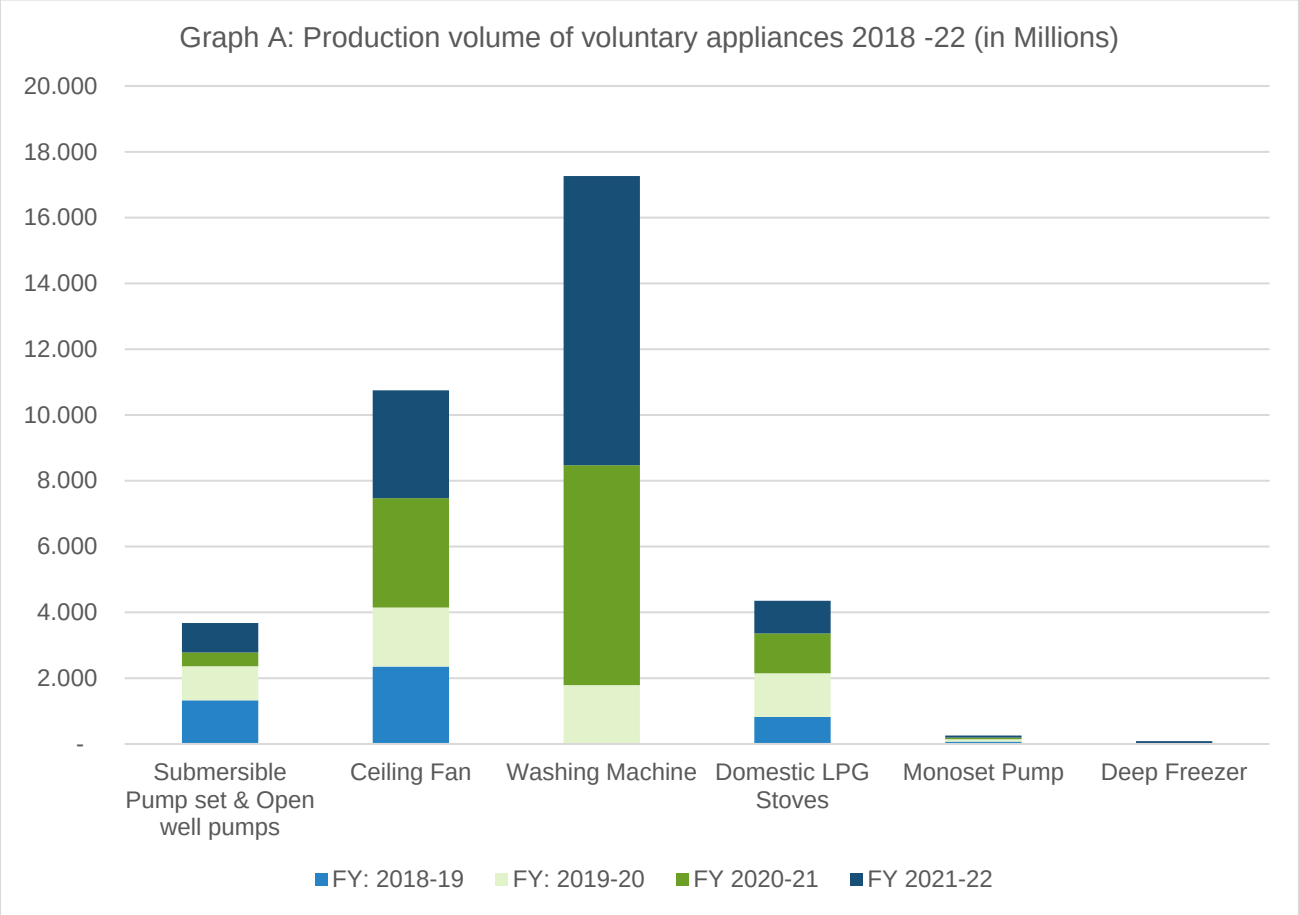


Figure 45: Production volume of mandatory appliances in FY 2018-22



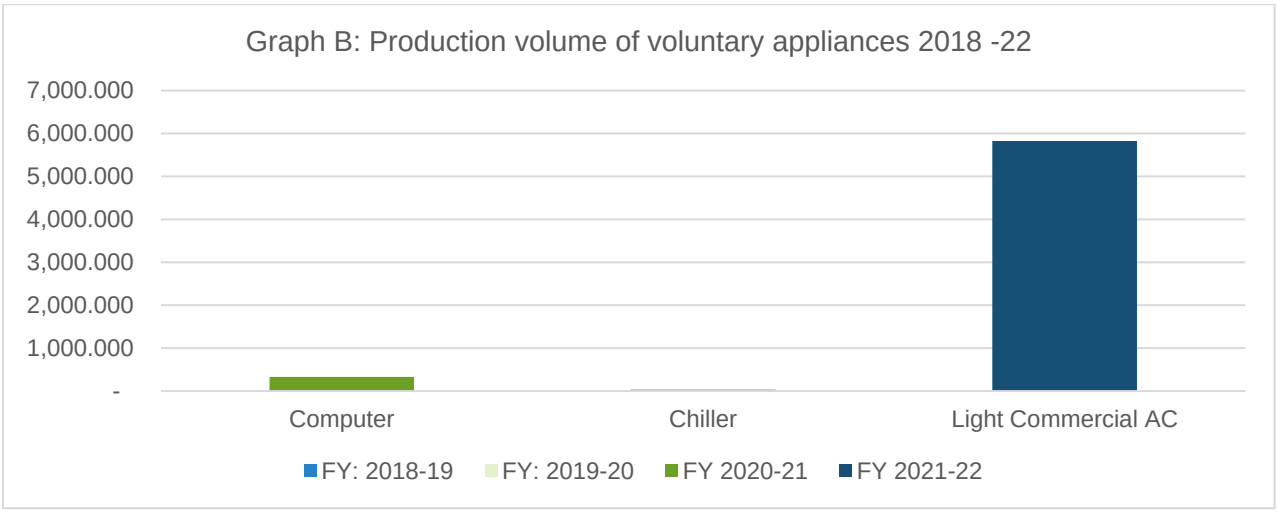
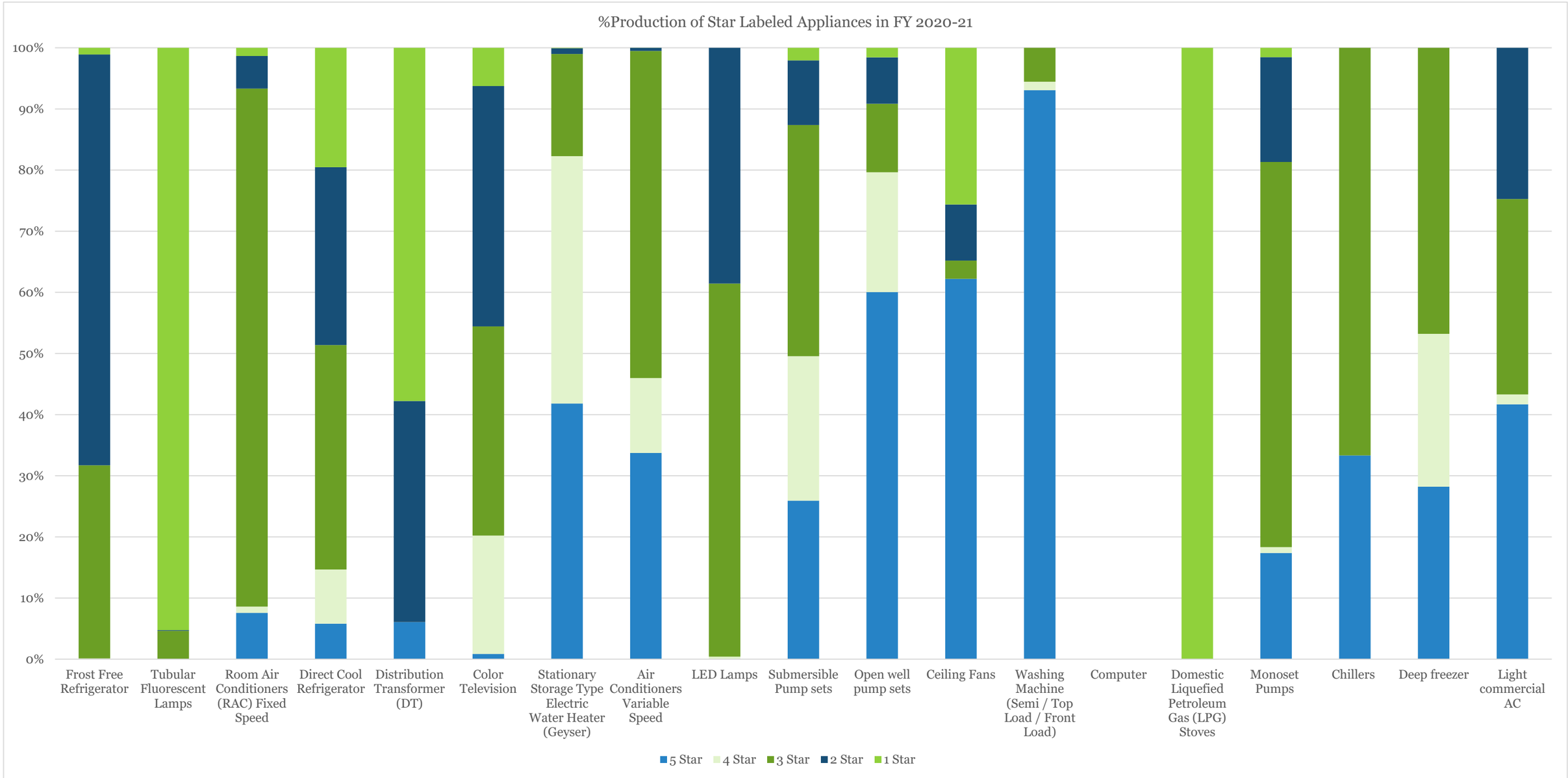


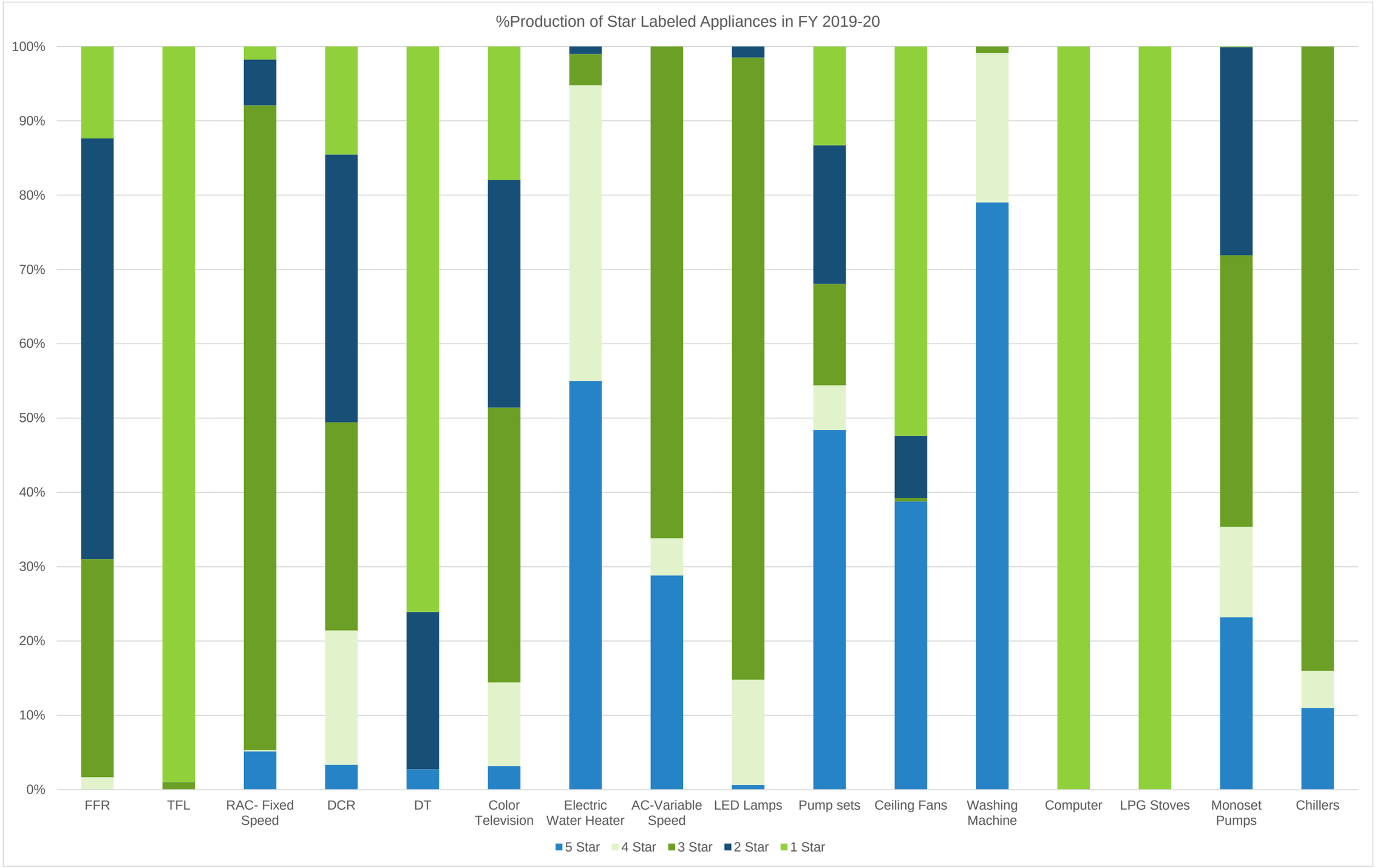
Figure 46: Production volume of voluntary appliances 2018 -22

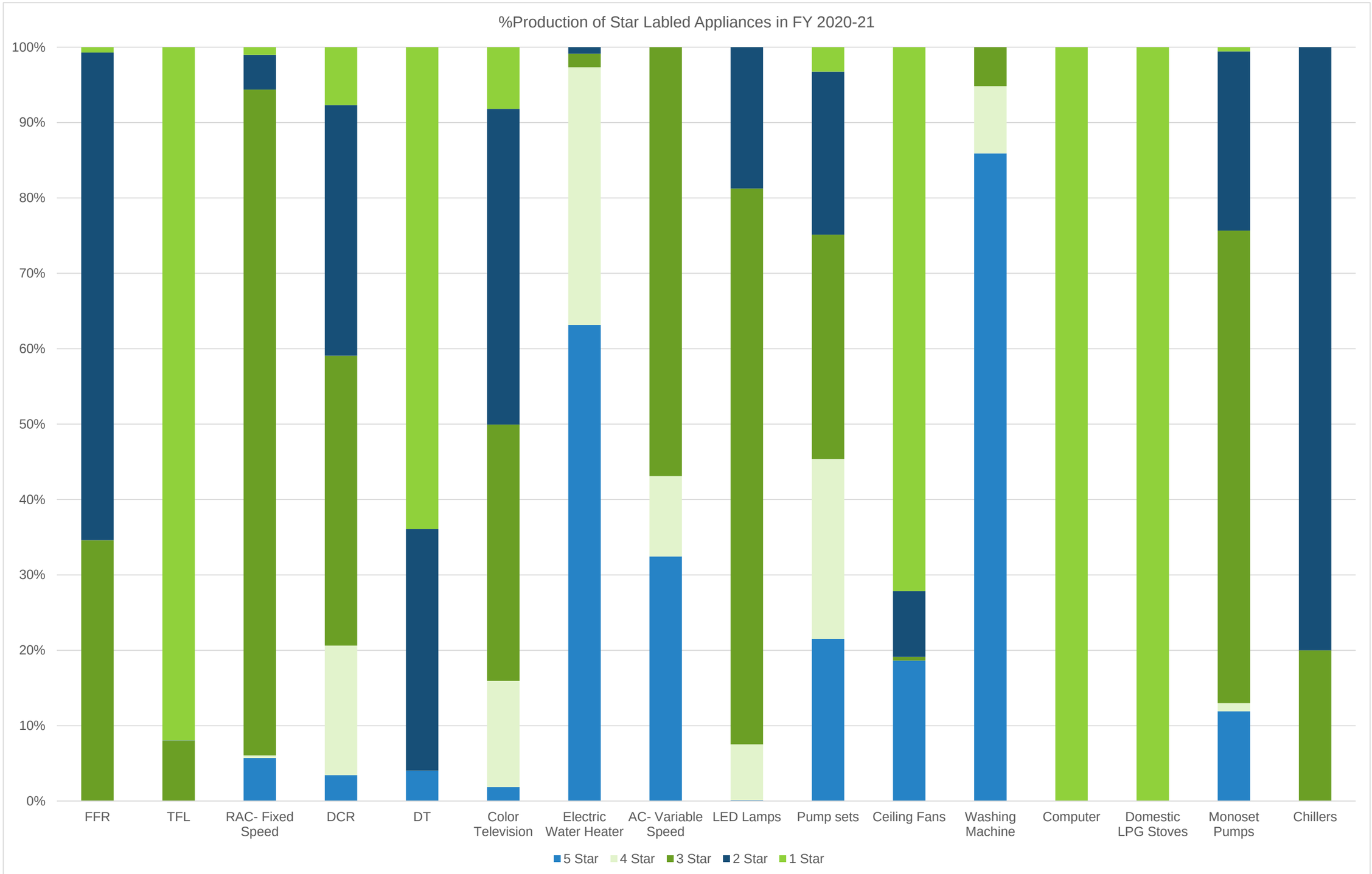
The findings from the production volume of appliances showcased in the above figures is listed below:

1. The production of LED lamps and Tubular Fluorescent Lamps were highest for the mandatory appliances
2. While, for voluntary appliances the production was highest for washing machines followed by ceiling fan and domestic LPG stoves for the FY 2018-22.

The consolidated year wise percentage production figures for mandatory and voluntary appliance (considered for the study) for each FY from 2018 to 2022 are showcased in the figures below:




%Production of Star Labeled Appliances in FY 2019-20
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
FFR
TFL
RAC- Fixed Speed
DCR
DT
Color Television
Electric Water Heater
AC-Variable Speed
LED Lamps
Pump sets
Ceiling Fans
Washing Machine
Computer
LPG Stoves
Monoset Pumps
Chillers
5 Star
4 Star
3 Star
2 Star
1 Star


%Production of Star Labled Appliances in FY 2020-21
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
FFR
TFL
RAC- Fixed Speed
DCR
DT
Color Television
Electric Water Heater
AC- Variable Speed
LED Lamps
Pump sets
Ceiling Fans
Washing Machine
Computer
Domestic LPG Stoves
Monoset Pumps
Chillers
5 Star
4 Star
3 Star
2 Star
1 Star

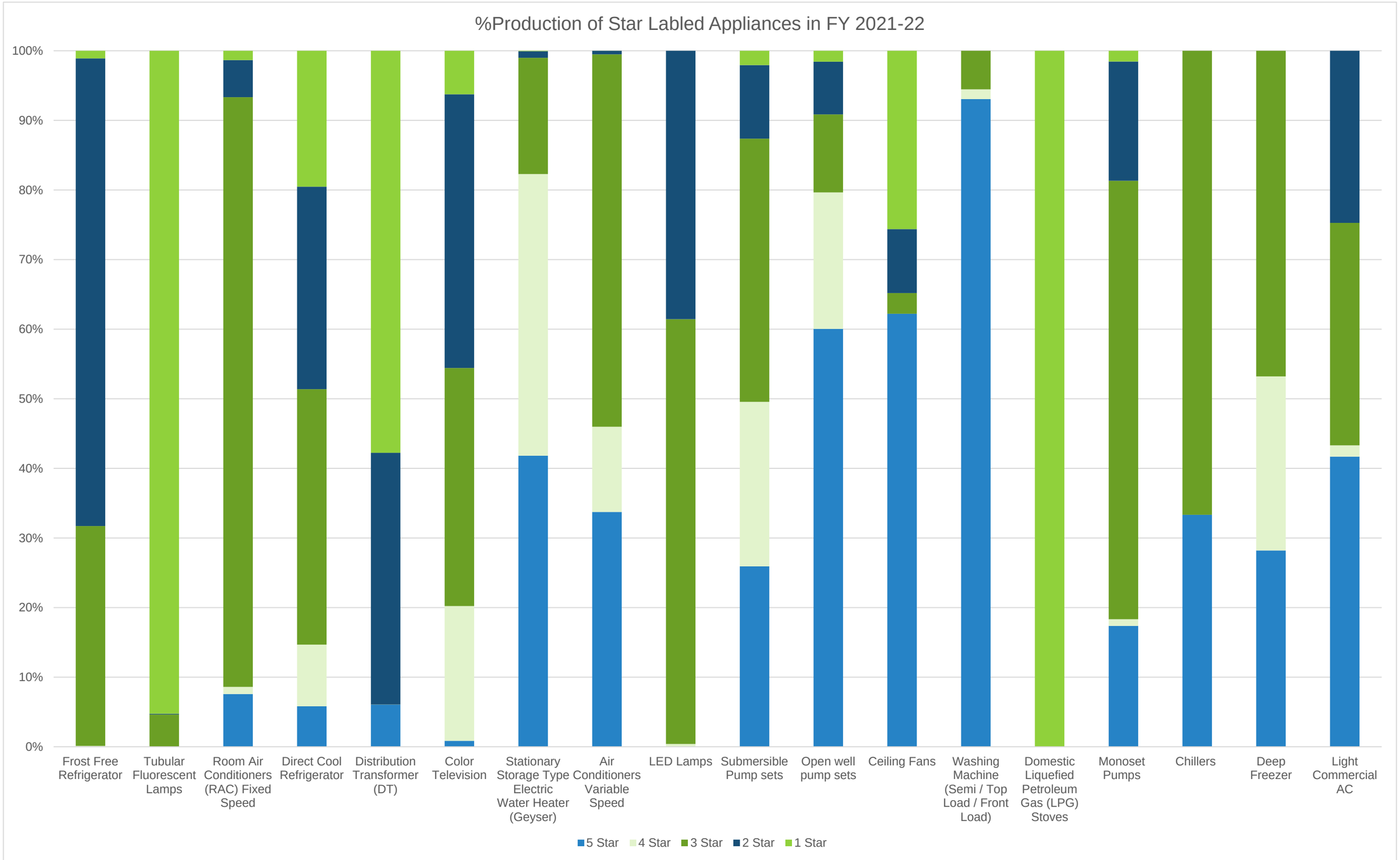


Figure 47: Production as % of total Production for different appliances for the FY 2018-22

It can be inferred from the above analysis that:

1. Maximum percentage of 5 star labeled appliances manufactured during FY 2021-22 are washing machine, followed by ceiling fans, open well pump sets and electric water heaters.
2. Majority of LED lamps manufactured fall under 3-star label category
3. Majority of TFL lamps manufactured fall under 1 star label category.

5.3. 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. Savings of each appliance is evaluated using the following formula:

Annual Energy Savings = (Baseline Value- Actual Value) x Production *x Operating hours x (1-T&D losses)*

Details of baseline energy consumption for different appliances are presented in Table 49.

Table 49: Baseline energy consumption for appliances

S. No	Appliance Name	Label Details	Baseline Energy / Baseline standard
1.	Frost Free Refrigerator	Annual Energy consumption (kWh)	759 + adjusted volume*0.8716
2.	Tubular Fluorescent Lamps	Lumen /Watt	61
3.	Room Air Conditioners (RAC)	ISEER	2.3
4.	RAC (Cassette, Floor Standing Tower, Ceiling, Corner AC)	ISEER	2.3
5.	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)
6.	Direct Cool Refrigerator	Annual Energy Consumption (kWh)	561 + adjusted volume*0.645
7.	Stationary Storage Type Electric Water Heater (Geyser)	Standing energy loss in 24 hours (%)	Baseline energy consumption Matrix
8.	Color Television	Annual Energy consumption (kWh)	0.1494 * screen area in m^2 + 4.38
9.	Room Air Conditioners (Variable Speed)	ISEER	3.1 for Split AC 2.5 for Window AC
10.	LED Lamps	Lumen /Watt	79
11.	Induction Motors	Efficiency (%)	IE2
12.	Agricultural Pump sets	Performance factor	IS 14220 for Open well, IS8034 for Submersible pump set, IS9079 for moonset pump sets
13.	Ceiling Fans	Service value	3.1

S. No	Appliance Name	Label Details	Baseline Energy / Baseline standard
14.	Domestic Liquefied Petroleum Gas (LPG) Stoves	Thermal Efficiency (%)	68%
15.	**a)** Washing Machine (Front loaders (drum type))	kWh/kg/cycle	0.18
	b) Washing Machine (Top loaders & semi-automatic machines)	kWh/kg/cycle	0.0185
16.	Computer (Notebook/Laptops)	Endorsement	
17.	Ballast (Electronic/Magnetic)	Ballast Efficiency Class	B1
18.	Office equipment (printer, copier, scanners)	Endorsement	
19.	Solid State Inverter	Efficiency Range	83%
20.	Microwave Oven	Energy consumption per cycle (Wh)	60 Wh/cycle
21.	Diesel Pump sets	Specific Fuel Consumption (g/h/m/l/s)	1
22.	Diesel Generator	Specific Fuel Consumption (g/kWh)	336
23.	a) Chillers (Air cooled)	ISEER	3 - 3.1 (Matrix)
	b) Chillers (Water cooled)	ISEER	4.8 - 6 (Matrix)
24.	Solar Water Heaters	Efficiency	40%
25.	Light Commercial Air conditioners	ISEER	2.7
26.	Deep freezers	Annual Energy Consumption(kWh)	5.07*V + 151.98 (Hard Top) 9.21*V+613.4 (Glass Top)
27.	Air Compressor	Isentropic Efficiency (%)	44 ≤ ηisen < 50
28.	UHD TV	Annual Energy Consumption(kWh)	0.0325*A + 6.226

5.4. Step-3: Defining the operating hours

Energy saving for the appliances sold under FY 2018-22[75]

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 produced during the FY 2018-22 * annual operational hours of the appliance as defined under the S&L program

Energy saving for the FY 2021-22 is calculated considering the production of the appliance on quarterly basis. For example, if Variable AC is having the 1600 annual operation hours, appliance manufactured in Q1 can be operated for 100% of the operational hours i.e. 1600 hours, and if appliance is manufactured in Q2, then appliance can operate to max of 75% of the available operation hours i.e. 1125 hours; if appliance is manufactured in Q3 then it can only work for 50% of the annual operation hours for that FY i.e. 750 hours; and if manufacturing occurs in Q4 then appliance can only work for 25% of operation hours during that particular

[75] Annual operating hours are considered as the appliances manufactured before the 1st April 2021 will operate for 100% hours as defined under the S&L guidelines

FY i.e. 375 hours. While, energy savings for the previous 3 FY's i.e., 2018-19, 2019-20, 2020-21 is calculated based on 100% running hours.

Accordingly, the contribution of appliances to savings will vary proportionality. Details of the operation hours for the different appliance is defined in table below:

Table 50: Annual operation hours for appliance

S.No	Appliance	Annual operation hours [76]
1.	Frost Free Refrigerator	8760
2.	Tubular Fluorescent Lamp	1200
3.	Room Air Conditioners (RAC)	1600
4.	Distribution Transformer	8760
5.	Direct Cool Refrigerator	8760
6.	Electric Geyser/ Stationary water heater	6000
7.	Color Television[77]	6570
8.	Variable Capacity Air Conditioner	1600
9.	LED Lamp	1200
10.	Pump set	2000
11.	Ceiling Fan	3600
12.	Domestic LPG stove	730
13.	Chillers	4000
14.	Washing machine	220 Cycles per year
15.	Domestic LPG stove	730
16.	Deep Freezer	8760
17.	Light Commercial AC	1600

5.5. 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 savings for the different appliances is presented table below:

[76] https://beeindia.gov.in/content/standards-labeling
[77] Note: For Color Television 6 Hours has been considered as operating daily hours of television, while 12 hours considered for Standby Active Low mode on daily use

Table 51: Energy Savings in FY 21-22 from appliances manufactured during FY 2018-22 [78]

S.No	Appliance	FY: 2018-19	FY: 2019-20	FY 2020-21	FY 2021-22	Total Savings FY 2018-22 (BU)	Annual Savings (Million Rs)
1	Frost Free Refrigerator	2178	2372	2384	1561	8494.98	50970
2	TFL	365	278	303	95	1041.31	6248
3	Room Air Conditioner (Fixed Speed)	1794	2076	1376	839	6085.04	36510
4	Direct Cool Refrigerator	5072	5648	4806	2749	18274.38	109646
5	Distribution Transformer	628	379	758	499	2263.56	13581
6	Color Television	3749	3534	3451	2040	12774.21	76645
7	Stationary Type Water Heater	563	665	676	507	2411.71	14470
8	Room Air Conditioner (Variable Speed)	999	1359	2386	866	5609.62	33658
9	LED Lamps*	695	1527	1525	1045	4792.32	28754
10	Submersible Pump set	3017	1405	888	768	6078.30	36470
11	Open well pumps		632		186	818.84	4913
12	Ceiling Fan	156	139	275	233	802.64	4816
13	Washing Machine	-	46	34	744	823.16	4939
14	Computer	-	-	0	0	0.00	0
15	Monoset Pump	50	46	35	35	166.07	996
16	Chiller	-	2	5	3	10.49	63
17	Deep Freezer	0	0	0	119	119.26	716
18	Light Commercial AC				1	0.95	6
	Total Savings (BU)	**19.27**	**20.11**	**18.90**	**12.29**	**70.57**	**423401**

[78] Energy savings estimated for LED on account of sales of 76.14 (1.041 + 75.1) Mn LED are considered under UJALA programme for FY 2018-22. Saving from 473 Mn LED during 2021-22 and saving from 1.041 Mn LED during 2021-22 is considered under S&L programme. Total discounted saving for LED under S&L programme during 2018-22 is 54.63 MU considered in total. Similar approach is used for emission calculations

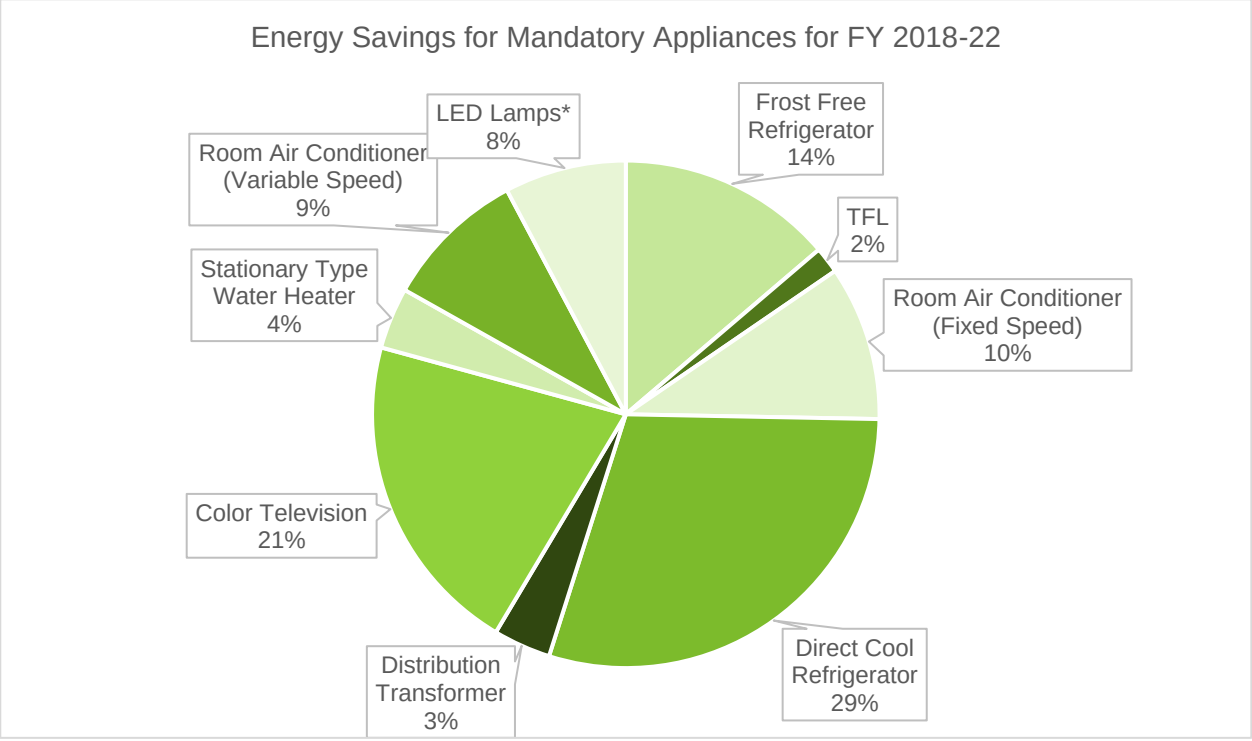
These electrical savings don't include savings incurred due to LPG stove, as the fuel consumed by the domestic stove is LPG, the energy savings achieved due to improving energy efficiency in the appliances is in the form of thermal energy. Accordingly, thermal energy saved in domestic LPG stoves is presented in the table below:

Table 52: Thermal Energy saving due to production of Domestic LPG stoves during 2018-22

Year	Q1	Q2	Q3	Q4	Total (TOE)
2018-19	330	600	558	1232	2720
2019-20	793	1937	974	580	4284
2020-21	1184	2505	2196	1426	7310
2021-22	1812	1213	1141	309	4475
Total (2018-22)					**18,789**

S&L programme has led to savings of 70.57 BU and 18,789 toe during 2021-22 and annual savings of Rs 423.40 Billion due to interventions carried out during the FY 2018-22

The energy savings from each appliance considered in the study (both mandatory and voluntary), is showcased in the form of a pie chart below:



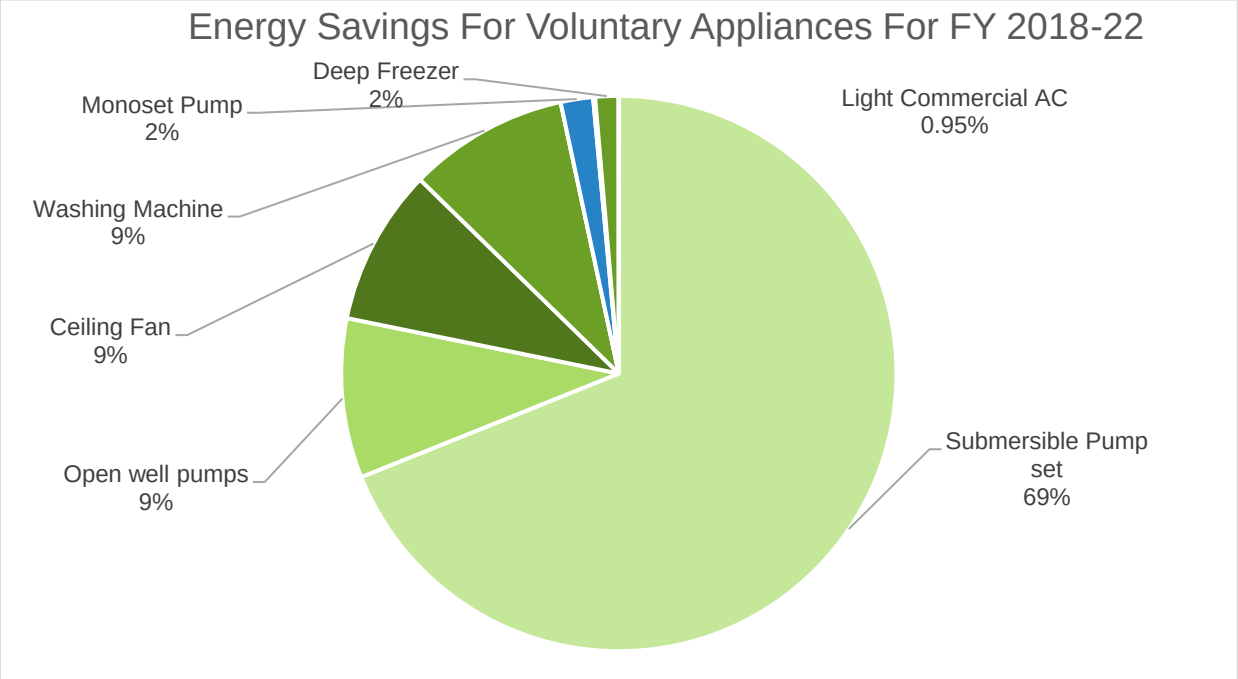


Figure 48: Energy savings analysis for mandatory and voluntary appliances in FY 2018-22

It can be inferred from the figure above that Direct Cool Refrigerator (29%) followed by Color Television (21%) and Frost Free Refrigerator (14%), contributed to 54% of the total energy savings due to mandatory star rated appliances under S&L programme.

Summary of the emission reduction is tabulated in Table 53.[79]

Table 53 : Annual Emission reduction (Mn tCO2) due to S&L programme

S.No	Appliances	FY: 2018-19 (MntCO2)	FY: 2019-20 (MntCO2)	FY 2020-21 (MntCO2)	FY 2021-22 (MntCO2)	FY: 2018-22 (MntCO2)
Mandatory Appliances						
1.	Frost Free Refrigerator	1.764	1.922	1.931	1.264	6.88
2.	TFL	0.296	0.225	0.246	0.077	0.84
3.	Room Air Conditioner (Fixed Speed)	1.453	1.682	1.114	0.680	4.93
4.	Direct Cool Refrigerator	4.108	4.575	3.893	2.226	14.80
5.	Distribution Transformer	0.509	0.307	0.614	0.404	1.83
6.	Color Television	3.037	2.863	2.795	1.653	10.35
7.	Stationary Type Water Heater	0.456	0.539	0.548	0.411	1.95
8.	Room Air Conditioner	0.809	1.101	1.932	0.702	4.54

[79] Note: Emission reduction by the initiatives under the programme is evaluated considering the grid emission factor of 0.81 kg of CO_2 emission reductions per kWh of the energy saved

S.No	Appliances	FY: 2018-19 (MntCO2)	FY: 2019-20 (MntCO2)	FY 2020-21 (MntCO2)	FY 2021-22 (MntCO2)	FY: 2018-22 (MntCO2)
	(Variable Speed)					
9.	LED Lamps*	0.563	1.237	1.236	0.846	3.88
Voluntary Appliances						
10.	Submersible Pump Set and Openwell Pump Set	2.444	1.138	0.719	0.622	4.92
11.	Ceiling Fan	0.000	0.512	0.000	0.151	0.66
12.	Washing Machine	0.126	0.113	0.223	0.188	0.65
13.	Computer	0.000	0.037	0.027	0.603	0.67
14.	Monoset Pump	0.000	0.000	0.000	0.000	0.00
15.	Chiller	0.041	0.038	0.028	0.028	0.13
16.	Deep Freezer	0.000	0.002	0.004	0.003	0.01
17.	Light Commercial AC	0.000	0.000	0.000	0.097	0.10
Total Savings (MntCO2)		**15.61**	**16.29**	**15.31**	**9.95**	**57.16**

Total CO2 emission savings achieved by S&L program, as showcased in the Table 53, for the FY 2018-22:

S&L programme has led to reduction of 57.16 Mn tonne of carbon dioxide emissions during FY 2021-22 due to interventions carried out during the FY 2018-22

Energy Efficiency initiatives by EESL

Apart from the energy efficiency initiative taken by BEE, EESL has also taken several Energy Efficiency initiatives some of which are

Super - Efficient Air Conditioner (SEAC) Program

With the goal of integrating energy efficiency into India's cooling sector, EESL had initiated a first of its kind, Super-Efficient Air Conditioning (SEAC) programme. These Super-Efficient ACs are 5 star rated product and have high 5.4 ISEER and use environment friendly refrigerant with low Global Warming Potential (GEP) and Zero Ozone Depletion Potential (ODP) introduced in the market at competitive prices.

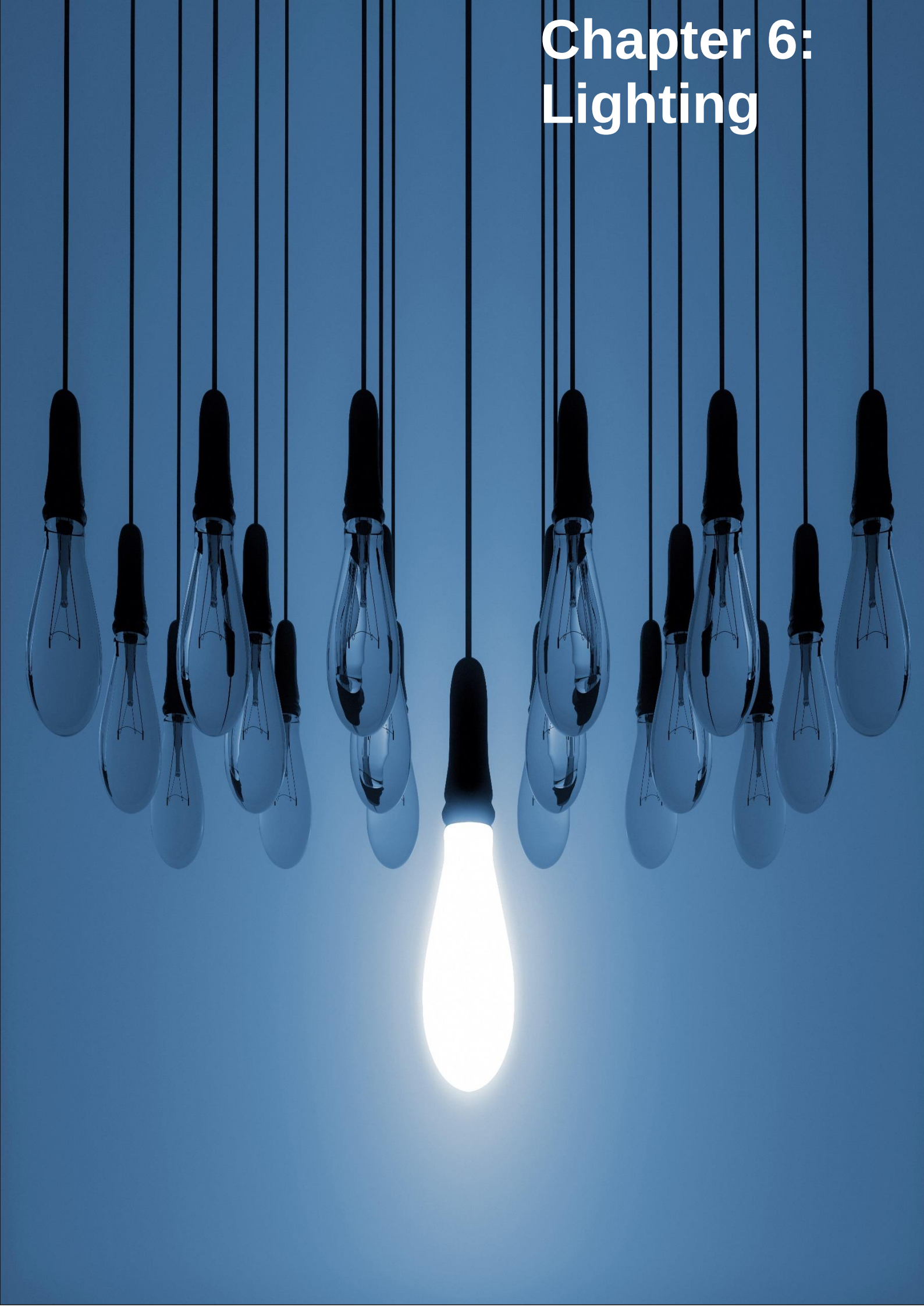
The SEACs provides 1.5-TR cooling capacity at high ambient temperature while also reducing the cost of cooling by 50%. During the financial year 2021 – 22, EESL had sold 926 nos. of Super-Efficient Air Conditioners. As on 31st March 2022, EESL has sold 3,146 Super-Efficient Air Conditioners which lead to an energy saving of 26.5 Lakhs Units annually and CO2 emission reduction of 24 lakh kg CO2e. Further, EESL also supported GEM authority for adding Green AC in its categories of products which are super energy efficient having ISEER 5.4 and above.

Energy Savings from Super-Efficient Air-conditioners (Split AC) Program in FY 21-22			
State	**No. of Super-Efficient Air-conditioners (Split AC) sold**	**Total Electricity Savings (kWh) per annum**	**Total CO2 emission reduction (tCO2) per annum**
PAN India (Residential)	**150**	**141,058.50**	**112.85**
PAN India (Industrial)	**777**	**548,010.33**	**438.41**

Motor Replacement Program

EESL aims to create an infrastructure to accelerate adoption for Higher Efficient Motors Specifically IE3 efficiency class through innovative financing business model & awareness creation. Under this program we are offering IE3 motors ranging from 1HP to 100 HP to the Indian Industries. This program is advantageous for MSME as well as non-MSME industries. EESL is offering Upfront/PMC and EQI/ESCO business modalities to the end users. During the financial year 2021 – 22, EESL has deployed 1,920 nos. of IE3 motors. As on 31st March 2022, 5,280 IE3 motors have been deployed in the industry.

Chapter 6: Lighting



6. *Lighting*

India is witnessing urbanization rate of 31.41%, with present urban population is 377 million, projected to reach 590 million by 2030[80]. As our economies grow and populations expand, the demand for lighting in India will also increase. Lighting is a basic necessity and widely used in everyday life. It is a significant factor contributing to our quality of life and productivity of our workforces. Artificial illumination enables people to work in homes, offices, buildings, and factories. In India, building sector account for 35% of total energy consumption and growing at 8% annually.[81] According to international research, energy consumption for residential and commercial buildings in India is expected to increase by an average of 2.7% per year between 2015 and 2040[82]. It is also projected that among all regions of the world, the fastest growth in buildings energy consumption through 2040 will occur in India[83]. In terms of the saving potential, building sector in India offers a huge opportunity through use of efficient lighting.

Over the past decade, lighting market has seen a bend towards LED lighting technology, which is up to 75% more energy efficient than traditional incandescent and compact fluorescent (CFL) bulbs. India's LED lighting market grew 130-fold within five years, skyrocketing from annual sales of 5m bulbs per year in 2014 to about 670 million in 2018. This resulted in 30 terawatt hours (TWh) of annual energy savings – roughly enough to power 28 million average Indian households[84]. There is a trend towards first-time LED use in low-income households and in regions like Uttar Pradesh, households have leap-frogged from having no electrical lighting straight to LED lights[85].

The key driver of India's market transformation was a policy initiative, known as "Unnat Jyoti by Affordable LEDs for All" or "UJALA", which procured LED bulbs for the national market. UJALA scheme was launched in 2015 by Ministry of Power. This scheme led to LED prices coming down reasonably through the process of bidding, consequentially the bulbs were sold at profitable, but lesser price in comparison to the retail prices through kiosks and vendors. UJALA succeeded in bringing down the retail price of LED bulbs from INR 300-350 per bulb to INR 70-80 per bulb[86]. Energy Efficiency

Image Source: www.pragmaticinstitute.com

80 Source: MoHUA, 2019. Handbook of Urban Statistics, New Delhi: Government of India Press: http://mohua.gov.in/pdf/5c80e2225a124Handbook%20of%20Urban%20Statistics%20 2019.pdf
81 Source: https://www.beeindia.gov.in/sites/default/files/Flyer_22nd%20Jan.pdf
82 Source: https://www.eia.gov/todayinenergy/detail.php?id=33252
83 Source: https://www.eia.gov/todayinenergy/detail.php?id=33252
84 Source: https://www.carbonbrief.org/guest-post-how-energy-efficient-led-bulbs-lit-up-india-in-just-five-years/
85 Source: https://www.carbonbrief.org/guest-post-how-energy-efficient-led-bulbs-lit-up-india-in-just-five-years/
86 Source: https://www.pib.gov.in.

Services Limited (EESL), a government company under the administrative control of Ministry of Power, Government of India, has been designated as the implementing agency for this program.

As on 31 March 2022, EESL distributed 10.50 lakh LED bulbs covering all 36 States and Union Territories (UTs.) This resulted into estimated energy savings of 47.78 billion kWh per year, and avoided peak demand of 9567 MW and GHG emission reduction of 38.70 million CO_2 per year[87].

Also, as on 31st March 2022, EESL distributed **52,451 LED tube lights** resulting in estimated energy savings of **316.17 million kWh per year** with avoided peak demand of 144 MW and GHG **emission reduction of 259.26 kilotons CO2 per year[88]**. EESL also distributed **56,674** BEE 5 Star rated energy efficient ceiling fans which resulting into an estimated **energy savings of 219.40 million kWh per year** with avoided peak demand of 59 MW and GHG **emission reduction of 179.91 kilotons CO2 per year**.

The Unnat Jyoti by Affordable LEDs for All (UJALA) observed the need for DISCOMs to invest in the upfront cost of LED bulbs. EESL has evolved a service model where it works with electricity distribution companies (DISCOMs) through a benefit sharing approach The upfront investment made by EESL is paid back in two different ways as indicated under:

(a) DISCOM Cost Recovery: The investments of EESL are recovered from the DISCOMs as annuity over a period of 3-10 years by monetizing the energy savings that accrue as a result of replacement of incandescent lamps with LEDs. Each replacement leads to a reduction of connected load by 53W. The energy savings are monetized based on the peak procurement cost of DISCOM and is used to pay back the investment made by EESL under an approval by the State Electricity Regulatory Commission.

(b) On Bill Financing (OBF): Cost recovery from consumers by deduction of easy instalments of 12.66 INR every month for 8-12 months. The entire cost of the LED bulbs, including the awareness, distribution and cost of capital is recovered from the consumer bills.

6.1 Methodology for estimation of the saving

Methodology adopted for the energy saving for the UJALA program is illustrated in the figure below:

[87] Source: https://eeslindia.org/wp-content/uploads/2022/09/Annual-Report-FY-2021-22.pdf
[88] Source: http://ledtubes.ujala.gov.in/

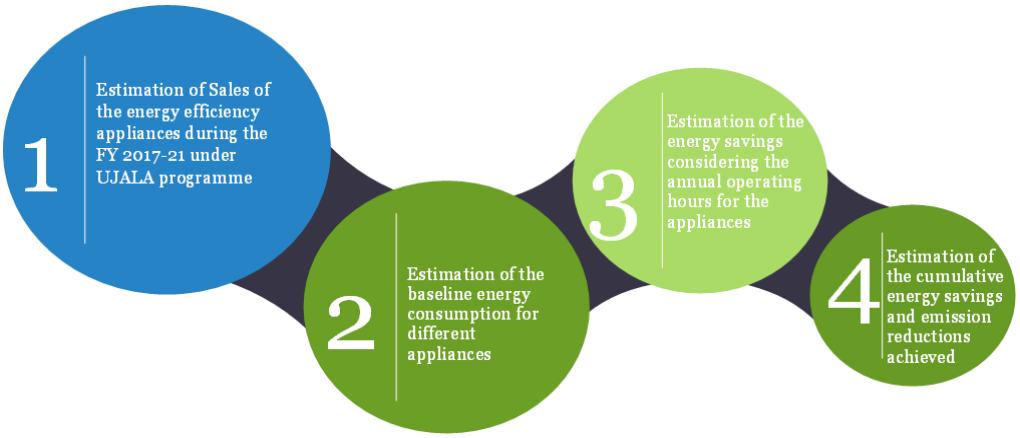


Figure 49: Methodology for estimation of Saving under UJALA scheme

Total number of different appliances retrofitted under UJALA programme is shown in the table below:

Table 54: Sales of appliances under UJALA programme

Year	Number of units distributed (Million)		
	LED bulbs	LED Tube lights	EE Fans
2018-19	58.2	1.52	0.57
2019-20	12.03	0.24	0.11
2020-21	4.98	0.103	0.043
2021-22	1.04	0.052	0.056
Total	**76.25**	**1.915**	**1.783**

The distribution of the LED lamps in the FY 2021-22 across Indian states have been shown in the figure below:

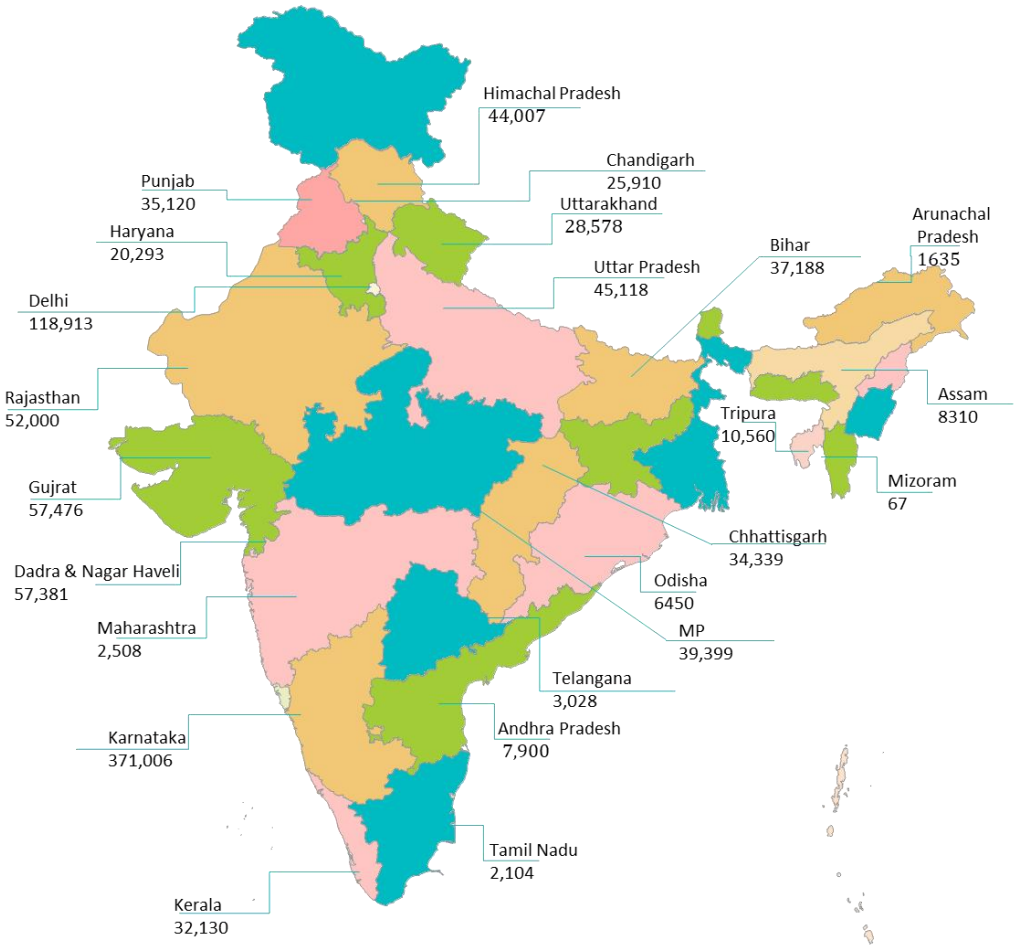


Figure 50: LED Lamps distribution across different states

As per the figure above, Karnataka has the highest distribution of the LED bulbs followed by Delhi under the UJALA programme, in the FY 2021-22.

Baseline power consumption and power consumption of the energy efficient appliance replaced under the programme is tabulated in table 3:

Table 55: Power saving estimation per appliance

Appliance	Base line wattage of appliance	Wattage of energy efficient appliance	Reduction in wattage
LED Lamp[89]	59	9	50
LED tube light	40	20	20
EE Fan[90]	75	50	25

[89] 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
[90] 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 are 16 hours a day and with average operation of 240 days a year. Number of LED installed are presented in Energy saving estimations are tabulated in Table 56: Number of LED bulbs distributed across different states

Table 56: Number of LED bulbs distributed across different states

S. No.	States/UTs	No. of LED lamps distributed in Millions				Total No. (Millions) FY: 18-22	Energy saving (MU) FY 18-22
		FY 18-19	FY 19-20	FY 20-21	FY 21-22		
1.	Andaman & Nicobar Islands	0.01	0.0	-	-	-	-
2.	Andhra Pradesh	0.19	0.01	0.00	0.01	1.03	1.03
3.	Arunachal Pradesh	0.32	0.01	0.00	0.00	0.21	0.21
4.	Assam	4.95	0.10	0.01	0.01	1.08	1.08
5.	Bihar	1.41	0.20	0.05	0.04	4.83	4.83
6.	Chandigarh	0.11	0.01	-	0.03	3.36	3.36
7.	Chhattisgarh	0.98	0.13	0.15	0.03	4.46	4.46
8.	Dadra & Nagar Haveli	0.04	0.03	-	0.06	7.45	7.45
9.	Daman & Diu	0.04	0.02	-	-	-	-
10.	Delhi	0.45	0.25	-	0.12	15.44	15.44
11.	Goa	0.0	0.0	-	-	-	-
12.	Gujarat	1.31	0.37	0.22	0.06	7.46	7.46
13.	Haryana	0.84	0.08	0.02	0.02	2.64	2.64
14.	Himachal Pradesh	0.34	0.23	0.14	0.04	5.72	5.72
15.	Jammu & Kashmir	0.26	0.01	-	-	-	-
16.	Jharkhand	1.38	0.14	0.34	-	-	-
17.	Karnataka	2.75	1.21	0.62	0.37	48.18	48.18
18.	Kerala	0.33	0.14	0.03	0.03	4.17	4.17
19.	Madhya Pradesh	1.34	0.50	0.07	0.04	-	5.19
20.	Maharashtra	0.26	0.02	0.01	0.00	-	0.33
21.	Manipur	0.29	0.03	-	-	0.32	-
22.	Meghalaya	0.22	0.0	-	-	0.22	-
23.	Mizoram	0.09	0.0	0.00	0.00	0.09	0.01
24.	Nagaland	0.25	0.05	-	-	0.3	-
25.	Odisha	32.33	7.02	-	0.01	39.36	0.84
26.	Puducherry	0.03	0.0	-	-	0.03	-
27.	Punjab	0.38	0.12	1.57	0.04	2.11	4.56
28.	Rajasthan	1.46	0.33	0.09	0.05	1.93	6.75
29.	Sikkim	0.04	0.0	0.00	-	0.04	-
30.	Tamil Nadu	1.84	0.42	0.15	0.00	2.41	0.27

S. No.	States/UTs	No. of LED lamps distributed in Millions				Total No. (Millions) FY: 18-22	Energy saving (MU) FY 18-22
		FY 18-19	FY 19-20	FY 20-21	FY 21-22		
31.	Telangana	0.28	0.01	1.26	0.00	1.55	0.39
32.	Tripura	0.29	0.01	0.02	0.01	0.33	1.37
33.	Uttar Pradesh	1.97	0.31	0.08	0.05	2.41	5.86
34.	Uttarakhand	0.63	0.23	0.06	0.03	0.95	3.71
35.	West Bengal	0.80	0.05	0.00	-	0.85	-
36.	**Total**	**58.2**	**12.0**	**4.89**	**1.05**	**76.14**	**135.32**

Table 57: Energy saving from UJALA programme[91]

Year	Energy savings (MU): LED lamps	Energy savings (MU): LED Tube lights	Energy savings (MU): EE Fans
FY 18-19	7,436	57	55
FY 19-20	1,533	8.7	10
FY 20-21	630	4.52	3.96
FY 21-22	135.32	2.30	5.25
Total	**9734**	**73**	**74**

LED's contribute to 98.51% of the total energy savings under the programme, and tube lights contribute 0.73% of the savings and EE fans contribute 0.74% of the savings[92]. CO_2 emission reductions are calculated considering the grid emission factor as 0.81 kg/kWh[93].

***UJALA programme has led to energy savings of 9.8 BU** during 2021-22 on account of the implementations carried out during the FY 2018-22*

[91] Saving of the fans is considered under S&L programme
[92] Source: https://eeslindia.org/wp-content/uploads/2022/09/Annual-Report-FY-2021-22.pdf
[93] Source: https://cea.nic.in/wp-content/uploads/baseline/2023/01/Approved_report_emission__2021_22.pdf

UJALA has successfully distributed more than **100 million LED lamps** across **120 cities** in India resulting in a wide range of multiple benefits, such as:

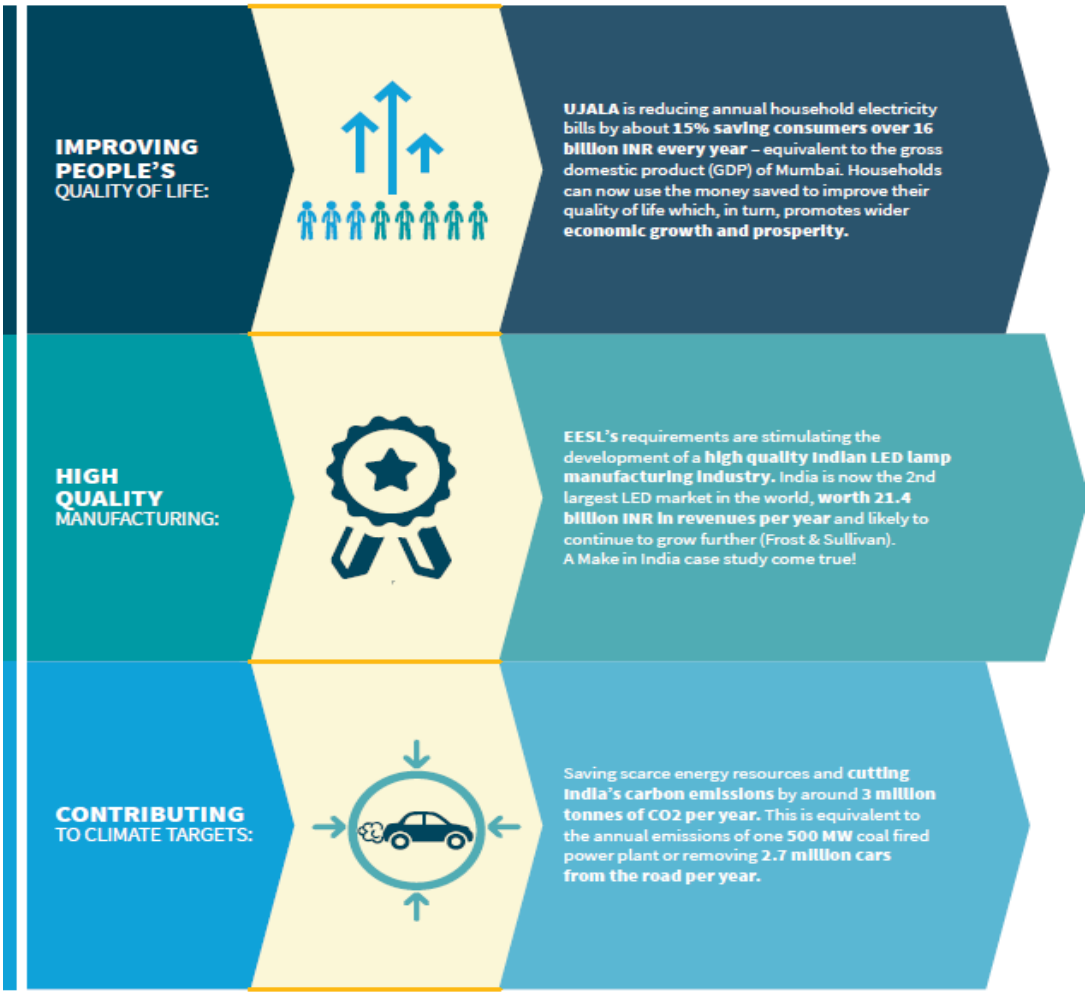
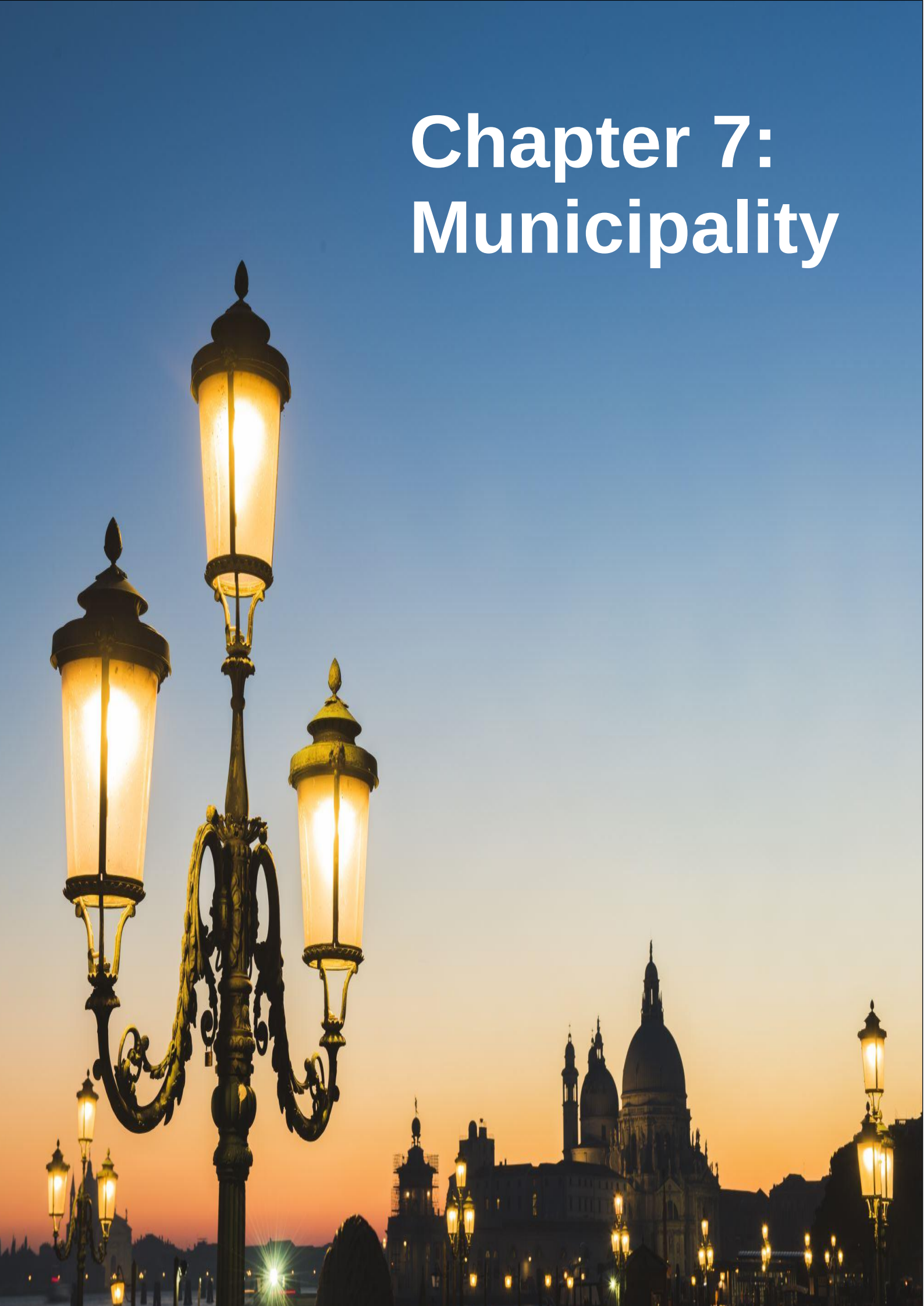


Figure 51: Outcomes of UJALA Scheme

Chapter 7: Municipality



7. *Municipality*

India is witnessing rapid economic growth and steady population growth. At present, 34% of India's population lives in urban areas, and it is estimated that more than 50% of the country's population will be urban by 2050[94]. By 2030, it is expected to be the most populous country in the world and one of the largest consumers of energy. The National Institution for Transforming India (NITI) Aayog also estimated that in 2031-2032, India will need 2,628 billion Units (BUs) of electricity, which is more than double the current demand of 1,049 BU[95]. Energy demand of public utilities and municipal services is also expected to grow by many folds as the infrastructure of the country develops to meet the growing urbanization.

India 's municipal sector consumes around 4% of total electricity consumed in the country and is deemed to be the second largest opportunity for energy conservation, accounting for 23% of energy use inefficiency in the country[96]. 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. The energy requirement in ULBs is showcased in the figure below:

Figure 52: Energy Requirement in ULBs

The energy consumption of the municipality sector is characterized by frequent changes and rising peaks in power load curves in the morning hours due to water pumping and evening hours for street lighting. The inefficient use of electricity due to limited diffusion of energy

[94] Source: https://nudm.mohua.gov.in/about/
[95] Source: https://shaktifoundation.in/wp-content/uploads/2016/04/Vol-12-Journal-of-Governance.pdf
[96] Source: BEE annual report 2021-22

efficiency technology have considerably increased the energy consumption, thereby resulting in high operating costs of the municipalities.

Municipalities have been facing the challenge of high operating costs due to inefficient energy usage. Public lighting and public water work account for 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[97]. As per a study, municipal sector holds 23% energy saving potential[98] The consumption of energy and electricity under the municipal activities has varied peak in power loads, for example, water pumps consume energy during the morning and streetlights consume electricity after sunsets. This is also leads to limited diffusion of energy efficiency technology and lack of alignment in demand side management.

BEE has identified immense energy saving potential in the municipal sector. The Municipal Demand Side Management (MuDSM) initiative aims to increase efficiency of the Urban Local Bodies (ULBs) with the purpose of generating energy savings and henceforth reducing operational cost for the ULBs.

7.1 Municipal Demand Side Management (MuDSM)

Identifying the immense energy saving potential in municipal sector, BEE initiated Municipal Demand Side Management (MuDSM) during XI plan. the basic objective of the MuDSM, is to improve the overall energy efficiency of the ULBs which can lead to substantial savings in the electricity consumption thereby resulting in cost reduction and savings. MuDSM is a mechanism to conserve consumers' energy consumption pattern in accordance with the utility's energy production and distribution capacity. It aims to provide cost effective ways to balance electric supply and demand. ESCOs are being encouraged to take up implementation of the programme with financing from institutions like banks, etc.

The objective of the program is to improve energy efficiency in water pumping, sewage pumping, street lighting and public buildings across Urban Local Bodies (ULBs) in the country

Capacity building programmes for the officials of ULBs/UDDs/Municipalities/pump-technicians conducted by BEE:

Under MuDSM programme, stakeholder engagements and capacity building initiatives across the country of the officials of Urban Local Bodies (ULBs), Public Water Bodies, Urban Development Directorates (UDDs), Municipal Corporations (MCs), SERCs, and pump technicians were conducted by Bureau of Energy Efficiency.

To promote the Energy Efficiency in Municipality sector following interventions were taken:

- Capacity building workshops for the officials of Urban Local Bodies(ULBs), Public Water Bodies, Urban Development Departments (UDDs) and other implementing agencies

[97] Source: https://beeindia.gov.in/sites/default/files/Impact%20Assessment_Print_Final.pdf
[98] Source: https://bee-staging.demosl-02.rvsolutions.in/sites/default/files/publications/files/BEE%20Annual%20Report%20-%20%28English%20Final%29.pdf

- BEE in coordination with SDAs is organizing various capacity buildings workshops for the officials of ULBs, public water bodies, urban development departments. In 2021-22, 57 no. of capacity building programmes for the officials of Urban Local bodies (ULBs), Urban Development Directorates (UDDs) and Municipalities on Energy Efficiency measures in municipality sector have been conducted covering around 3400 no. of officials from different ULBs, UDDs and MCs in around 10 states[99].
- Preparation Of training content/training module/tutorials for pump technicians/ ULB/UDD/MC officials. In order to make the training program more interesting and interactive, BEE in coordination with SDAs is developing tutorial videos on MuDSM (especially on Energy Efficient pump sets and its benefits).

The details of such capacity building workshops conducted from the FY 2021-22 is given in the figure below:

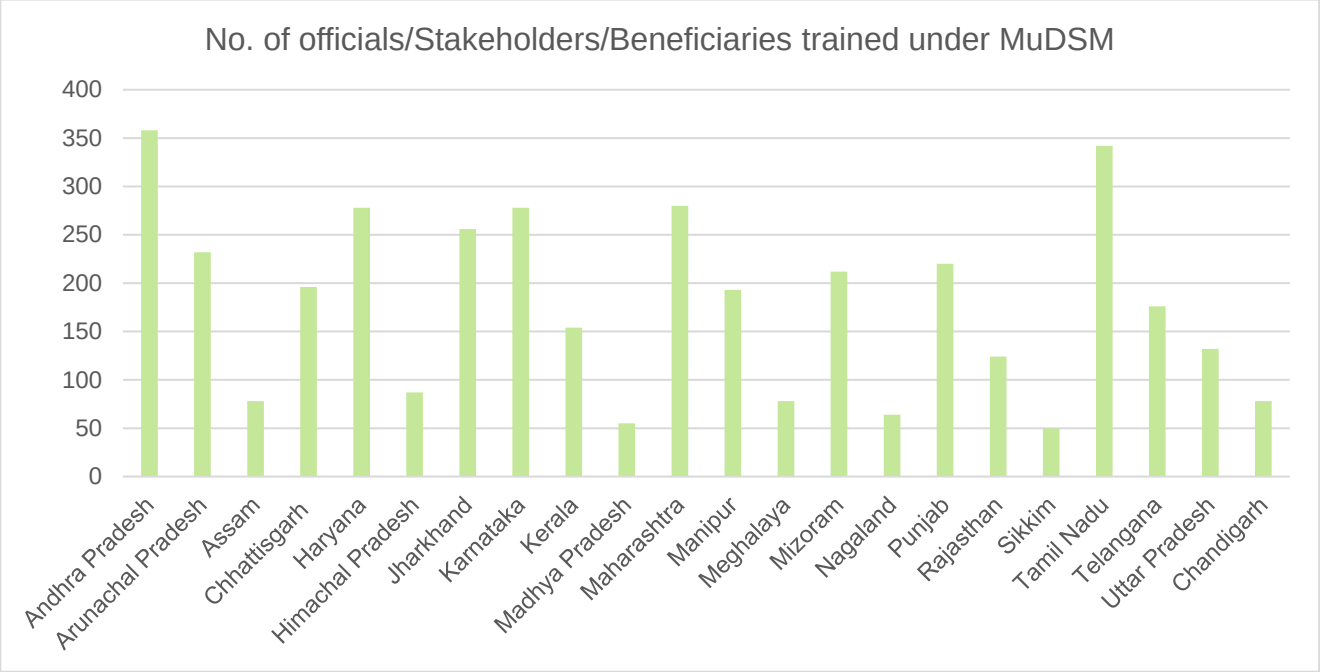


Figure 53: No. of officials/Stakeholders/Beneficiaries trained under MuDSM in the FY 2021-22

Programmes operational under MuDSM by BEE and EESL to improve the energy efficiency across streetlighting pumping system is discussed in the section below:

7.1.1. Street Lighting National Programme (SLPN)

In India, city streetlights have not been a focus area for the local governments to operate efficiently. As a result, energy consumption for city street lighting in India is very high. Public lighting in India consumes 7,753 GWh of electrical energy. India's 35 million streetlights consume 1.5 percent of the country's energy[100]. The energy saving potential in the public lighting is estimated to be 30% of the total energy consumed by the public lighting system.

As the nation witnesses economic growth and constant urbanization, it will have to respond with infrastructure that is sustainable and profitable for the government. Street lighting loads

[99] Source: BEE Annual report 2021-2
[100] Source: http://dcmsme.gov.in/Street%20light%20fittings.pdf

require electricity during peak demand hours, and thus it's imperative to adopt energy efficient measures in Street lighting systems. Keeping this in view, Street Lighting National Programme was launched by Hon'ble Prime Minister, on 5th January 2015, to replace conventional streetlights with smart and energy efficient LED streetlights across India. Energy Efficiency Services of India (EESL) has been entrusted to execute the project.

Under the Street Lighting National Program (SLNP), EESL replaces conventional streetlights with smart and energy efficient LED streetlights across India, at its own costs, without any need for municipalities to invest. The consequent reduction in energy and maintenance cost of the municipality is used to repay EESL over a period of time. Usually, the contact duration between EESL and municipalities is of 7 years, where it not only guarantees a minimum energy saving (of-typically 50%) but also provides free replacements and maintenance of lights at no additional cost to the municipality.

EESL's LED lamps have a Central Control Monitoring System (CCMS), which allows remote monitoring and operation of the installed streetlights. This ensures that streetlights are automatically switched on once the sun sets and switched off after dawn. The system also sends alerts for each light that needs attention, to reduce failure and the need for sudden repair. Therefore, the avoided capacity of electricity can be ascertained from the reduced consumption of electricity. The system also helps note the exact consumption of energy, which is used to define the cost to be paid.

Over **69.27 Lakh LED** Lights have been installed in the FY 2018-22

Methodology for energy saving estimations

Energy savings due to number of inefficient streetlights that have been replaced by LED streetlights during FY 2018-22, are calculated. To calculate the energy (electrical) savings and emission reduction, following steps are used:

Step-1: Identification of the lights installed during the FY 2018-22

Total number of lights installed during the FY18 -22 are presented in the table below:

Table 58: State wise installations of LED streetlights[101]

S. No.	States/UTs	No. of LED streetlights installed during FY 2018-22				Total Number of LED lights installed (Lakhs)
		2018-19	2019-20	2020-21	2021-22	2018-22
1	Andaman & Nicobar Islands	136	1,237	258	-	0.02
2	Andhra Pradesh	1,505,402	357,639	970	10674	18.75
3	Assam	2,757	17,086	-	180	0.20

[101] EESL has installed a cumulative total of 5,74,413 lights across various states and UTs during FY 2018-22

S. No.	States/UTs	No. of LED streetlights installed during FY 2018-22				Total Number of LED lights installed (Lakhs)
		2018-19	2019-20	2020-21	2021-22	2018-22
4	Bihar	176,471	250,920	105,866	59650	5.93
5	Chandigarh	548	1,534	1,995	702	0.05
6	Chhattisgarh	82,136	58,606	-	3210	1.44
7	Delhi	250	26,078	17,400	20240	0.64
8	Goa	0	2,866	-	73	0.03
9	Gujarat	35,632	5,081	230	2638	0.44
10	Haryana	52,596	16,340	4,515	446	0.74
11	Himachal Pradesh	515	3,789	3,318	2160	0.10
12	Jammu & Kashmir	0	74,728	18,896	11184	1.05
13	Jharkhand	1,380	389,493	31,692	4200	4.27
14	Karnataka	290	2,428	-	124	0.03
15	Kerala	30,032	46,768	161,639	183125	4.22
16	Lakshadweep	0	1,000	-	-	0.01
17	Madhya Pradesh	22,518	35,567	33,730	80392	1.72
18	Maharashtra	326,110	420,956	105,613	116490	9.69
19	Odisha	254,397	29,601	4,657	-	2.89
20	Puducherry	50	0	-	-	0.00
21	Punjab	52,866	29,288	7,056	12626	1.02
22	Rajasthan	79,712	68,827	3,642	16891	1.69
23	Sikkim	0	0	-	205	0.00
24	Tamil Nadu	0	1,010	-	-	0.01
25	Telangana	49,926	161,403	196,942	136843	5.45
26	Tripura	1,559	375	625	-	0.03
27	Uttar Pradesh	323,644	204,178	113,868	74579	7.16
28	Uttarakhand	8,715	12,304	16,561	59751	0.97
29	West Bengal	5,568	59,690	3,400	6043	0.75
Total (Lakhs)		**30.13**	**22.78**	**8.32**	**8.02**	**69.27**

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 the table below:

Table 59: Energy savings 2018-22 from Street-Lighting programme:

Sr. No.	FY	Number of Installations	Number of States	Annual energy savings in BU
1.	2018-19	3,013,210	24	2.356
2.	2019-20	2,278,792	27	2.022

3.	2020-21	832,873	21	1.529
4.	2021-22	802426	23	0.53
	Total	**9,635,558**		**6.437**

Step-3: Estimation of the emission reduction [102]

The state wise energy savings and emission reduction achieved under the SLNP programme is showcased in the table below:

Table 60: Energy saving and emission reduction from SLNP programme (state wise)

S.No.	States/UTs	No. of LED streetlights installed in FY 2018-22	Energy Savings in FY 2018-22 (MU)	Emission reduction (MntCO2)
1	Andaman & Nicobar Islands	1631	-	-
2	Andhra Pradesh	1874685	1,552.37	0.005
3	Assam	20023	23.99	0.000
4	Bihar	592907	409.27	0.028
5	Chandigarh	4779	31.01	0.000
6	Chhattisgarh	143952	267.66	0.001
7	Delhi	63968	71.06	0.009
8	Goa	2939	84.50	0.000
9	Gujarat	43581	505.25	0.001
10	Haryana	73897	57.17	0.000
11	Himachal Pradesh	9782	28.64	0.001
12	Jammu & Kashmir	104808	77.98	0.005
13	Jharkhand	426765	346.00	0.002
14	Karnataka	2842	8.35	0.000
15	Kerala	421564	284.17	0.085
16	Lakshadweep	1000	-	-
17	Madhya Pradesh	172207	149.05	0.037
18	Maharashtra	969169	676.07	0.054
19	Odisha	288655	-	-
20	Puducherry	50	-	-
21	Punjab	101836	82.76	0.006
22	Rajasthan	169072	267.68	0.008
23	Sikkim	205	0.72	0.000
24	Tamil Nadu	1010	-	-
25	Telangana	545114	879.10	0.063
26	Tripura	2559	-	-
27	Uttar Pradesh	716269	799.69	0.035
28	Uttarakhand	97331	82.94	0.028

[102] http://www.cea.nic.in/reports/others/thermal/tpece/cdm_co2/user_guide_ver13.pdf

S.No.	States/UTs	No. of LED streetlights installed in FY 2018-22	Energy Savings in FY 2018-22 (MU)	Emission reduction (MntCO2)
29	West Bengal	74701	60.23	0.003
	Total	**6927301**	**6745.67**	**0.371**

SLNP programme has led to energy savings of 6.74 billion units and reduction of 0.371 million tonnes of CO_2 emissions during FY 2021-22 on account of the implementations carried out during the FY 2017-21.

7.1.2. Municipal Energy Efficiency Programme (MEEP)

India is home to one of the world's biggest municipal systems, but also it is plagued by high operating expenses in the supply of water. Anywhere between 40% to 60 % of energy costs arise only from supplying water, and an estimated 4800 million units in electricity is wasted every year due to inefficient water pumps[103]. India has immense potential to tap into savings from Municipal sector which includes retrofitting inefficient municipality pump sets.

To facilitate market transformation on a large scale in India, MEEP is being implemented in conjunction with Atal Mission for Rejuvenation and Urban Transformation (AMRUT), an initiative that will enable replacement of inefficient pumps in Public Water Works & Sewerage Systems at no upfront cost to the Municipal bodies. The investment will be recovered from the savings in energy.

AMRUT and EESL along with the Ministry of Housing and Urban Affairs deploying more efficient pumps in 500 cities. EESL will replace inefficient pumps in public water works and sewerage systems at no upfront cost to the municipal bodies. EESL is aggregating demand for these pumps from Urban Local Bodies (ULBs) and leveraging the resulting economies of scale to bring down their cost, making them a more attractive investment. With the deployment of superior, energy efficient pumps, and their reliability underpinned by 7 years of repair and maintenance, urban residents will be assured of uninterrupted supply, while states benefit from lower municipal energy bills and reduced water wastage.

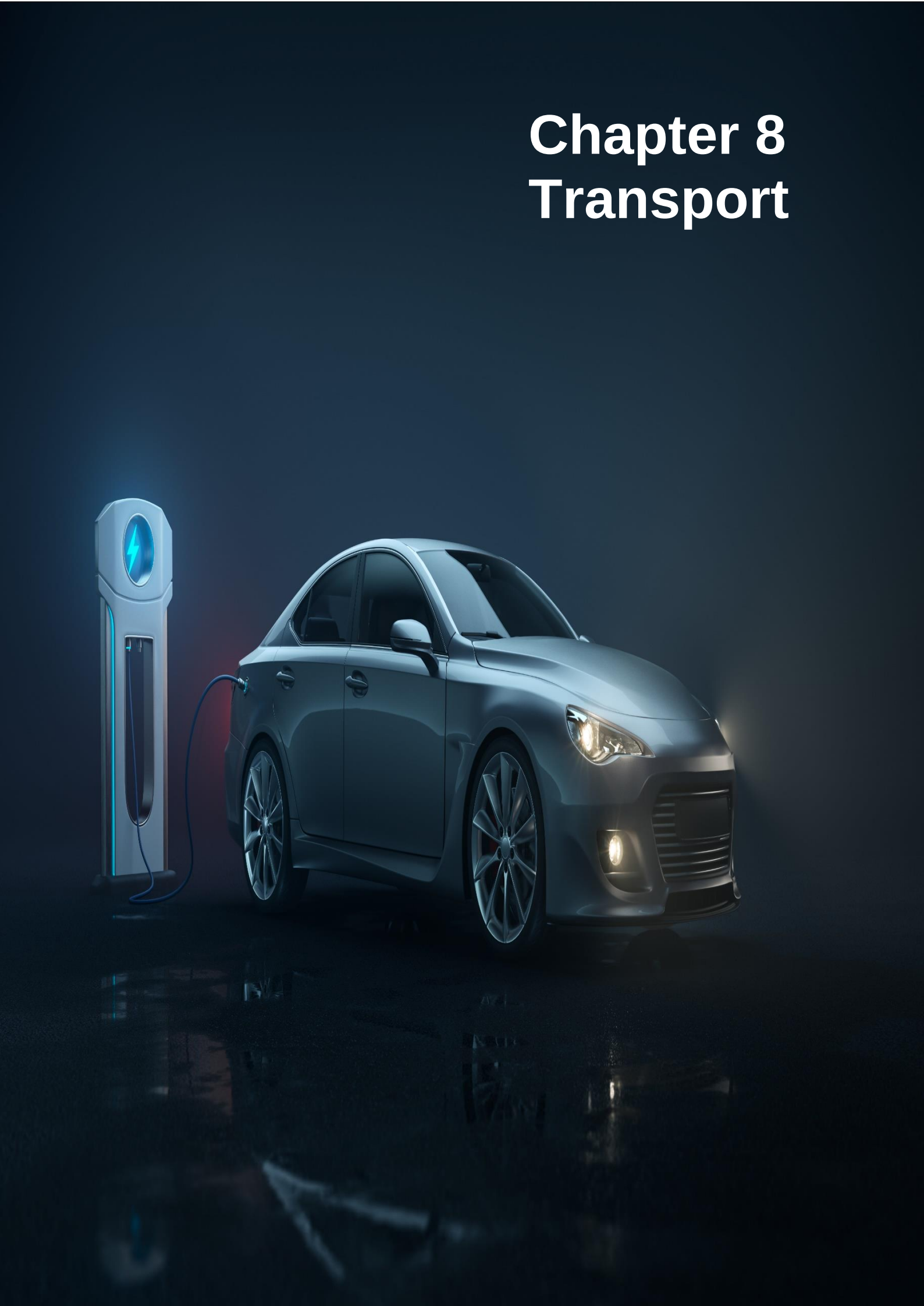
As on 31st March 2022, IGEA studies for 338 cities have been successfully conducted and reports were submitted. EESL has signed implementation agreements with 39 ULBs in the state of West Bengal and the project is presently being implemented in a phased manner. Till 31st March 2022, 18 pumps have been replaced in Khardah, and 12 more has been also installed in Bankura, West Bengal where the total number of pumps installed is 30. The savings of more than 20% have been achieved as mentioned in Third Party saving report for Khardah[104].

[103] Source: https://eeslindia.org/
[104] Source: EESL Annual Report 2021-22; Pg 11

EESL will also overlook 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 maintains the dashboard where the detailed status of the program is made online for the public: https://meep.eeslindia.org/dashboard/.

IGEA studies for **338 cities** have been successfully conducted and EESL has signed implementation agreements with **39 ULBs**

Chapter 8
Transport



8. *Transport*

A well-knit and coordinated system of transport plays an important role in the sustained economic growth of a country. It impacts the pace, structure and pattern of development. Increased economic activity in past decade has leads to growing income per capita; as standards of living rise and the demand for personal transportation increases, from a non-motorized mobility to a motorized has seen multifold rise in past decade in India.

In a country like India, the importance of transport is more because of its vastness as well as varied nature of geographical conditions. The present Indian transport system comprises several modes including rail, road, coastal shipping, air transport, etc. Transport has recorded a substantial growth over the years both in terms of length and output of the system.

The Road Transport Sector accounts for about 87% of passenger traffic and 60% of freight traffic movement in the country[105]. Easy availability, adaptability to individual needs and the cost savings are some of the factors which go in favour of road transport. Road transport also acts as a feeder service to railway, shipping, and air traffic.

With increasing demand for motorized transport, consumption of petroleum products has experienced steady growth over time. Petroleum products have experienced a steady growth over time. From a figure of 157.06 MTs during 2012-13 to 214.13 MTs during 2019-20 i.e., a growth of 36% over a span of 7 years. However, during FY:2020-21 the same has been decreased by 9.26% and stood at 194.30 MTS primarily because of COVID-19 pandemic. During FY:2021-22 the same has shown a positive growth rate of 5.77% and stood at 204.23 MTs. The figure below showcases the consumption of petroleum products over the years 2016-2022:

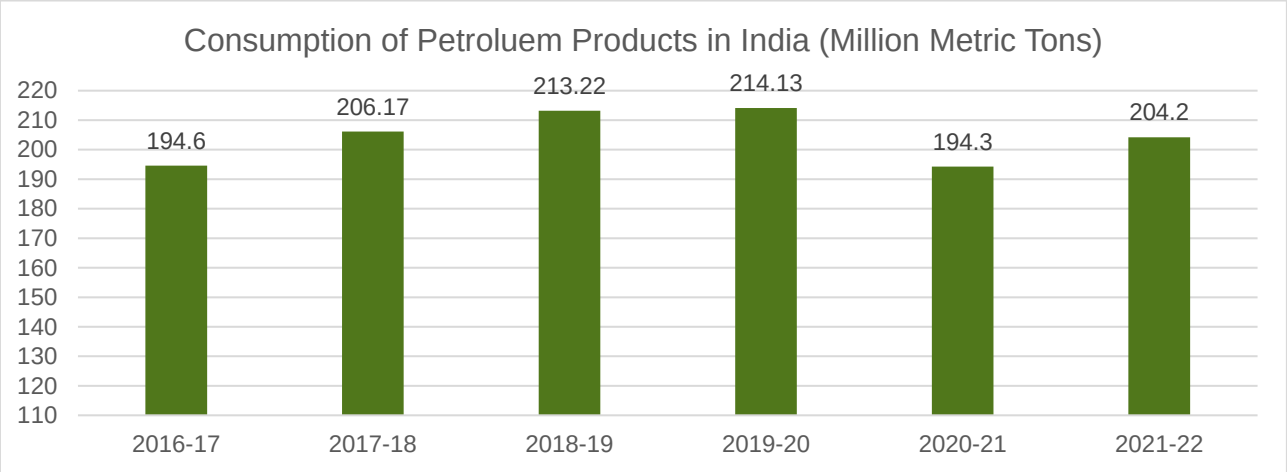


Figure 54: Total Consumption of Petroleum Products in India[106]

Among all the products the High-Speed Diesel (HSD) accounted for 37.55% of total consumption. This was followed by Petrol (15.10%), LPG (13.87%), Pet Coke (7.72%). The consumption of various types of petroleum products is depicted in figure below:

[105] Source: Ministry of Road Transport and Highways
[106] Source: Energy Statistics Report 2023, MoSPI

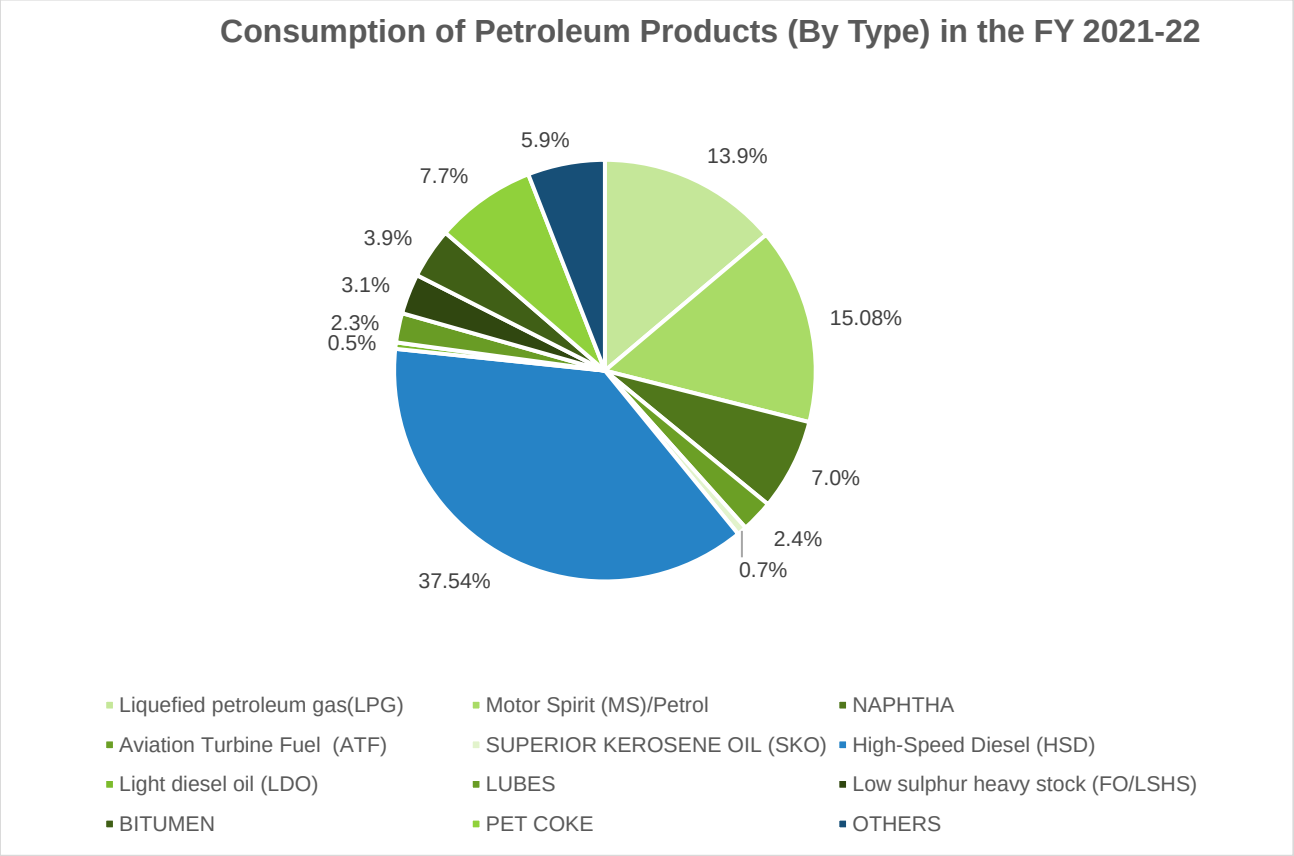


Figure 55: Consumption of Petroleum Products- by type during FY 2021-22[107]

Among all the Petroleum Products the HSDO, which has the highest share of consumption (37.55%) during FY 2021-22, experienced a positive growth of 5.47% over last year. The Petrol and Pet-Coke are also having a growth of 10.30% and 1.07% respectively over last year. The LPG has registered a positive growth during FY 2021-22; with a growth of 2.80% over last year it has stood at a figure of 28.33 MTs in 2021-22, as compared to 27.56 MTs during 2020-21[108].

The Government has come out with Automotive Mission Plan (AMP) 2016-26 which will help the automotive industry to grow and will benefit Indian economy. The rapidly globalizing world is opening newer opportunities for the transportation industry, especially while it makes a shift towards electric, electronic and hybrid cars, which are deemed more efficient, safe, and reliable mode of transportation

The Automobile industry is very important driver of economic growth of India. India is expected to be the world's third-largest automotive market in terms of volume by 2026[109].The Indian automotive industry produces a wide variety of vehicles: passenger cars, light, medium and heavy commercial vehicles, multi-utility vehicles such as jeeps, two wheelers that include scooters, motorcycles and mopeds, three-wheelers, tractors and other agricultural equipment.

[107] Source: Energy Statistics India 2023, MoSPI
[108] Source: Energy Statistics India 2023, MoSPI
[109] Source: An Overview of Automobile Industry in India https://ijcrt.org/papers/IJCRT2108158.pdf

The automobile sector of India is showcased be Figure 56: Overview of Indian Automobile Sector

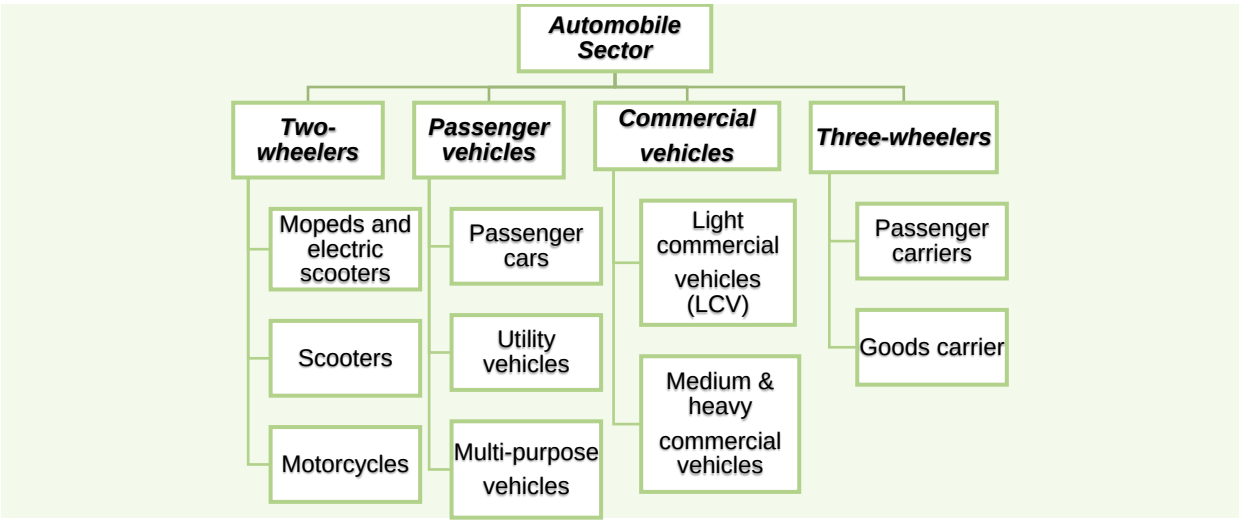


Figure 57:Overview of Indian Automobile Sector

Two wheelers and passenger vehicles dominate the domestic Indian auto market. Passenger car sales are dominated by small and midsized cars. Two-wheelers and passenger cars accounted for 76.9% and 17.5% market shares, respectively, in FY22. The market share by vehicle type and the total vehicle sale in India between FY17-FY 21 is presented in the figure below.[110]

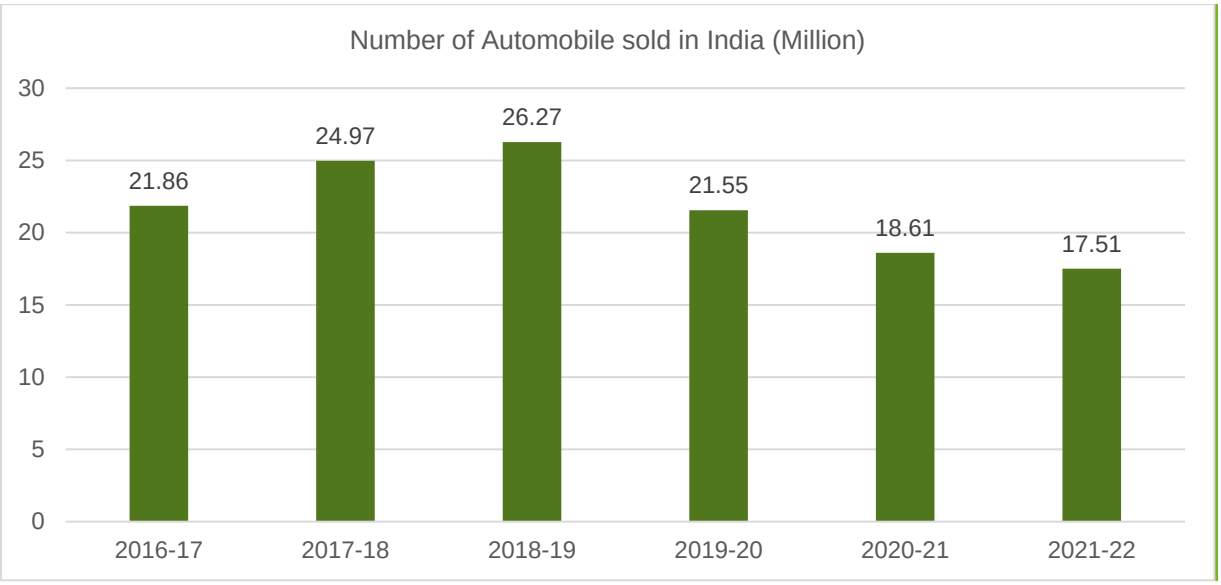


Figure 58 : Sales of Automobiles

Two wheelers and passenger vehicles dominate the domestic Indian auto market Passenger car sales are dominated by small and midsized cars Two wheelers and passenger cars accounted for 76.9% and 17.5% market shares respectively, in FY 2021-22.[111]

[110] Source: https://www.ibef.org/download/1673935106_Automobile-Nov2022.pdf
[111] Source: IBEF

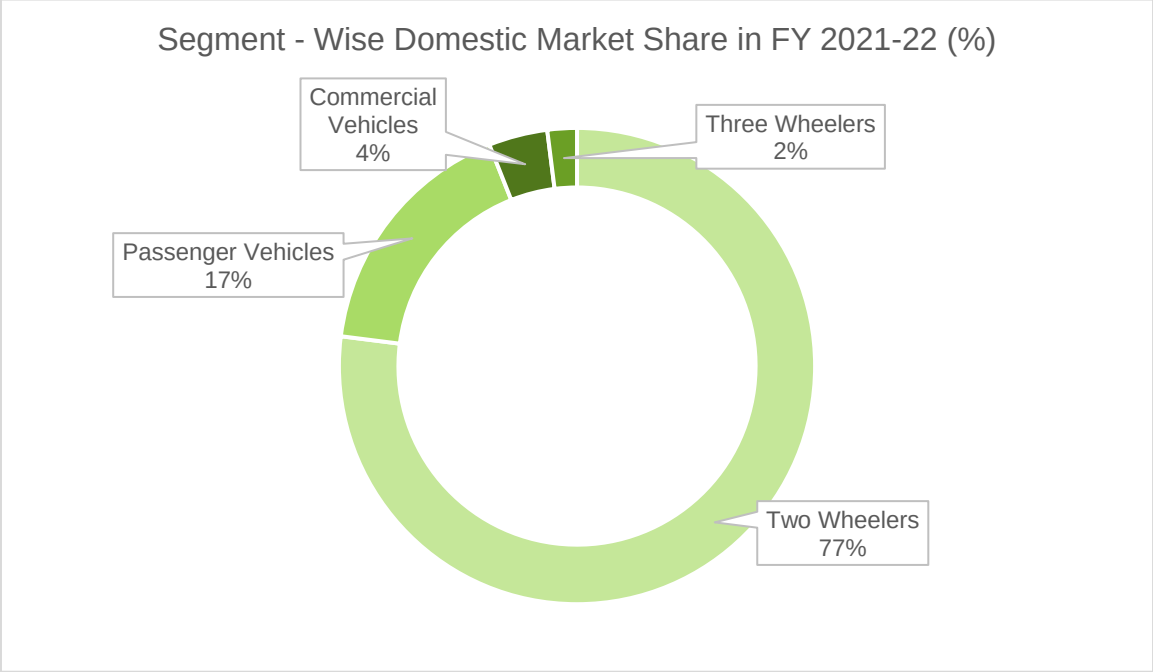


Figure 59 : Segment wise % sales of Automobiles

The Indian automobile industry has historically been a good indicator of how well the economy is doing, as the automobile sector plays a key role in both macroeconomic expansion and technological advancement. The Indian automobile industry contributes almost 6.4% of India's GDP and 35% of manufacturing GDP and is a leading employment provider[112]. India could be a leader in shared mobility by 2030, providing opportunities for electric and autonomous vehicles.

India enjoys a strong position in the global heavy vehicles market as it is the largest tractor producer, second-largest bus manufacturer, and third-largest heavy trucks manufacturer in the world. India's annual production of automobiles in FY 2021-22 was 22.93 million vehicles.

The automotive manufacturing industry comprises the production of commercial vehicles, passenger cars, three & two-wheelers. The Indian auto industry is expected to record strong growth in FY 23, post recovering from the effects of the COVID-19 pandemic. Electric vehicles, especially two wheelers, are likely to witness positive sales in FY23. A report by India Energy Storage Alliance estimated that the EV market in India is likely to increase at a CAGR of 36% until 2026. In addition, projection for the EV battery market is forecast to expand at a CAGR of 30% during the same period The trend of automobile production in India is shown in the figure below[113].

[112] Source: https://www.ibef.org/industry/india-automobiles
[113] Source: https://www.ibef.org/download/1673935106_Automobile-Nov2022.pdf

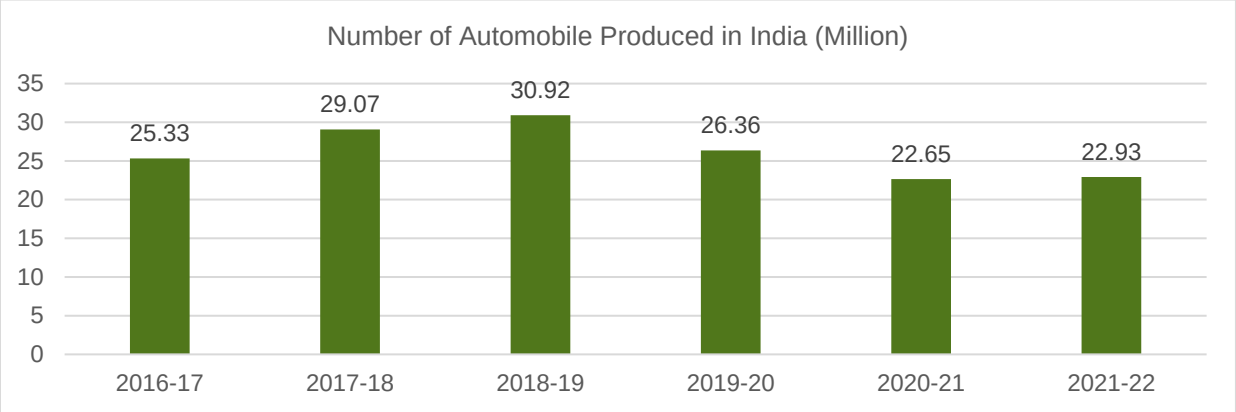


Figure 60: Production details of Automobiles

Indian automotive industry is targeting to increase export of vehicles by five times during 2016-22. In FY22, total automobile exports from India stood at 5.61 million wherein there is 36% increase in export of vehicles as compared to FY 21. Indian automobile exports of two wheelers stood at 4,443,018 in FY22.

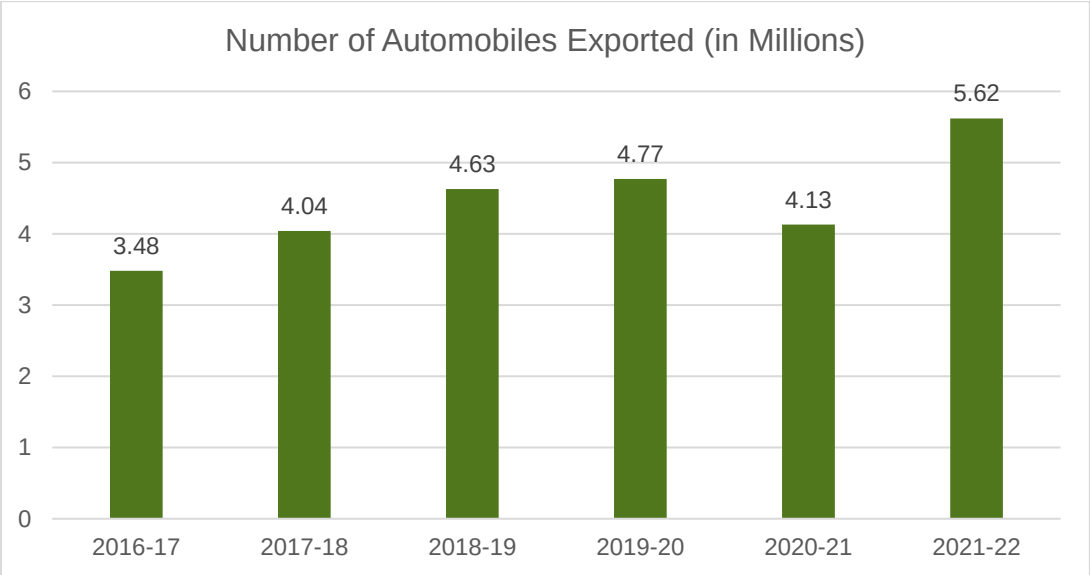


Figure 61: Number of Automobiles Exported from FY 17-22

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

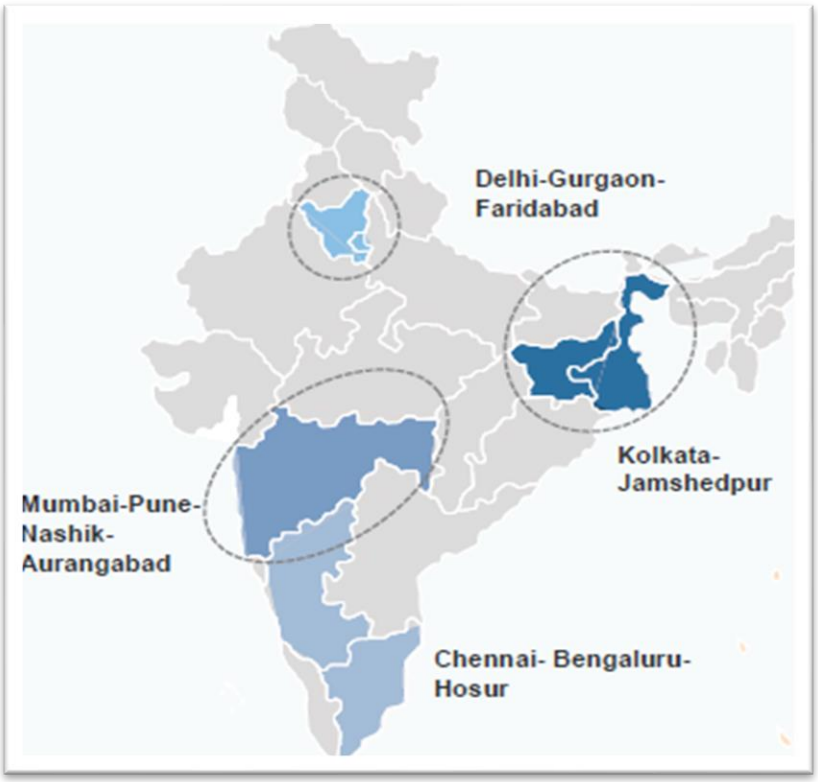


Figure 62: Major automobile manufacturing clusters in India[114]

North	West	East	South
• 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	• Ashok Leyland • Bajaj Auto • FIAT • GM • M&M • Eiche • Skoda • Bharat Forge • Tata Motors • Volkswagen • Renault Nissan • John Deere • Mercedes • Benz • Tata Hitachi • Volvo Eicher	• Tata Motors • Hindustan Motors • Simpson & Co • International Auto Forgings • JMT • Exide	• Ashok Leyland • Ford • M&M • Toyota Kirloskar • , Volvo • Sundaram Fasteners • Enfield • Hyunda • BMW • Bosch • TVS Motor Company • Renault Nissan • TAFE • Daimler • Caterpillar • Hindustan Motors

Table 61: Cluster wise leading companies[115]

Each segment in the Indian automobiles sector have few established key players, who hold a major portion of the market.

8.1. Vehicular pollution in India

Air pollution is one of the serious environmental concerns where majority of the population is exposed to poor air quality. The health-related problems such as respiratory diseases, risk of

[114] https://www.ibef.org/download/1673935106_Automobile-Nov2022.pdf
[115] https://www.ibef.org/download/1673935106_Automobile-Nov2022.pdf

developing cancers and other serious ailments etc. due to poor air quality are known and well documented. Besides the health-related issues, 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.

Most of the Indian Cities are also experiencing rapid urbanization and the majority of the country's population is expected to be living in cities within a span of next two decades. Since poor ambient air quality is largely an urban problem this will directly affect millions of the dwellers in the cities. The rapid urbanization in India has resulted in a tremendous increase in the number of motor vehicles, as showcased in the above section. As the number of vehicles continues to grow and the consequent congestion increases, vehicles are now becoming the main source of air pollution in urban India.

Automotive vehicles emit several pollutants depending upon the quality of the fuel they consume and engine efficiency. The release of pollutants from vehicles also includes fugitive emissions of the fuel and the source and level of these emissions depending upon the vehicle type, its maintenance, etc. The major pollutants released as vehicle/fuel emissions are, carbon monoxide (CO), nitrogen oxides (NOx), photochemical oxidants, air toxics, namely benzene (C6H6), aldehydes, 1,3 butadiene (C4H6), lead (Pb), particulate matter (PM), hydrocarbon (HC), oxides of sulphur (SO2) and polycyclic aromatic hydrocarbons (PAHs). While the predominant pollutants in petrol/gasoline driven vehicles are hydrocarbons and carbon monoxide, the predominant pollutants from the diesel-based vehicles are Oxides of nitrogen and particulates.[116]

As stated above, air pollution from motor vehicles is one of the most serious and rapidly growing problems in urban centers of India. The problem of air pollution has assumed serious proportions in some of the major metropolitan cities of India and vehicular emissions have been identified as one of the major contributors in the deteriorating air quality in these urban centers. The problem has further been compounded by the concentration of large number of vehicles and comparatively high motor vehicles to population ratios in these cities. Reasons for increasing vehicular pollution problems in urban India are as below:

[116] Source: Status of the Vehicular Pollution Control Programme in India, CPCB

India is taking many significant steps in responding to air pollution challenge. The Government of India is envisaging a revision of its the ambient air quality standards and has strengthened vehicular and industrial emission standards in recent years. A strong emphasis on expanding renewable energy, promoting electric vehicles, and supplying LPG cooking fuel to millions of households are some examples of the actions India is taking to combat air pollution. 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.

8.2. Savings under Corporate Average Fuel Economy (CAFE) implementation

The Government of India, Ministry of Power, issued average fuel consumption standards for cars on 23rdApril 2015.This standard is applicable for the motor vehicle using petrol or diesel or liquefied petroleum gas or compressed natural gas, which carry passengers and their luggage and comprising not more than nine seats including driver's seat, and of Gross Vehicle Weight not exceeding 3,500 kilograms tested.

The fuel consumption standards would be effective from 2017-18 onwards, and a second set of standards would come into force from 2022-23. The standards relate the Corporate Average Fuel Consumption (in liters/100 km) to the Corporate Average Curb Weight of all the cars sold by a manufacturer in a fiscal year.

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.

8.3. Methodology to calculate savings under CAFE norms

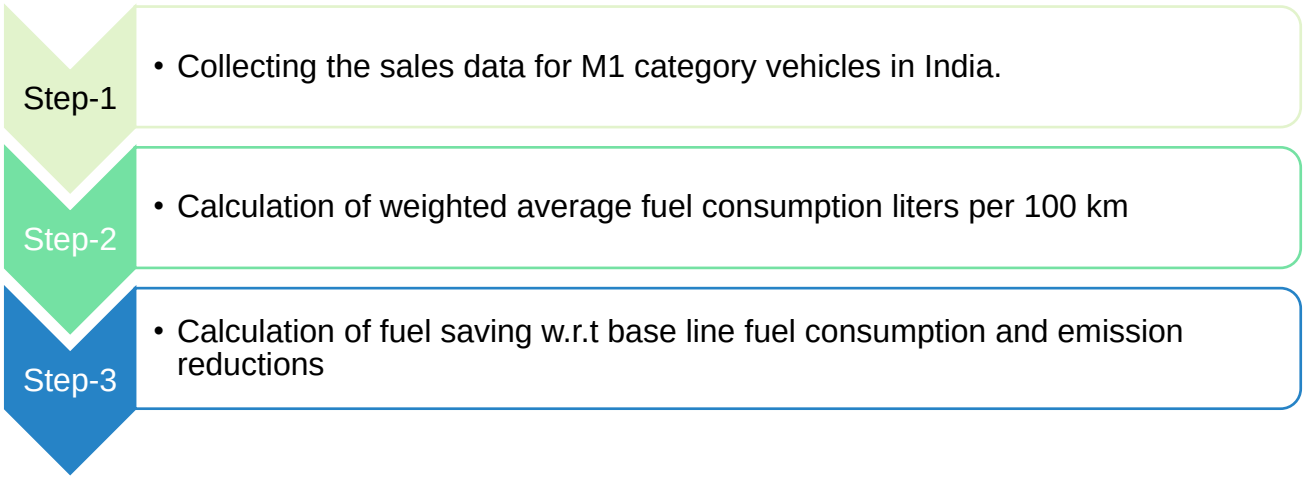


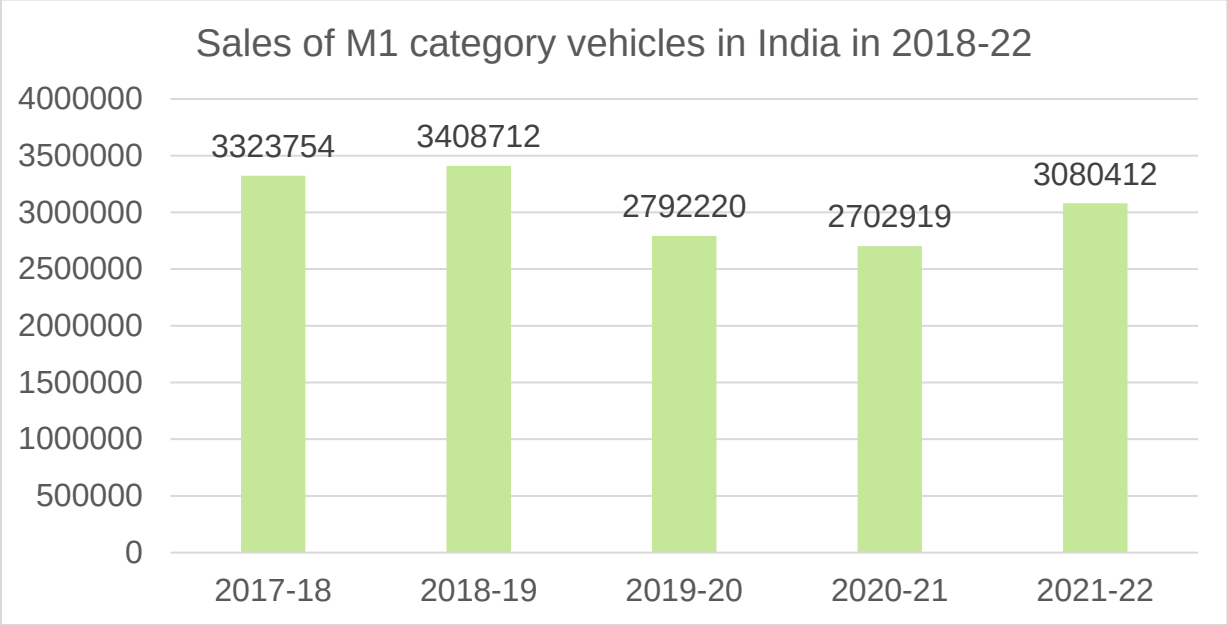
Figure 63 : Methodology for saving calculation under CAFE norms

8.4. Energy and emission saving calculations

Sales data for M1 vehicle category was received from ICAT and is presented in Table 62 and Figure 64 (including petrol, diesel, CNG, EVs including includes pure electric, plug in hybrid and strong hybrid models):

Table 62: Sales of M1 category vehicles in India in 2018-22

2017-18	2018-19	2019-20	2020-21	2021-22
3323754	3408712	2792220	2702919	3080412



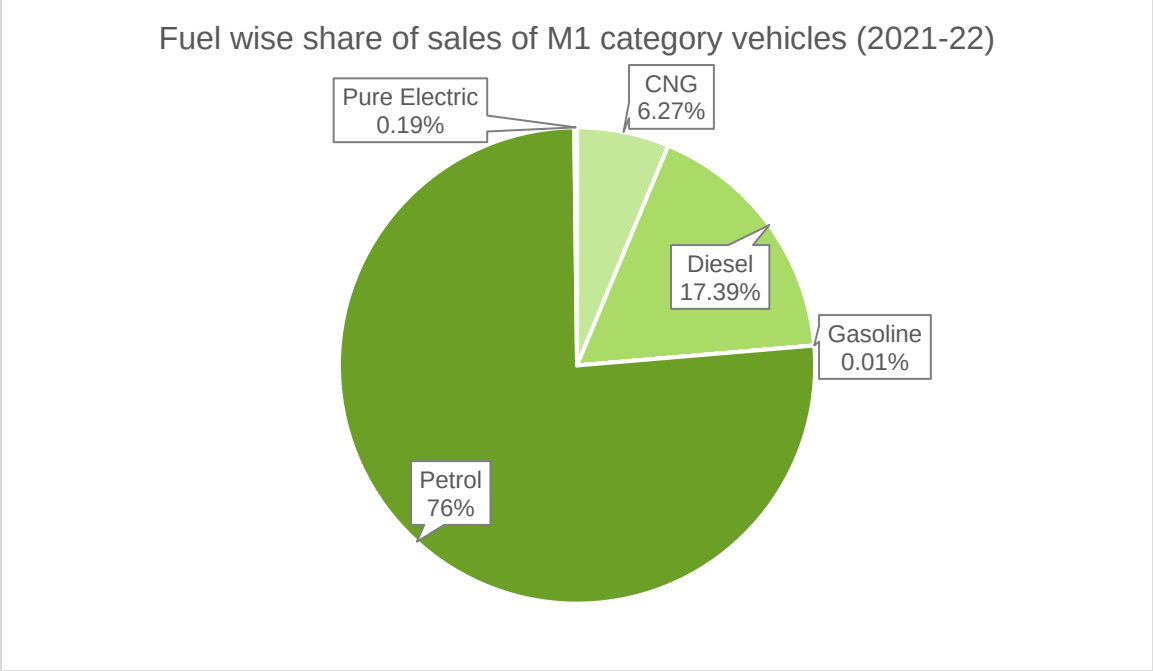


Figure 64: Fuel wise share of sales of M1 category vehicles (FY 2021-22)

Share of the petrol vehicles is highest (76.15%) followed the by the sales of the diesel vehicle (17.39%). Sales of the CNG vehicles were only 6.27% during the FY 2021-22.

Step-2: Calculation of fuel consumption per 100 km

The fuel consumption per 100 km for the vehicles sold during FY 2018-22 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.*

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 the year 2020-21 in petrol equivalent is shown in Table 63

Table 63: Fuel savings (in Mtoe) for the FY 2021-22

	Sales of M1 category vehicles (21-22)	Petrol saving for 10,000 Kms (Litres)[117]
Grand Total	3080412	482212234.7

The cumulative energy savings in TOE for the FY 2018-22 is showcased in the table below:

Table 64: Cumulative energy savings for FY 2018-22

Year	Savings in Mtoe
2018-19	0.43
2019-20	0.35
2020-21	0.31
2021-22	0.38
Cumulative 2018-22	**1.888**

The CO_2 emission savings for 2018-22 is presented in Table 65:

Table 65: CO_2 emission savings (in $MTCO_2$)

Year	CO_2 emission reductions (Million tCO2)
2018-19	1.32
2019-20	1.08
2020-21	0.92
2021-22	1.09
Cumulative 2018-22	**4.41**

8.5. Accelerating E-mobility adoption in India

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. The transport sector accounts for 18% of total energy consumption in India.

[117] Assumptions taken for savings calculation:
a) GCV is taken as 11200 kCal/kg
b) Density is taken as 0.7087 kg/Litre
c) 10,000 running kms per annum per vehicle considered
d) Different fuels consumed by M1 category vehicles are converted into petrol equivalent for calculating the fuel savings

This translates to an estimated 94 million tonnes of oil equivalent (MTOE) energy. If India were to follow the current trends of energy consumption, it would require an estimated 200 MTOE of energy supply annually, by the year 2030 to meet the demand of this sector.[118]

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 mobility brings multi-dimensional benefits for India. Improved air quality, reduced dependence on imported fuel, reduced emission of Greenhouse Gases (GHG), improved plant load factor for the electricity grid, and the opportunity to be a leader within a rapidly growing global market, are among some of these benefits

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.

While electric vehicles have been talked about for several decades, it is only in the last few years that it has seen a significant growth, largely due to:

- Increasing energy density of batteries that enables EVs to travel longer distances on a single charge.
- Emergence of battery swapping, in addition to charging, as a way of re-energizing batteries and enabling the use of smaller batteries so that EV costs are reduced.
- The increasing concerns relating to climate change coupled with the increasing share of clean renewables in the electricity mix of countries.

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

[118] https://beeindia.gov.in/content/e-mobility

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. India benefits immensely through a transition to electric mobility. Primarily it will enjoy the following gains:

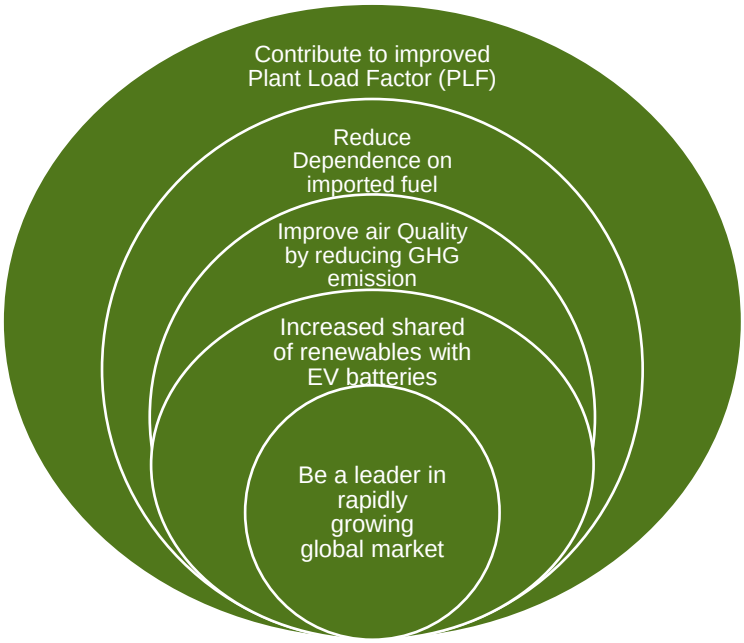


Figure 65: Benefits of transition to electric mobility

To reduce pollution caused by diesel and petrol operated vehicles and to promote electric or hybrid vehicles in India, the Central Government launched the Fame India Scheme in 2015.

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

FAME-I

The National Electric Mobility Mission Plan (NEMMP) 2020 is a National Mission document providing the vision and the roadmap for the faster adoption of electric vehicles and their manufacturing in the country. As part of the NEMMP 2020, Department of Heavy Industry formulated a Scheme viz. Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) Scheme in the year 2015 to promote manufacturing of electric and hybrid vehicle technology and to ensure sustainable growth of the same.

The Phase-I of this Scheme was initially launched for a period of 2 years, commencing from 1st April 2015, which was subsequently extended from time to time and the last extension was allowed up to 31st March 2019.

The 1st Phase of FAME India Scheme was implemented through four focus areas namely:

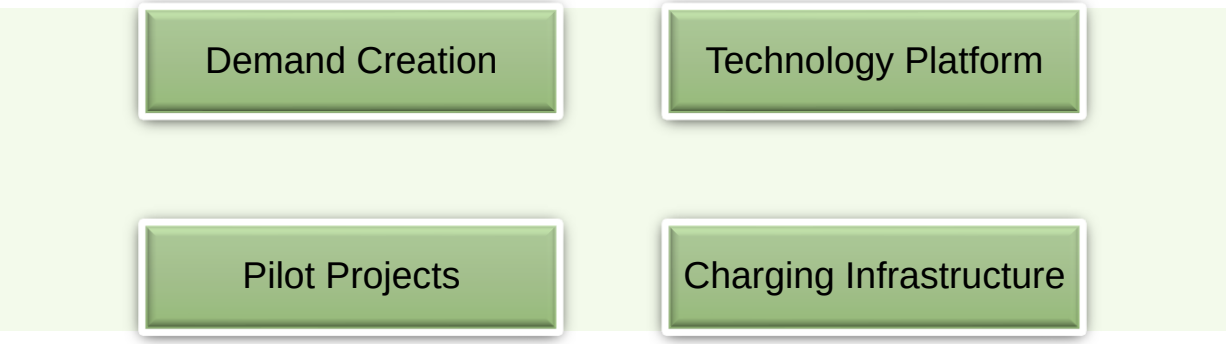


Figure 66: Focus Areas of FAME India

Market creation through demand incentives was aimed at incentivizing all vehicle segments i.e. 2-Wheelers, 3-Wheelers Auto, Passenger 4-Wheeler vehicles, Light Commercial Vehicles and Buses.

The scheme was one of the most important green initiatives of the Government of India, which will be one of the biggest contributors to reduction of pollution from the road transport sector. Phase-1 of the scheme was approved initially for a period of 2 years, commencing from 1st **April 2015 *i.e.* FY 2015-16 and FY 2016-17, with an outlay of 795 crore**. The duration of Phase-1 of the scheme was extended from time to time and the last extension was allowed up to 31st March 2019, with enhancement of total outlay to **895 crores**.

The funds were used to provide direct subsidy to the EV buyers. Along with direct subsidy, grants for specific projects under pilot projects were sanctioned along-with financial support for R&D/technology development and public charging infrastructure. Under the FAME-I scheme, 465 buses were sanctioned to various cities/states.

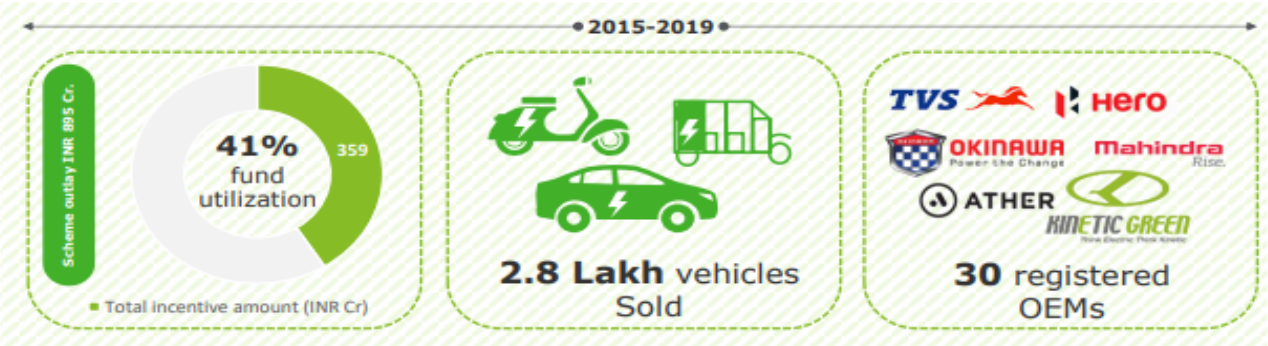


Figure 67: Snapshot of FAME I Scheme

Image Source: Niti Aayog

Achievements of Phase-1 of FAME India Scheme:

Electric Vehicles Supported	Projects Suported	Electric Buses Supported	Charging Stations Supported
•2.8 Lakh hybrid and electric vehicles supported •Resulted in saving of about **97 million liters of fuel and reduction of about 242 million Kg of CO2**	•Projects worth about ` 158 Crores are sanctioned for the technology development projects •Establishment of testing Infrastructure, setting up of 'Centre of Excellence' for Advanced Research in electrified transportation, Battery Engineering etc.	•Supported for deployment of 425 Electric buses in about 9 cities by way of incentive amounting to Rs 280 crore (Approx.). •An additional 80 million litres of fuel about 180 million kg of CO2 is expected to be saved during the lifetime of bus.	•Sanctioned Projects for setting up of 520 charging stations for Rs 43 crore (Approx.) in various cities •Out of these 520 Charging stations, 461 charging stations as on 21st Jan, 2022 have been installed

Figure 68: Achievement of Phase-1 of FAME India

FAME-II

Based on the experience gained during Phase 1 of FAME Scheme and suggestions of various stakeholders, the Department of Heavy Industry notified Phase-II of the Scheme, with the approval of Cabinet. Phase-II of the scheme is for a period of 3 years, commencing from 1st April 2019, with an outlay of INR 10,000 crore. Timeline of FAME India Scheme[119]:

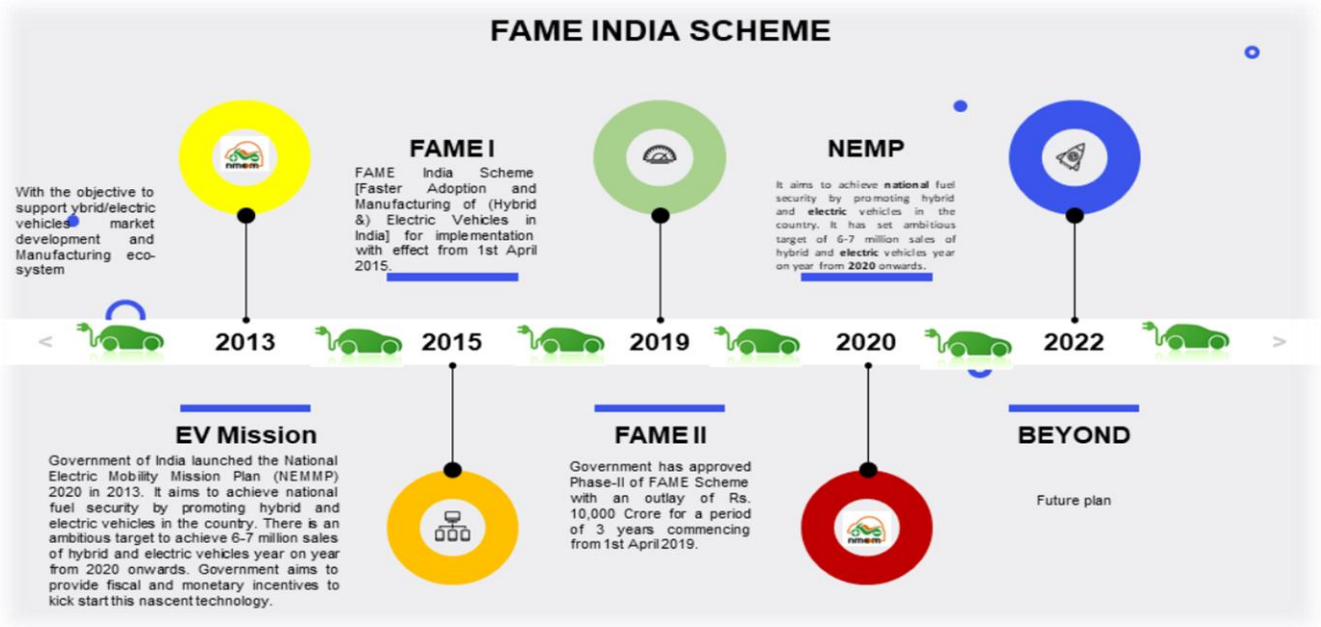


Figure 69: Timeline of FAME Scheme

The main objective of the scheme is to encourage faster adoption of Electric and hybrid vehicles by way of offering upfront Incentive on purchase of Electric vehicles and also by establishing the necessary charging Infrastructure for electric vehicles. The scheme will help

[119] Source: https://fame2.heavyindustries.gov.in/content/english/16_1_Timeline.aspx

in addressing the issues of environmental pollution and fuel security. The subsidies that have been provided under the scheme is presented in Table 66:

Table 66: 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

In the second phase of the FAME scheme, more emphasis will be given on:

- Electrification of public transportation, that includes shared transport
- Demand Incentives on operational expenditure model for electric buses will be delivered through State/city transport corporation (STUs).
- In 3W and 4W segments, incentives will be applicable mainly to vehicles used for public transport or registered for commercial purposes. In the e-2Ws segment, focus will be on private vehicles.
- The Scheme aims to create demand by way of supporting 7090 e-Buses, 5 lakh e-3 Wheelers, 55000 e-4 Wheeler Passenger Cars and 10 lakh e-2 Wheelers.
- Creation of charging infrastructure will be supported in selected cities and along major highways to address range anxiety among users of electric vehicles under the Scheme.

The Salient features of FAME India Scheme Phase II is depicted in the figure below:

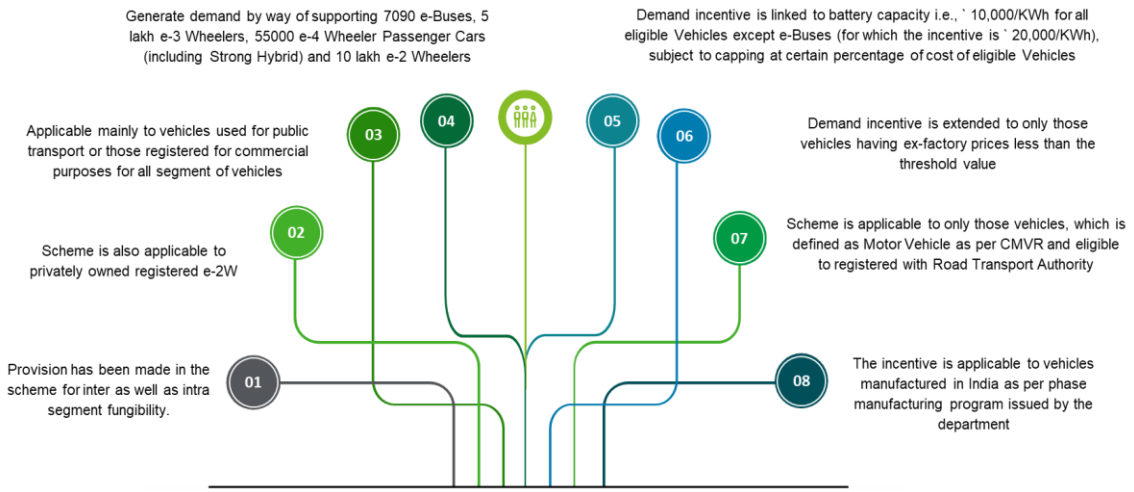


Figure 70: Salient features of FAME India Scheme Phase II

So far, as of 21st January 2022, 50 OEMs have registered their 103 EV Models for availing benefit of demand incentives under Phase-II of FAME Scheme as showcased in the table below[120]:

Table 67: Registered OEMs in FAME II till January 2022

Registered OEMs			Total Registered OEMs
Electric 2W	Electric 3W	Electric 4W	
15	33	2	**50**

Table 68 : Registered EV Models in FAME II till January 2022

Registered EV models			Total Registered EV models
Electric 2W	Electric 3W	Electric 4W	
33	63	7	**103**

About 220117 EVs have been incentivized to the eligible user of the electric vehicle under the FAME II Scheme as shown in the table below[121]:

Table 69: Sale of Electric Vehicles in FAME II till January 2022

Sale of Electric vehicles			Total Sale of EVs for availing benefits
Electric 2W	Electric 3W	Electric 4W	
184180	33874	2063	220117

Initiative for development of the Public Charging EV Infrastructure

The availability of user-friendly public charging infrastructure is one of the key requirements for accelerating the adoption of electric vehicles in India. In this regard, the Ministry of Power recently issued the revised consolidated Guidelines and Standards for EV charging infrastructure on January 14, 2022. The Government of India has undertaken multiple initiatives to promote the manufacturing and adoption of electric vehicles in the country. With the considerable expansion in the public EV charging infrastructure, the electric vehicles have started penetrating the Indian market.

Table 70: Electric Vehicle Sale in India[122]

Category	2018-19	2019-20	2020-21	2021-22
E-2 Wheelers	27478	26512	44394	249615
E-3 Wheelers	114136	140754	88497	178169
E-4 Wheelers	2460	2740	5952	20172
E-Buses	53	363	217	1066
Grand Total	**144127**	**170369**	**139060**	**449022**

[120] Source: Ministry of Heavy Industries Annual Report 2021-22
[121] Source: Ministry of Heavy Industries and Public Enterprises Annual Report 2021-22
[122] Source: https://www.smev.in/statistics

Ministry of Power has 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. The Government has increased its focus initially on these 9 mega cities (with population of over 4 million).

As on February 2022, India has a total of 1640 operational public EV chargers. Out of which, 9 cities (Surat, Pune, Ahmedabad, Bengaluru, Hyderabad, Delhi, Kolkata, Mumbai, and Chennai) account for approximately 940 stations. The aggressive efforts undertaken by the government through various implementing agencies have resulted in rapid growth in deployment of public EV charging infrastructure.[123]

DHI has sanctioned 1576 charging stations in 9 Expressways and 16 Highways and issued LOA to selected entities accordingly. The development of public charging infrastructure in India started gaining momentum slowly after the implementation of phase 2 of FAME India scheme in 2019-20. The government allocated a much higher budget of INR 1000 Crore under phase-2 of the scheme as compared to INR 43 crore spent under phase-1 of scheme for the development of 520 charging stations.

Under Phase II, the department of Heavy Industries (DHI) has already sanctioned 2,877 charging stations in 68 cities across 25 states/ UT's with a budget support of INR 500 Crore. Further, DHI has issued Letter of award for 1797 charging stations as on 21st January 2022.

Apart from FAME, various state governments are also offering additional incentives for the development of charging infrastructure under their EV policies. Around 20+ states have already notified their EV policies including the draft policies.

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 2021-22 are:

[123] Source: https://pib.gov.in/PressReleasePage.aspx?PRID=1799464

- In January 2022, Department of Heavy Industries the Ministry has sanctioned 1576 charging stations in 9 Expressways and 16 Highways.
- Under Phase-1 of FAME scheme, out of target of 520 charging stations, 461 charging stations as on 21st Jan, 2022 have been installed.
- Action plans for 9 major cities have been prepared by Bureau of Energy Efficiency (BEE) for installation of Public Charging Stations. As per the initial estimates, a total of 46,397 Public Charging Stations (PCS) is being targeted in these cities by 2030

- Ministry of Heavy Industries (MHI) had invited proposals from any Govt. Organization/Public Sector Undertaking (PSU) (State/Central)/Govt. DISCOM/ Oil Public Sector Undertaking and similar other Public/Private entities to build and operate Public EV charging infrastructure on Expressways and National Highways under FAME India Scheme Phase-II for Highways & Expressways.
- Energy Efficiency Services Limited (EESL), in consortium with Convergence Energy Services Ltd. (subsidiary of EESL), has been awarded the work for setting up of EV charging stations along 16 NH/Expressways.

- Apart from the key initiatives taken by MoP, the ministry of Housing and Urban Affairs (MoHUA) has also made amendment in Model Building Byelaws (MBBL) 2016 to include the provision of EV charging in buildings. The key points under the amendment were following:

i. 20% of all vehicles holding capacity/ parking capacity at the premise of a building shall be reserved for the charging of EVs.

ii. The building premises will have to have an additional power load, equivalent to the power required for all charging points to be operated simultaneously, with a safety factor of 1.25.

iii. The amendments are applicable to all buildings except independent residences

Figure 71: Few Key government Initiatives for creating public charging infrastructure

8.6. Methodology to calculate fuel savings from adoption of EVs

Step-1
- Collection of electric two-wheeler, three-wheeler, four-wheeler and e-buses as on 2018-22.

Step-2
- Freezing assumptions for calculation of energy consumption and savings from replacement of equivalent stock of ICE vehicles.

Step-3
- Calculation of incremental energy savings and emission savings

Figure 72 : Methodology for fuel saving estimation due to EVs

8.7. Energy and emission saving calculations

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

Under FAME-I scheme 2.8 lakh hybrid and electric vehicles were supported under a total demand incentive disbursement of INR 359 crores. The number of electric vehicles (excluding hybrids) supported under the scheme as on 2021-22 is presented in the table below:

Table 71: Number of EVs supported under FAME-I and FAME -II (as of March 2021)

Vehicle segment	Number of vehicles supported FAME -I	Number of vehicles supported FAME -II
e- 2-wheeler	1,70,000	1,19,000
e- 3-wheeler	2598	20,420
e- 4-wheeler	12,447	5080
e-buses	400	835
Total	185445	145335

As showcased in the table above, total 1.4 lakh Electric vehicles (1.19 Lakh electric two wheelers, 20.42 K electric three wheelers and 580 electric four wheelers) have been incentivized in the FY 2020-21.

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 72.

Table 72: 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	0.81 tCO_2/MWh[124]			

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 73 below:

[124] Source: https://cea.nic.in/wp-content/uploads/baseline/2023/01/Approved_report_emission__2021_22.pdf

Table 73: Annual running (Kilo meter) for ICE vehicles

Parameters	2-wheeler	3-wheeler	4-wheeler	Buses
Mileage	48 km/l	35 km/l	15 km/l	8 km/l
Fuel type	Petrol	Petrol	Petrol	Diesel
Total Yearly run	10000 km	36500 km	30000 km	70000 km
CO_2 emission factor[125]	44 g/km	92 g/km	231 g/km	1056 g/km

Step-3: Calculation of energy and emission savings

Of the 6,265 electric buses already sanctioned under FAME II, around 928 buses are on the road. These buses are already proving their role in the battle towards reducing carbon emissions.

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 2018-22 are given in Table 74

Table 74: Energy and CO_2 savings in 2021-22[126]

Particular	Savings due to sales during 2018-19	Savings due to sales during 2019-20	Saving due to sales during 2020-21	Saving due to sales during 2021-22
Energy savings in Mtoe	0.04	0.0045	0.018	0.042
CO_2 emission savings in $MtCO_2$	0.07	0.007	0.116	0.269

8.8. Achievements under FAME India Scheme Phase II

As on January,2021 under FAME India Scheme Phase II, following has been achieved:

- **OEMs and Vehicle Models:** So far, 50 OEMs have registered their 103 EV Models for availing benefit of demand incentives under Phase-II of FAME Scheme. About 220117 EVs have been incentivized to the eligible user of the electric vehicle under the Scheme.
- **Sanction of Electric Buses:** In order to promote electric mobility in public transport, the Department has invited the proposal from cities and state transport corporations through an Expression of Interest for deployment of Electric Buses under Operation cost model basis. After examining the proposal, the department sanctioned 6315 no of e-buses to 65 cities for intra-city and intercity operations across 26 states/ UT under the Scheme. These buses will run about 4 billion Kilometer distance during their contract period and are expected to save **cumulatively about 1.2 billion liters of fuel over the**

[125] https://shaktifoundation.in/wp-content/uploads/2017/06/WRI-2015-India-Specific-Road-Transport-Emission-Factors.pdf
[126] Fame I savings are reflected

contract period, which will result in avoidance of 2.6 million tonnes of CO2 emission.

- **Sanction of Charging Infrastructure:** To address the issue of range anxiety, Department of Heavy Industry issued an Expression of Interest (EoI) inviting Proposals from Urban Local Bodies (ULBs)/municipal corporations, PSUs (State/Central) and public/private entities desirous for deployment of EV charging infrastructure in different states/cities for availing incentives under Fame India Scheme Phase II. Thereafter, the Department sanctioned 2877 Electric Vehicle Charging Stations in 68 cities across 25 States/UTs under FAME India (Faster Adoption and Manufacturing of Hybrid & Electric Vehicles in India) scheme phase II.
- **Publicity:** DHI conducted publicity activity of EVs in a few colleges/universities across the country.

8.9. 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. Indian railways span over thousands of kilometres practically covering the entire nation, making it the fourth largest in the world after the US, China and Russia. The Railways Board, which has a monopoly over the provision of rail services in India, is in charge of overseeing the whole infrastructure.

The Indian Railways consumes over 20 billion kWh [127] of electricity annually, which is around 2% of the country's total power consumption, in addition to primary energy usage, mainly in the form of diesel. Indian Railways consumes approximately 2.5 billion units[128] of electricity for non-traction usage, spending about INR 1,700 crores per annum. This points to significant potential in saving energy in the Indian Railway. This has also been recognized by BEE, and various traction units and production units of the Indian Railways have been identified as designated consumers in the second cycle of the Perform Achieve and Trade (PAT) scheme of BEE.

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

[127] Source: IR Annual Environmental Sustainability Report 2020-21
[128] Source: https://shaktifoundation.in/wp-content/uploads/2020/03/Energy-Efficiency-in-Indian-Railways.pdf

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[129].

Indian Railways exceeded the targets set under PAT-II and 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 1 million tonnes of CO2[130]. Under PAT-II Cycle, Railways earned 1,18,790 'Escerts' to the tune of approx. Rs.5.3 crore.[131] The continuous efforts of Ministry of Railways and Zonal Railways to embrace various energy efficient technologies and energy conservation measures had resulted in bagging 11 National Energy Conservation Awards (NECA) 2021 year.

Over the years, Indian Railways, has taken significant measures towards promoting energy efficiency in both traction and non-traction areas. Indian Railways uses a mix of electric and diesel traction. The total electricity and diesel consumption in traction energy in Indian Railways over the years is presented in the figures below:

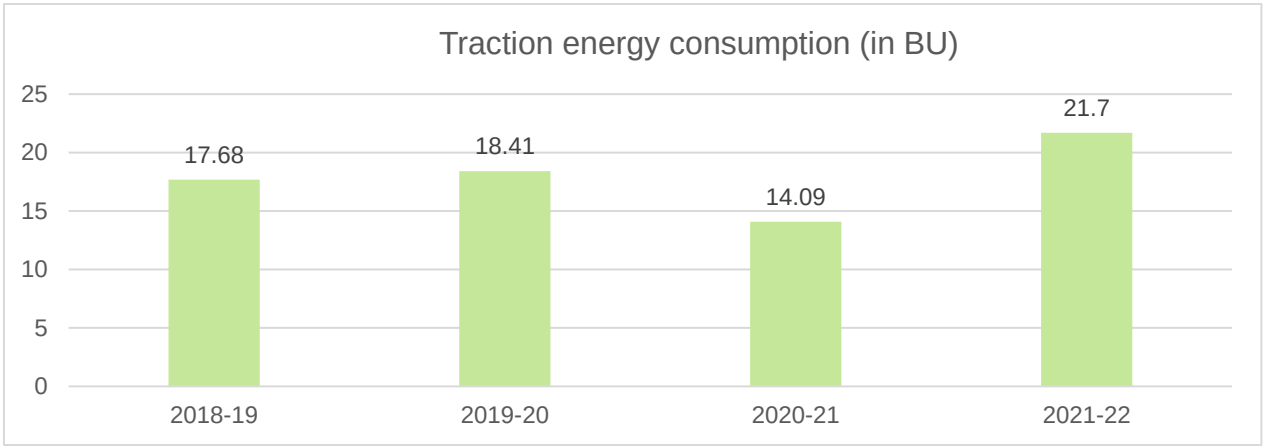


Figure 73: Traction energy consumption by Railways[132]

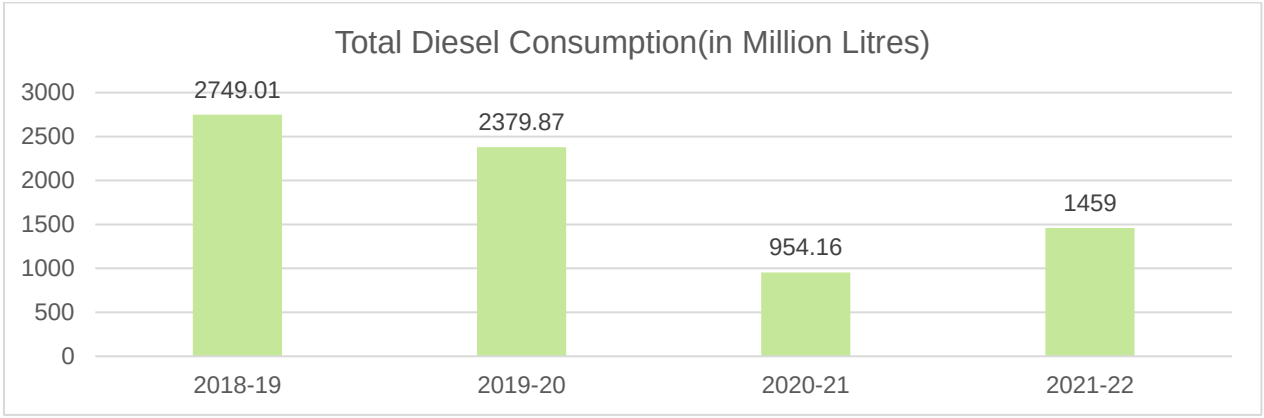


Figure 74: Consumption of Fuel by Locomotive[133]

[129]Source: https://shaktifoundation.in/wp-content/uploads/2020/03/Energy-Efficiency-in-Indian-Railways.pdf
[130] Source: https://beeindia.gov.in/sites/default/files/Outcomes%20PAT%20cycle%20-II.pdf
[131] Source: IR Annual Environmental Sustainability Report 2020-21
[132] Indian Railways Annual Report and Accounts 2021-22
[133] Indian Railways Annual Report and Accounts 2021-22

The entire passenger and freight traffic, in terms of Gross Tonne Kilometres (GTKMs) for the year 2018-22 is showcased in the figure below:

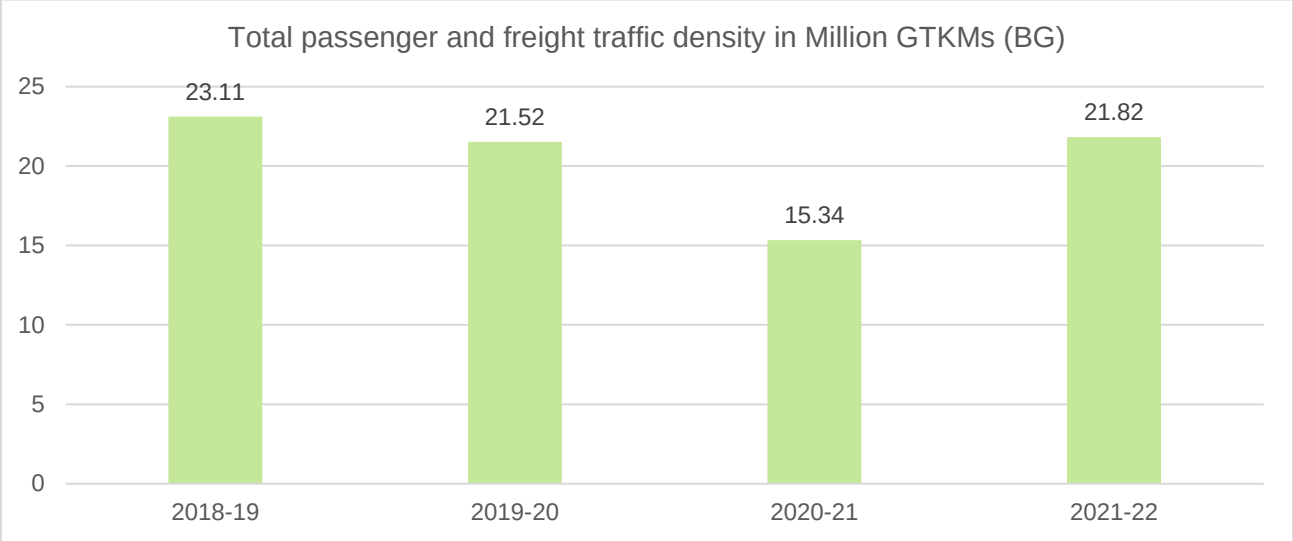


Figure 75: Total traffic density in Million GTKMs (Broad Gauge) for the year 2018-22

The Covid-19 pandemic severely impacted rail activities in the year 2020-21. Due to upliftment of Covid restrictions , the Gross Tonne Km (GTKM) or Passenger Km (PKM) moved over the railway system in the year 2021-22 increased from 15.34 Million GTKM in the FY 2020-21 to 21.82 Million GTKM in the FY 2021-22 (as showcased in the figure above). The total increase in GTKM value stood at 42.24% as compared to last year.

Due to increased GTMK travelled by the Indian Railways, the total energy consumption of the locos also went up from 14.09 BU in the year 2020-21 to 21.70 BU in the year 2021-22, as showcased in the Figure 73 above. The percentage increase in the energy consumption of the locos was around 54.01% in the year 2021-22 as compared to the previous year.

Non-traction energy

With a view to reduce energy consumption in non-traction area, Indian Railways has initiated various measures. IR consumed around 2.01 BU of electricity for its non-traction usage in the year 2020-21.

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. However, during the COVID-19 pandemic, the non-transaction energy consumption has also reduced, due to less intake of energy by the manufacturing workshops, maintenance depots, Station area, Platforms, etc. As a result, the total non-traction energy has come down to 2.01 BU in the year 2020-21 from 2.34 BU in the year 2019-20.

The non-traction energy consumption over the years is in presented in the figure below:

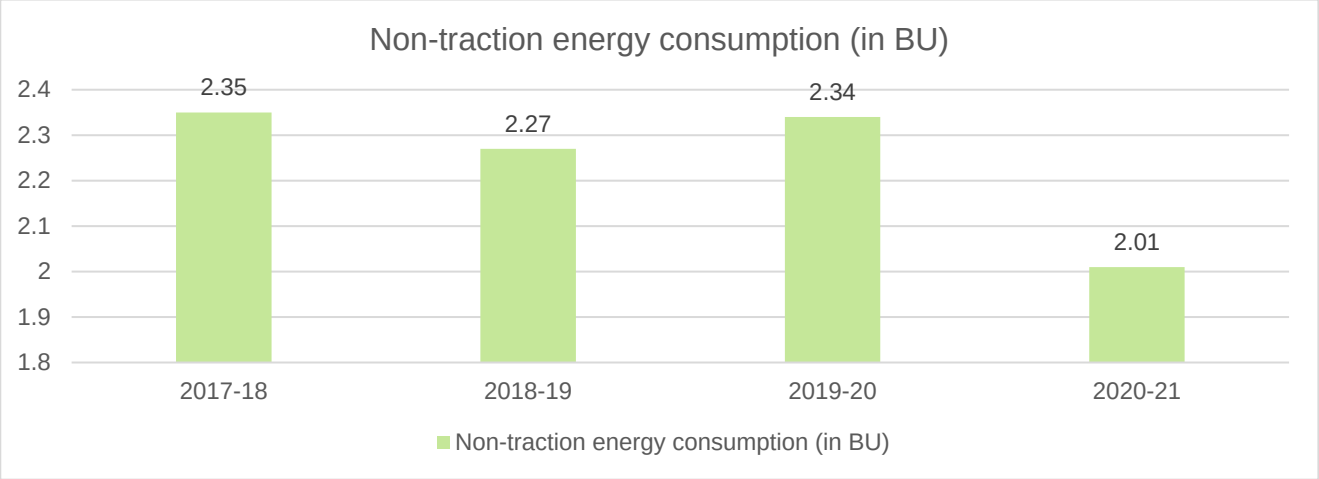


Figure 76: Non traction energy saving (BU)

However, 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. With a view to reduce the Nation's dependence on imported petroleum based energy and to enhance energy security to the Country as well as to make the Railway System more eco- friendly and to modernize the system, Indian Railways have been progressively electrifying its rail routes. By March,2022, electrification on Indian Railways has been extended to 50,394 RKMs out of the total Broad Gauge (BG) rail network of 65,093 RKMs including Konkan Railway. This constitutes 77.41% of the total BG Railway Network The progress of electrification of the railway RKM in the last 2 decades is showcased in the table below[134]:

Year	Cumulative Electrified (RKM)
2001	14,856
2011	19,008
2018	29,228
2019	34,319
2020	39,329
2021	44,802
2022	50,394

Total 6,366 RKM has been electrified during the year 2021-22. Total electrification of the railway track for the FY 2017-22 is showcased in the figure below:

[134] Indian Railways Annual Report and Accounts 2020-21

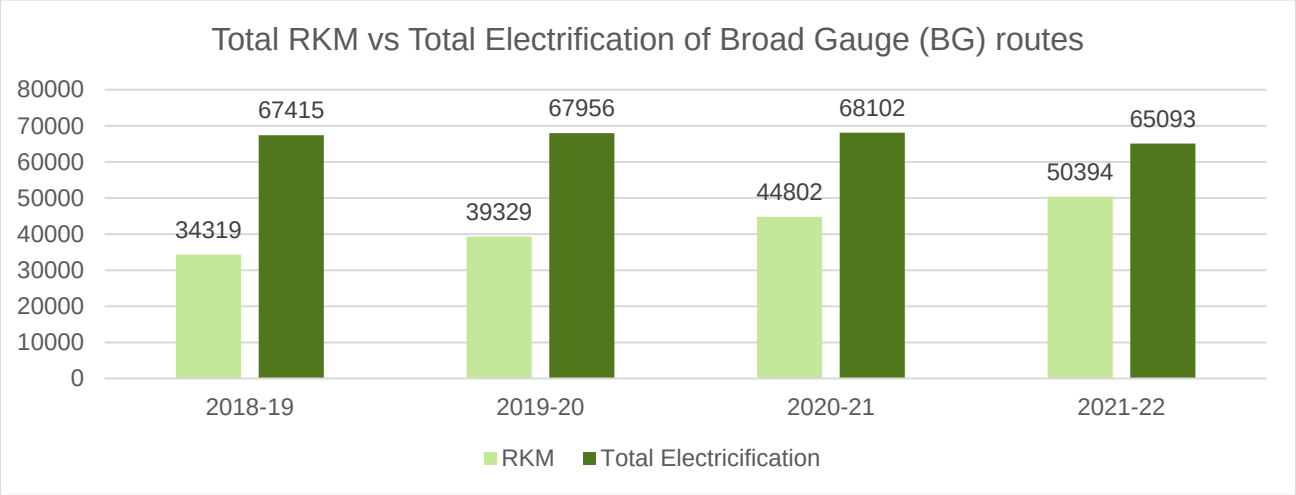


Figure 77: Route electrification in Indian Railways[135]

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

Innovations and new initiatives of EMU, MEMU and Kolkata Metro

The details of innovations and new initiatives of EMU, MEMU and Kolkata Metro rakes during 2020-21 is as under:

- During 2021-22, 55 Main Line Electrical Multiple Unit (MEMU) rakes equipped with indigenously developed 3 phase IGBT based on-board propulsion system have been turned (32 from Railways Production Units and 23 from BEML).
- During 2021-22, ICF has turned out 4 Kolkata Metro rakes with indigenous 3-Phase IGBT based propulsion system for Metro Railway Kolkata.

HOG (Head-on-Generation) Trains: Head on Generation system is electrical power supply system where electrical power for catering hotel load of train includes Train Lighting, Air conditioning, fan and other passenger interface requirement working on electrical power supply:

- All LHB coaches have been made HOG complaint.
- All power cars have been made HOG Complaint.
- Reduction in diesel consumption on account of HOG operation 1,844.8 Lakh Ltrs during 2021-22.
- Reduction in fuel bill on account of HOG operation Rs. 1,660.39 crore.
- Reduction in CO2 emission on account of HOG operation 4.8 Lakh Tonnes.

[135]Source: Indian Railways Annual Report and Accounts 2021-22

Green Environment

In APU System, Main Engine shuts down and small 25 HP Engine starts and charges batteries and air brake pipes, when locomotive idles for more than 10 minutes. The diesel engine of APU consumes only 3 liters of diesel per hour in comparison to 25 liters by the main engine of the locomotive. Expected savings per loco fitted with APU is `20 lakh/year on account of savings in fuel oil only. APU units have been fitted in all the new diesel locomotives being manufactured at Marhowra plant.

Training: A number of initiatives were taken to improve the quality of training programmes for railway employees in order to improve productivity. In this direction, 'National Rail & Transportation Institute' (NRTI) has been set up as India's first University focused on transport related education, multidisciplinary research & training in Vadodara, Gujarat. Refresher training was imparted to 1,62,925 Non-Gazetted employees during the year 2021-22

100% LED initiative:

- Railways have taken up the work of retro-fitment of LED light in coaches under sanctioned item of Railway Board Bulk RSP for 64,864 coaches. In the year 2021-22, **total 17,213 coaches** have been retrofitted with Led fittings. Per coach per annum saving on account of LED lights is likely to be Rs. 6,160 for coaches converted in 2021-22. There is likely saving of Rs. 39.90 crore annually
- All Railway stations have been fitted with 100% LED luminaries. By this, Indian Railway has become a major Railway across the world to have 100% LED lighting at all its stations. All railway installations including offices, maintenance depots etc. are also being provided with 100% LED luminaries and all Residential quarters have also been provided with 100% LED lights.

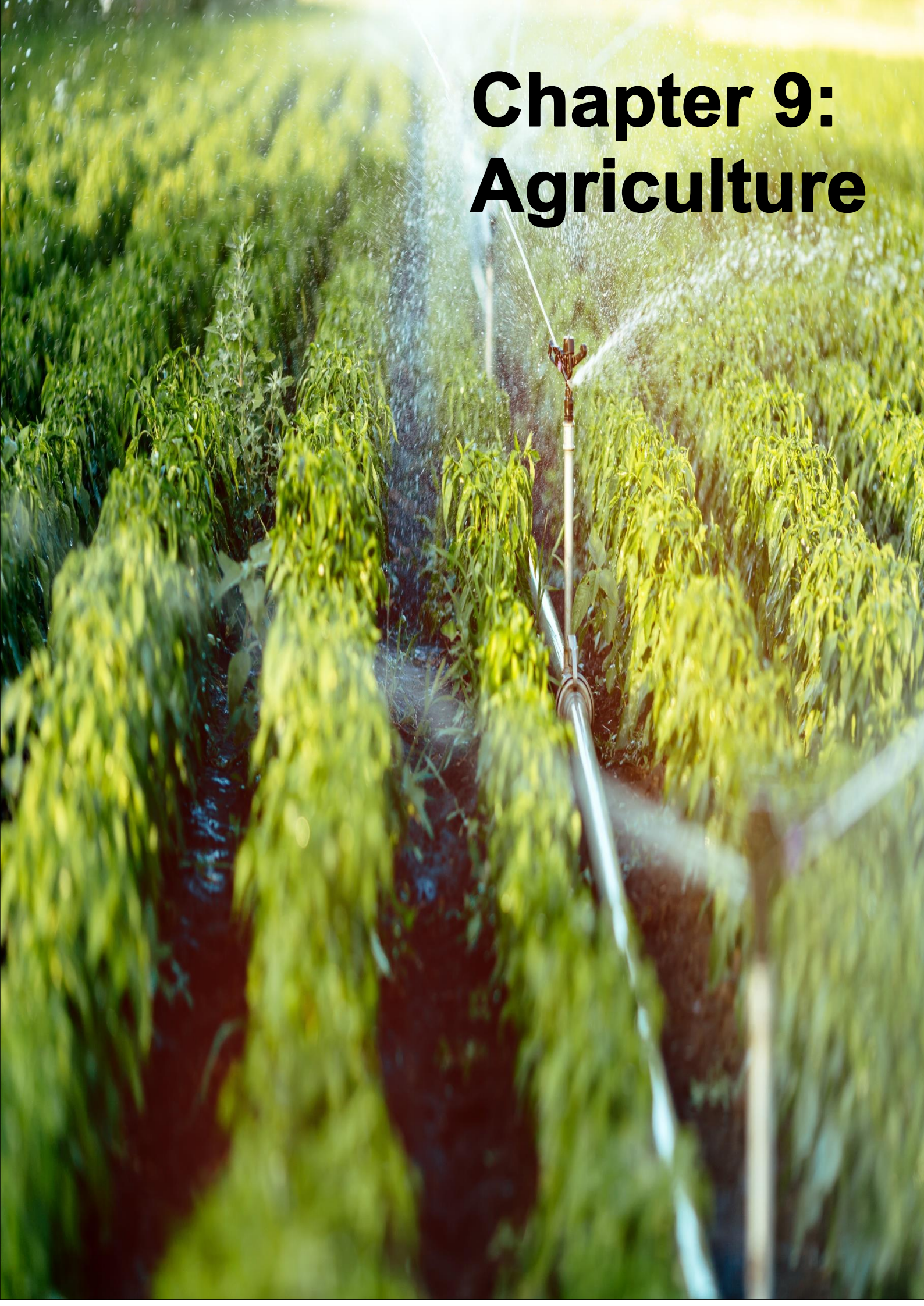
Through implementing the various energy efficiency measures stated above, the Indian railways has its specific energy and fuel consumption over the past years. The specific energy and fuel consumption for the year 2021-22 as compared to that of year 2020-21 is showcased in the table below[136]:

Specific Energy Consumption (Consumption per 1000 GTKMs) – (BG)	Unit	2020-21	2021-2022
Passenger service- Electricity	kWh/1000 GTKMs	15.6	21.6
Goods services -Electricity	kWh/1000 GTKMs	7.09	7.26

Specific Fuel Consumption (Consumption per 1000 GTKMs) – (BG)	Unit	2020-21	2021-22
Passenger service- Diesel	Litres/ 1000 GTKMs	3.31	3.33
Goods services -Diesel	Litres/ 1000 GTKMs	1.92	1.75

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

[136] Source: INDIAN RAILWAYS ANNUAL REPORT & ACCOUNTS 2021-22



Chapter 9: Agriculture

9. *Agriculture*

The Indian economy is highly dependent on agriculture and is also known as agro-economy. Indian agriculture sector is the largest employer of workforce within the country, accounted for 18.8% (2021- 22) in Gross Value Added (GVA) of the country, registering a growth of 3.6% in 2020-21 and 3.9% in 2021-22[137], also is responsible for 14% of country's total GDP[138]. India has about 54.6% of the total population engaged in the agriculture sector[139] and half of the income generated in the industrial sector comes from agricultural-based industries.

The agriculture sector accounts for approximately 80 percent of India's total water consumption and pumps are the most vital element of the irrigation process. As per the available data, more than 2.1 crore pump sets are installed in agriculture sector[140], and majority of the pump sets are inefficient, largely because farmers have no incentive to invest in higher efficiency pump sets due to low electricity tariffs and subsidies. This has resulted in increased annual burden on State governments which has grown to more than INR 65,000 crore per annum. Studies reveal that about 30%-40% energy savings is possible in agriculture sector by adoption of Energy Efficient Star Labelled Pump Sets[141].

Image Source: Tata Power Solar

Agriculture activities like mechanical irrigation are energy intensive in nature. There are estimated 21 million grid connected agricultural pump sets in India which consume about 187 billion kWh of energy every year, accounting for about 18% of national energy consumption[142]. Upgrading of existing pumping systems presents an immediate need and an unprecedented opportunity.

BEE acknowledged these issues and initiated The Agriculture Demand Side Management (Ag-DSM) scheme during the XI plan. The objective of the AgDSM program is to reduce peak

[137] Source: https://www.investindia.gov.in/sector/agriculture-forestry#:~:text=The%20agriculture%20sector%20in%20India,3.9%25%20in%202021%2D22.
[138] Source: https://unacademy.com/content/ssc/study-material/indian-economy/role-of-agriculture-in-the-indian-economy/#:~:text=The%20majority%20of%20the%20country's,of%20the%20country's%20total%20GDP.
[139] Source: https://agricoop.nic.in/Documents/annual-report-2020-21.pdf
[140] Source: https://www.peda.gov.in/ec/agdsm.php
[141] Source: https://www.iea.org/policies/7460-agricultural-demand-side-management-agdsm-programme
[142] Source: http://agdsm.in/

demand, shift the time during which electricity is consumed to off-peak hours and to reduce the total quantum of consumption. The AgDSM proposition is very simple i.e., replacement of inefficient agricultural pump sets with BEE star rated and high efficiency pump sets to reduce the amount of electricity needed to pump water in agriculture sector. By doing so, electricity usage can be reduced. If the savings from the reduction in electricity usage can be sustained and the total cost of the electricity saved exceeds the total installed cost of the pump sets over its useful life, there will be a net economic gain.

Energy efficiency and DSM in agriculture in India has been driven by pump set replacement programs. A timeline of major Agriculture DSM programs is showcased in the figure below:

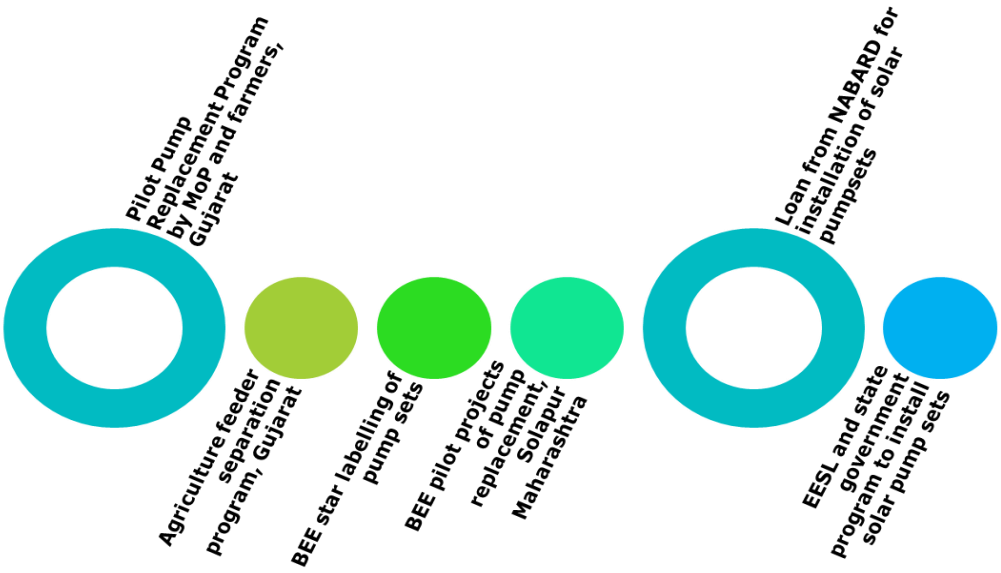


Figure 78: Timeline of major Agriculture DSM programs in India

The objective of the program is to reduce the energy intensity of agriculture pumping sector by carrying out efficiency up gradation of agricultural pump sets.

AgDSM scheme of BEE was initiated during XI plan in eleven DISCOMs of selected eight states (Maharashtra, Haryana, Punjab, Rajasthan, Gujarat, Andhra Pradesh, Madhya Pradesh and Karnataka) which were agriculturally intensive and accounted for more than 70% of electricity consumption in this sector. In the XII plan, the approach for achieving sustainable energy efficiency was widespread replication through regulatory mechanism which will be coupled with the subsidy provided by the GoI for bridging the EEPS pump sets higher cost, capacity building of all stakeholders, few demonstration projects in rural drinking water pumping systems and strategic approach for dissemination of results[143].

[143] Source: https://www.iea.org/policies/7460-agricultural-demand-side-management-agdsm-programme

9.1 AgDSM program

The objective of the AgDSM program is to reduce peak electricity demand, and, ultimately, the total energy consumption of the agriculture sector. Under the system, when a farmer pays a fixed price per horsepower per month for electricity, or what is termed as a flat-rate system, the marginal cost of pumping water is zero and hence the burden of paying for sub-optimal agricultural energy pricing rests with the state government. The subsidy bill is already a significant proportion of the state GDP and therefore, there is a strong incentive for the state to facilitate investment in efficient agricultural pump sets and reduce consumption.

EESL under the aegis AgDSM, is implementing the Energy Efficient Pump Program to distribute BEE 5-star energy efficient agricultural pumps and ensures a minimum of 30% reduction in energy consumption with smart control panels which can be remotely operated to enhance the ease of operation of pumps by the farmers. During the financial year 2021 – 22, **EESL has installed 2,562 energy efficient agricultural pumps** in the state of Uttar Pradesh. As on 31st March 2022, **79,975 agricultural pumps** have been installed in Andhra Pradesh and Uttar Pradesh[144].

The current status of the number of pumps installed for the FY 2018-21 is presented in the table below:

Table 75: Number of pump-set installations under AgDSM in the FY 2018-22

Parameter	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22
Pump-set installation (Number)	40,488	10,784	2500	2562

The AgDSM programme involves several stakeholders such as farmers (the main beneficiary), Discoms (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 below:

[144] Source: EESL Annual Report 2021-22; Pg; 32

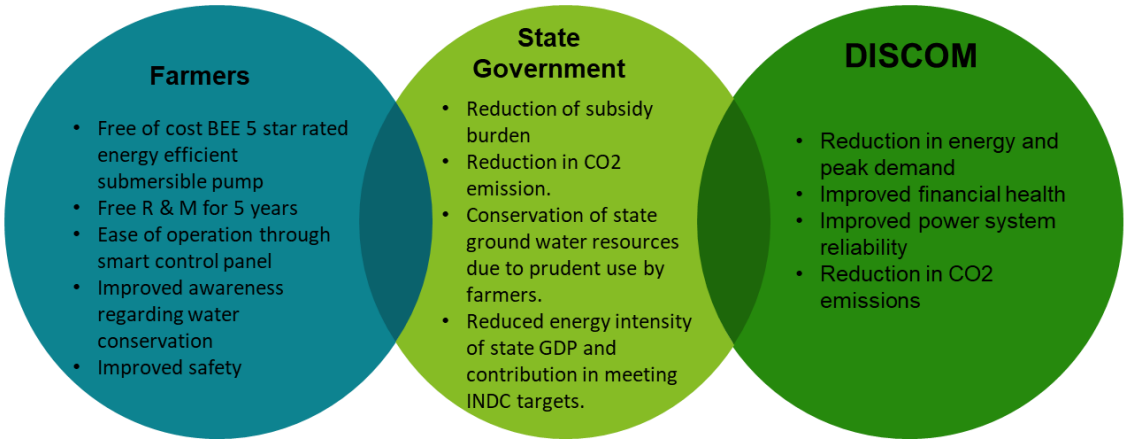


Figure 79: Benefits of the AgDSM programme

As a part of Demand Side Management Program, Bureau of Energy Efficiency, under AgDSM program, imparts training & awareness program to the agricultural farmers, agricultural universities/ officials of Krishi Vigyan Kendra's (KVKs)/ equipment technology providers and other concerned stakeholders. Various farmer training workshops have also been conducted by SDAs with support of KVKs on "Energy and Water Conservation" and around 25,000 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.

9.1.1 Recent efforts by BEE to promote AgDSM scheme

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. Under AgDSM programme, organized by BEE capacity building workshops for the Farmers/Stakeholders and pump-technicians were conducted in several states. The details of such capacity building and training workshops conducted for the FY 2021-22 is showcased in the figure below:

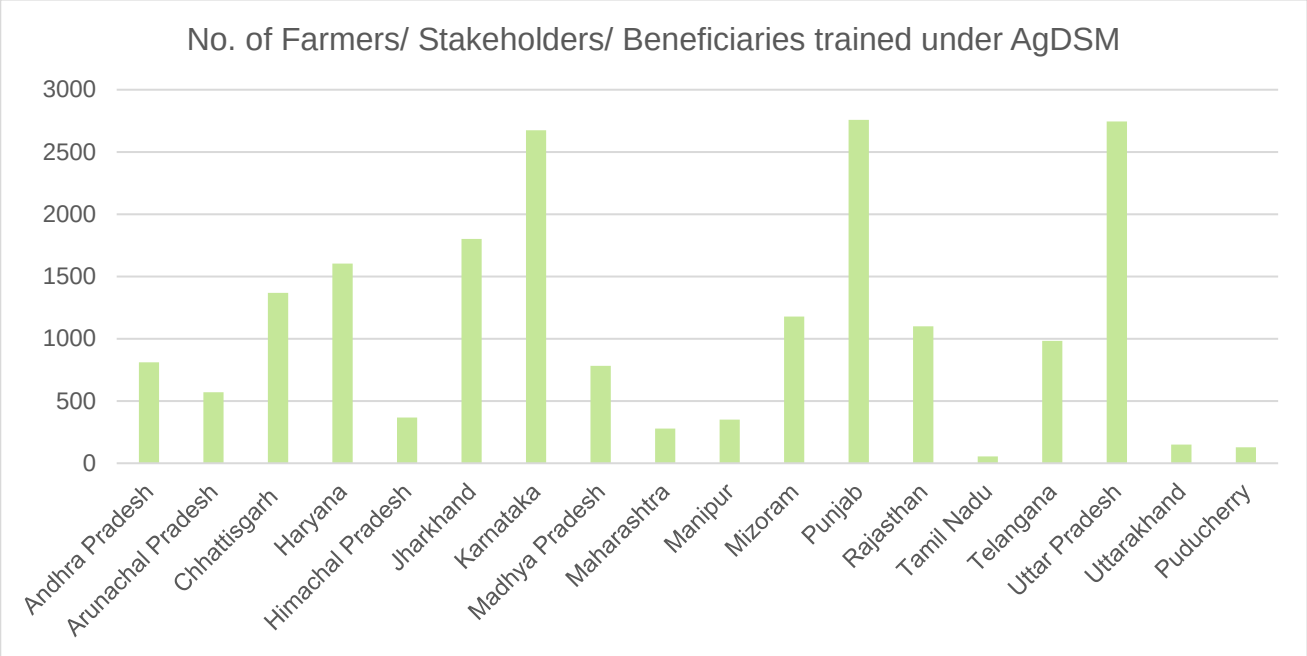


Figure 80: No. of Farmers/ Stakeholders/ Beneficiaries trained under AgDSM in the FY 2021-22

Given below are the details of the capacity building workshops conducted for the Farmers/ Stakeholders/ Beneficiaries trained under AgDSM and some of the other major initiatives that were taken during the last FY 2021-22:

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

BEE in coordination with State Designated Agencies (SDAs) is conducting various training and awareness programmes for farmers and equipment technicians. In 2021-22 about 240 number of training and awareness programmes for Farmers/ Stakeholders have been conducted for promoting EE pumpsets in agriculture sector along with water conservation covering about 18063 farmers/stakeholders[145].

Organizing technical training programs for pump technicians

In AgDSM space particularly, BEE in coordination with SDAs is organizing training programs for equipment technicians who have a major role to play in replacing old inefficient pumps with BEE star rated pump sets. In 2021-22 about 48 numbers of capacity building programs for equipment technicians have been conducted in 10 states providing training to around 378 pump technicians[146].

Demonstration project on "IoT and sensor-based Climate Smart Agriculture Initiatives".

The pilot intervention is intended to showcase and mainstream the business model of climate smart sustainable agriculture practice. With the main objective of judicious water usage, the

[145] Source: BEE Annual Report 2021-22
[146] Source: BEE Annual report 2021-22

operation of solar driven agriculture pump is guided by automatic soil moisture sensors regulating the operation of drip, sprinkler or generic water flow to the irrigation network.

9.1.2 Methodology adopted to calculate energy savings and CO_2 emission savings

Around 2562 BEE 5 star rated pumps which were distributed during FY 2021-22 to replace inefficient pumps. For the purpose of energy saving calculations in 2021-22, 50% of the total number of installations in the year 2021-22 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**: To calculate the reduction in total CO_2 emission, conversion factor of CO_2 for electricity is considered (1 MWh = 0.81 t CO_2)[147]

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

9.1.3 Impact of the scheme

In total of **78,977** BEE five star rated agricultural pumps were installed across India[148]. In the financial year 2021-22, there were total 2562 number of inefficient 5 HP pumps that were replaced by 5 HP BEE five star rated pumps under AgDSM program, details are presented below:

Energy Savings from Energy Efficient pumps		
No. of pumps replaced	**Total Electricity Savings (kWh) per annum**	**Total CO2 emisison reduction (tCO2) per annum**
2562	6,634,753.14	4,909.74

Figure 81: Energy Savings from AgDSM Program in FY 21-22

[147] Source: https://cea.nic.in/wp-content/uploads/baseline/2023/01/Approved_report_emission__2021_22.pdf
[148] EESL Annual Report 2021-22; Pg 32

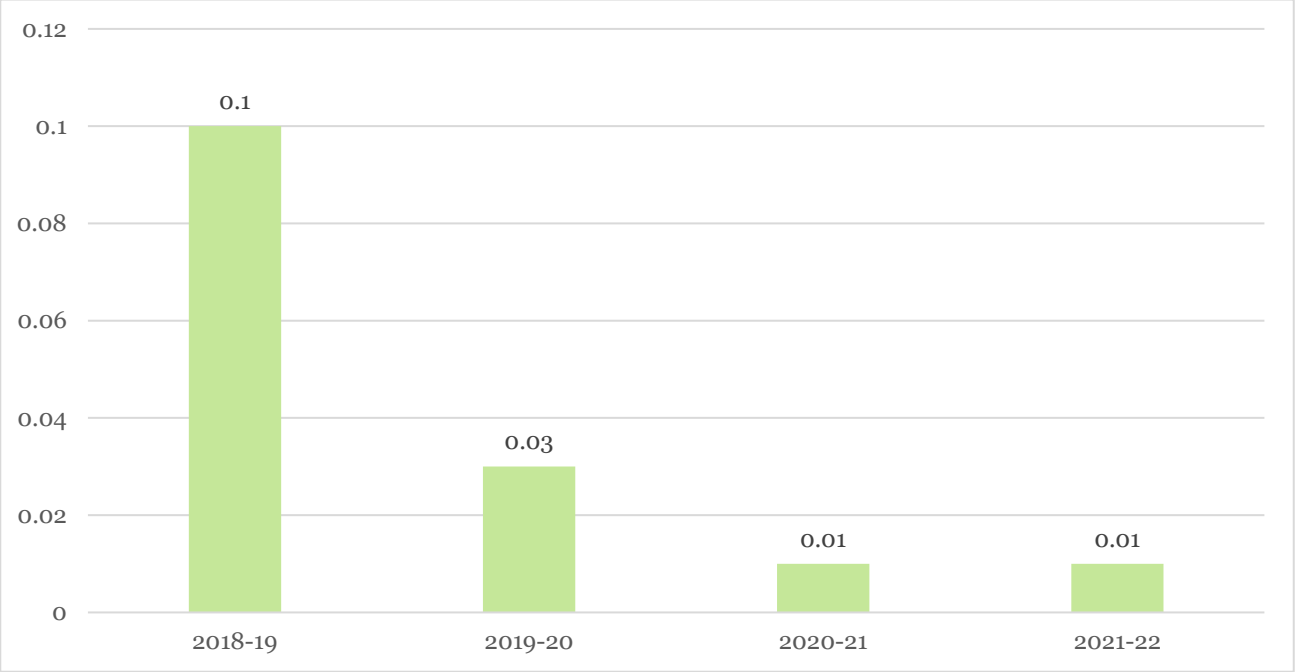


Figure 82: BEE five star rated pumps under AgDSM program

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 2021-22 is **0.01 BU** and reduction in emission of CO_2 is **0.005 Million Tonnes**.

Chapter 11: DISCOMs

10. *DISCOMs*

Demand Side Management is a crucial process to reduce electricity consumption, especially when the usage is at its peak. A high requirement of electricity does not only increase the electricity cost but also causes power outages by putting pressure on the electricity grid.

Therefore, capacity building and other support is essential for the DISCOMs to implement Demand Side Management programs in their respective areas. In this context, Bureau of Energy Efficiency launched a program for capacity building of DISCOMs since 2014. This was helped in capacity building of DISCOM's officials and development of various mechanisms to promote DSM in their respective areas. Bureau has includ ed 62 electricity distribution companies and the activities like establishment of DSM cell, load research and preparation of DSM action plan for these DISCOMs, manpower/consultancy support, capacity building of officials of DISCOMs had been completed.

The major achievements under Capacity Building of DISCOMs program on Demand Side Management scheme till date are as follows:

- Included 62 distribution companies (DISCOMs) at pan India level.
- Dedicated DSM cells have been established at these DISCOMs.
- DSM action plans have been prepared based on load survey carried out for all beneficiary DISCOMs and submitted to DISCOMs for their implementation.
- DSM regulations have been notified for 24 States and 8 UTs. Remaining states are
- pursuing to notify their DSM regulations for their respective states.
- On DSM & energy efficiency, 1,450 master trainers from senior and middle management officials of DISCOMs have been trained and capacity building of 7650 circle level officials have been trained under this program.
- 69 DSM proposals have been prepared for 53 DISCOMs and submitted to respective DISCOMs for implementation. is estimated that there is a saving potential of 22919 MW and an annual saving of about 62696 MU lies with these 28 DISCOMs and the investment requirement is about Rs. 44, 994 Crore.

A. Capacity building of circle-level officials of DISCOMs on DSM and Energy Efficiency

Bureau has organized capacity building of circle-level officials of DISCOMs training program on DSM and energy efficiency in association with SDAs. The technical sessions were arranged by the engaged agency during these training programs under this program.

The primary objective of this program was to introduce the trainers to the changing dynamics of energy efficiency in the country. The program was mainly designed to provide basic concepts of DSM and various financial analyses involved in its implementation.

B. Preparation of DSM action plans based on a load research study conducted at DISCOMs.

The agency has conducted the load survey at beneficiary DISCOMs and DSM action plans were prepared for each DISCOM under this program. These DSM action plans have been submitted to the DISCOMs for implementation. However, some of the DISCOMs have implemented demand-side measures at their DISCOMs.

Chapter 11:

State Designated Agencies (SDAs)

11. *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.

All 36 States/UTs have nominated a SDA in their respective State/UT, out of which, 16 are Renewable Energy Development Agencies, 7 are State Government Power Departments, 7 are Electrical Inspectorates, 4 are Electricity Distribution Companies and 2 are Standalone SDAs. Andhra Pradesh and Kerala are the two states who have established Standalone SDA. Remaining 34 States/UTs have assigned additional responsibility of facilitating and enforcing the provisions of EC Act at State level to one of their existing agencies/departments.

11.1. BEE support extended to SDAs

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

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

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

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

1. **State Partnership for Energy Efficiency Demonstrations (SPEED)**

    a. **Implementation of energy efficiency demonstration projects** – These demonstration projects can be implemented by the SDAs in the areas of street lighting, water pumping (drinking water supply systems, agricultural water pumping systems, etc.), retrofitting of electrical equipment / appliances in buildings, installation of smart-meters in municipalities, Government buildings, etc.

    These projects have been successful in facilitating most of the State Governments in replicating the demonstrated technology through various departments / agencies.

b. **Implementation of energy efficiency activities in Government schools** – Replacement of existing conventional appliances with energy efficient appliances in Govt. schools is undertaken by SDAs under this head along with disseminating awareness 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, streetlights, fans, water pumps, etc.

3. I**nstitutionalization 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 smoothly and effectively. The engaged manpower may be made responsible for overall implementation of various programmes viz. Perform Achieve and Trade (PAT), Demand Side Management (DSM), etc.

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

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

   b. To enhance the outreach activities undertaken by SDAs.

   Through this component, SDAs can draw key experts and can undertake extensive stakeholder engagement, comprehensive analysis, and focused technical assistance to enhance clean energy policy implementation in the State.

6. **Workshops / Capacity Building of energy professionals:** The SDAs may organize workshops at regular interval to disseminate information regarding energy efficiency to energy professionals like Accredited / Certified Energy Auditors, 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. **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.

8. **Maintenance and updation of Internet Platform and other database created–** Under this component, financial support is provided to the SDAs towards establishment

of internet platform through creation of a separate website on energy efficiency and regularly updating its contents.

9. **Student Awareness / Student Capacity Building Programme (SCBP)–** Following are the major activities being undertaken by SDAs under this component.
   - Development and incorporation of chapters on EC for School/ State Boards/ ITI/ Dip. Engg. College Curriculum.
   - Training of School Teachers/ Lecturers on new modules/chapters.
   - Debate and Quiz competitions in Schools and at Degree College level, ITI, Diploma Engineering Colleges (polytechnic), Engineering Colleges upon creation of energy clubs.

11.1.2. Contribution to State Energy Conservation Fund (SECF):

Section 16(1) of the EC Act, 2001 requires State Governments / UT Administrations to constitute a fund called SECF for the purpose of promotion of efficient use of energy and its conservation within the State. The SECF can facilitate to overcome the major barriers for implementation of energy efficiency projects. It is intended to be used as an instrument to facilitate implementation of energy efficiency projects through market transformation.

The scheme is for contribution to all the State/UTs with a maximum ceiling of Rs. 4.00 crore for any State/UT provided in two installments of Rs. 2.00 crore each. The second installment of Rs. 2.00 crore under contribution to SECF is released only after the states have provided a matching contribution to the first installment of Rs. 2.00 crore provided by BEE. Till date, 32 states have constituted SECF out of which about 27 States have also provided matching contribution.

For undertaking energy efficiency projects through SECF, major part of the funds disbursed under SECF is to be earmarked separately as Revolving Investment Fund (RIF). This RIF may be utilized to finance implementation of various energy efficiency projects including those for public buildings of Central Government, State Government and Central or State Government undertakings' / agencies' buildings, energy efficiency street-lighting or common area lighting projects, energy efficiency projects in public drinking water pumping stations and in agricultural pumping, energy efficiency projects in various industrial sectors and MSME clusters, etc.

11.2. Key highlights of activities of SDAs during FY 2021-22

11.2.1. Andhra Pradesh

Andhra Pradesh State Energy Conservation Mission (APSECM), the SDA of Andhra Pradesh completed replacement of conventional luminaries and fans with energy efficient ones in all 541 Nos. Court Buildings under Judiciary department across 13 districts, through Andhra Pradesh State Energy Efficiency Development Corporation (APSEEDCO) Limited.

Andhra Pradesh SDA has carried out implementation of energy efficiency measures as pilot project in 1 No. Govt. hospitals.

11.2.2. Arunachal Pradesh

Arunachal Pradesh Energy Development Agency (APEDA), the SDA of Arunachal Pradesh completed replacement of conventional luminaries (bulbs and tube-lights) and ceiling fans with energy efficient luminaries and fans in 86 Nos. Govt. schools.

Energy efficient IoT and sensor-based drip irrigation system has been installed at Old Abali village in lower Dibang Valley district, for demonstration purpose.

The SDA has carried out implementation of energy efficiency measures as pilot project in 6 Nos. Govt. hospitals across the State.

11.2.3. Assam

The Assam SDA conducted Energy Audit and implemented audit recommendations thereof, in Assam Secretariat (Janta Bhawan).

11.2.4. Bihar

Bihar Renewable Energy Development Agency (BREDA), the SDA of Bihar completed replacement of conventional luminaries and fans with energy efficient ones in 45 Nos. Govt. schools across the State.

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

11.2.5. Chandigarh

SDA has completed replacement of Existing CFL/ HPSV lamps with energy efficient LED Fixtures in the following Public Buildings:
a) UT Secretariat Building Sector 9
b) Govt Hospital and Medical College at Sector 16 & Sector 32
c) Urban Training Health Centre Sector 44
d) Rural Health Training Centre Sector 56
e) Govt Hospital Sector 45

Chandigarh SDA implemented energy efficiency demonstration projects at 44 Nos. Govt. schools by replacing therein, the existing conventional lights and ceiling fans with energy efficient ones.

11.2.6. Chhattisgarh

Chhattisgarh State Renewable Energy Development Agency (CREDA), the SDA of Chhattisgarh implemented energy efficiency demonstration projects at 10 Nos. Community Health Centres, 28 Nos. Govt. buildings and 112 Nos. Govt. schools by replacing therein, the existing conventional lights and ceiling fans with energy efficient ones.

The SDA has carried out installation of EC Mascot in 06 Nos. of Energy Education Park.

11.2.7. Daman and Diu

Daman & Diu SDA undertook GIS mapping of 261 no. of streetlights with numbering stated from south to north along coastal Highway, Daman, followed by their replacement with energy efficient LEDs.

SDA Daman has initiated “Urja Saksharata Tamare Dwar” program to spread awareness in village areas and Gram Panchayats.

11.2.8. Goa

Goa SDA implemented Model Energy Efficient Village Campaign in Assolda village, converting it into model energy efficient village by replacing existing conventional household lamps, streetlights, and fans with energy efficient ones.

Implementation of Energy Efficiency measures in 27 Nos. of Govt. Schools, including 5 Kendriya Vidyalayas and 2 Jawahar Navodaya Vidyalayas to Energy Efficient Schools by replacing all existing conventional appliances with Energy Efficient appliances has been completed through M/s. Energy Efficiency Services Limited.

11.2.9. Gujarat

Gujarat Energy Development Agency (GEDA) implemented Model Energy Efficient Village Campaign in 4 Nos. villages, by replacing existing conventional household lamps, streetlights, and fans with energy efficient ones.

11.2.10. Haryana

Haryana SDA completed replacement of conventional appliances by energy efficient ones in 22 Nos. Government Hospitals.

The SDA installed Emergency rescue device with 15-minute battery storage at Service lift of Mini secretariat Rewari.

Haryana SDA completed the replacement of existing conventional luminaries and fans with energy efficient ones in 470 Nos. Govt. schools across Haryana.

11.2.11. Himachal Pradesh

Himachal Pradesh SDA implemented Energy Efficiency measures in 100 Nos. of Govt. Schools by replacing all existing conventional appliances viz. lights and fans with Energy Efficient appliances.

11.2.12. Jharkhand

Jharkhand Renewable Energy Development Agency (JREDA), the SDA of Jharkhand has undertaken energy efficiency demonstration projects in drinking water pumping systems of Chandil and Kapali at Chaibasa Division and Hazari-Khudgadda at Tenughat Division, Dhanbad.

11.2.13. Karnataka

Karnataka Renewable Energy Development Limited (KREDL), the SDA of Karnataka provided smart energy saver units with centralized monitoring system in the street light circuits in Bengaluru and Mysore cities.

Replacement of low efficient electrical gadgets by Energy Efficient Gadgets at Govt. Polytechnic and Hostel Buildings, Channapatna, Ramanagara Dist., was undertaken by KREDL.

KREDL implemented EE gadgets work at four selected buildings under **Model Energy Efficient Building Programme:**

- Govt. Administrative Training Institute, Mysuru.
- State Institute of Urban Development, Mysuru.
- State Institute of Rural Development, Mysuru.
- Govt. Horticulture Department Building & hostel, Bengaluru.

KREDL completed replacement of conventional luminaries (bulbs and tube-lights) and ceiling fans with energy efficient luminaries and fans in 244 Nos. Govt. schools and 08 Govt. Residential Schools in Tumakur Dist.

11.2.14. Kerala

Energy Management Centre (EMC) – Kerala, the SDA of Kerala undertook energy efficiency study for 15 Nos. Distribution Transformers of Kerala State Electricity Board Limited and replaced 8 Nos. inefficient transformers with energy efficient ones.

Carrying out the activity in association with PWD electrical wing, EMC has made the below mentioned 8 Government buildings energy efficient by replacing the inefficient appliances with energy efficient appliances:

- Government Secretariat Main Building, Thiruvananthapuram
- High Court Complex, Ernakulam
- Civil Station, Kozhikode
- Vikas Bhavan, Thiruvananthapuram
- Vyllopalli Samskrithi bhavan, Thiruvananthapuram
- Civil Station, Kannur
- Civil Station, Palakkad
- Civil Station, Pathanamthitta

Implementation of EE activities in selected 70 Nos. Govt. Schools by Replacement of inefficient electrical appliances viz. lights and fans with energy efficient ones has been completed by Kerala SDA.

11.2.15. Lakshadweep

Lakshadweep SDA implemented energy efficiency measures including replacement of conventional luminaries (bulbs and tube-lights) and ceiling fans with energy efficient luminaries and fans in 35 nos. of Govt. schools and 5 Nos. of Govt. hospitals across the UT of Lakshadweep.

The SDA has undertaken replacement of existing Ceiling fans with BLDC fans at 5 Nos. of Govt. educational Institutions.

11.2.16. Madhya Pradesh

Madhya Pradesh Urja Vikas Nigam (MPUVN) Limited, the SDA of Madhya Pradesh completed replacement of all existing conventional luminaries and fans with energy efficient ones in 466 Govt. schools.

SDA Madhya Pradesh commissioned 3 Nos. of AC charging infrastructure and 1 Nos. of DC charging infrastructure for electrical vehicles for creating awareness about EVs and their uses.

11.2.17. Maharashtra

Maharashtra Energy Development Agency (MEDA), the SDA of Maharashtra completed replacement of conventional luminaries (bulbs and tube-lights) and ceiling fans with energy efficient luminaries and fans in 50 Nos. Govt. schools.

Implementation of EE activities under Model EE Village Campaign in 11 Nos. villages has been completed.

11.2.18. Manipur

SDA Manipur celebrated National Energy Conservation Week and Day, 2021 by organizing seminars, webinars & meetings; rallies by students; and competitions viz. painting, quiz & slogan-writing etc.

11.2.19. Meghalaya

Meghalaya SDA completed replacement of existing conventional lighting by energy efficient LED luminaries at the Meghalaya Legislative Assembly and its premises.

The SDA undertook replacement of drinking water pumps of the PHE Department with efficient ones at Jongsha, Water Supply Scheme.

11.2.20. Mizoram

Mizoram SDA completed the replacement of all existing conventional luminaries and fans with energy efficient ones in 120 Nos. Govt. schools.

The SDA undertook Model Energy Efficient Village Campaign by implementing energy efficiency measures in 19 Nos. selected villages.

11.2.21. Nagaland

Nagaland SDA has completed the replacement of conventional luminaries and fans with energy efficient luminaries and fans in 194 Nos. Govt. schools across the State.

Nagaland SDA undertook replacement of energy inefficient drinking water pumps by EE star rated pumps operating under Kohima, Dimapur & Mokokchung Town Councils.

Nagaland SDA has completed energy efficiency activities at 5 (five) Govt. District Hospitals of Kohima, Dimapur, Paren, Mokokchung, and Wokha where energy efficient gadgets like LED Bulb, LED Streetlight, EE Fans, Star labelled ACs, Refrigerators and Freezers were installed.

11.2.22. Odisha

Odisha SDA successfully completed LED street lighting demonstration project in Hydro Electric Projects at Upper Kolab, Chipilima, Rengali, Upper Indravati and Balimela.

To bring about energy efficiency improvements in Drinking Water Pumping Systems (DWPS), 12 nos. of DWPS were implemented at Palasuni, Bhuasuni, Rourkela, Bolangir, Rayagada, Jeypore, Sunabeda, Berhampur, Bolangir, Baripada and two at Sambalpur, by Odisha SDA.

Further, they have completed implementation of EE measures involving retrofitting of energy efficient appliances/equipment in 34 Nos. Govt. schools.

SDA Odisha has completed replacement of all the existing conventional household bulbs and streetlights with LED lights in 4 nos. villages namely, Sarei (Keonjhar District), Baruan (Keonjhar District), Sansada (Jajpur District) and Khandahata (Jajpur District). These 4 villages have been declared as LED villages by the State Govt.

11.2.23. Puducherry

Renewable Energy Agency Puducherry (REAP), the SDA of Puducherry implemented demonstration projects in 20 Nos. Police stations, 100 Nos. Anganwadi centers, 2 Nos. of KVK premises, Botanical garden, 5 nos. of Govt. farm house, 8 nos. of farmers help centers, Energy Education Park, 01 no. of Commune Panchayat building, 04 nos. of Govt. buildings, and 01 No. temple in the UT of Puducherry by retrofitting of energy efficient equipment/ appliances therein.

The SDA implemented various EE activities in following 5 nos. of Govt. Hospitals in the UT of Puducherry (entire project involved replacement of existing appliances with 3215 nos. of 20W LED Tube lights, 280 nos. of 40W LED Tube lights, 20 nos. of 120W LED Street Lights and 1080 nos. of 30 W BEE 5 star rated EE BLDC ceiling fans):

- Indira Gandhi Govt General Hospital & Post Graduate Institute, Puducherry
- Rajiv Gandhi Govt. Women and Children Hospital, Puducherry
- Community Health Centre, Karikalampakkam
- Public Health Centre, Bahour
- Public Health Centre, Kirumampakkam

11.2.24. Punjab

Implementation of energy efficiency measures with installation of 212 nos. LED Lamps, 277 nos. LED Tube-lights, 784 nos. EE BLDC ceiling fans, 112 Nos. Street lights and 10 nos. super-efficient inverter ACs in 2 Nos. villages namely Khatkar Kalan and Hansali under Model Village Campaign has been completed by Punjab Energy Development Agency (PEDA), the SDA of Punjab.

PEDA completed replacement of conventional luminaries (bulbs and tube-lights) and ceiling fans with energy efficient luminaries and fans in 117 Nos. Govt. Schools.

11.2.25. Rajasthan

Rajasthan Renewable Energy Corporation Limited (RRECL), the SDA of Rajasthan replacement of conventional appliances with energy efficient appliances in public buildings (Community Centres, Health Centres, etc.), streets, and various other common property resources at 4 Nos. villages across Rajasthan State.

11.2.26. Sikkim

Sikkim SDA completed replacement of conventional Lights with LED Bulbs and Tube-lights at common property resources in 20 Nos. villages.

The replacement of conventional lights & fans with energy efficient ones has been completed in 50 Nos. of Govt. schools across the State.

11.2.27. Tamil Nadu

Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO), the SDA of Tamil Nadu completed implementation of EE measures including replacement of conventional luminaries (bulbs and tube-lights) and ceiling fans with energy efficient luminaries and fans in two Govt. buildings namely: 1) NKM building and 2) Ezhilagam Main building.

Implementation of Energy Efficiency activities in 127 Nos. Govt High and Higher Secondary Schools in Chennai, Tiruvallur, Kanchipuram and Chengalpattu districts has been completed by the SDA.

11.2.28. Telangana

Telangana State Renewable Energy Development Corporation (TSREDCO) Limited, the SDA of Telangana implemented energy efficiency measures including retrofitting of energy efficient equipment/appliances in selected 74 Nos. Fire stations, 202 Nos. Post offices, 4 Nos. Police Stations and 7 Nos. Public Health Centres.

The SDA completed replacement of conventional luminaries (bulbs and tube-lights) and ceiling fans with energy efficient luminaries and fans in 100 Nos. Govt. schools.

Further, implementation of Energy Efficiency measures in 6 Nos. of Govt Hospitals has been completed by TSREDCO.

11.2.29. Tripura

Tripura SDA undertook distribution of 2500 nos. of 7-watt LED Bulbs & 120 nos. of 18-watt LED Street Lights in 8 villages in Tripura under the LED Village Campaign.

The replacement of conventional lights & fans with energy efficient ones has been completed in 28 Nos. of schools.

SDA Tripura celebrated National Energy Conservation Week and Day, 2021 by organizing seminars, webinars & meetings; rallies by students; and competitions viz. painting, quiz & slogan-writing etc.

11.2.30. Uttar Pradesh

Uttar Pradesh New & Renewable Energy Development Agency (UPNEDA), the SDA of Uttar Pradesh completed the replacement of all lights by LED lights, ceiling fans by BEE 5 star rated fans and ACs by BEE 5 star rated ACs etc. in 05 Buildings of Uttar Pradesh Secretariat to make it Model Energy Efficient Building.

UPNEDA has replaced 9 nos. of existing conventional rural drinking water pumps with BEE star rated energy efficient pumps through UP Jal Nigam for demonstration purposes.

11.2.31. Uttarakhand

Uttarakhand Renewable Energy Development Agency (UREDA), the SDA of Uttarakhand undertook replacement of conventional luminaries and fans with energy efficient luminaries and fans in 100 Nos. Govt. schools across the State.

UREDA completed retrofitting of electrical equipment / appliances viz. lights and fans in 29 Nos. Public Health Centres.

11.2.32. West Bengal

West Bengal State Electricity Distribution Company Limited (WBSEDCL), SDA of West Bengal completed the replacement of pumping system at 06 establishments of Rama Krishna Mission.

Replacement of conventional lighting systems by LEDs and old Fans & drinking water Pumps at Kartika Sub-Stn., Kumargram Sub-Stn, Falakata Sub-stn and Alipurduar Divisional Store under Alipurduar Division, WBSEDCL has been completed.

Chapter 12: Conclusion

12. *Conclusion*

India is a major force in the global energy economy. India's continued industrialization and urbanization will make huge demands of its energy sector and its policy makers. Energy use on a per capita basis is well under half the global average, and there are widespread differences in energy use and the quality of service across states and between rural and urban areas. To mitigate the impact of GHG emissions and climate change, India has taken substantial efforts to address national developmental and environmental priorities while meeting the obligations under the key multilateral environmental agreements.

Energy sector has experienced exponential growth in last decades. 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.

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 23.85 Mtoe, while overall electricity savings are to the tune of 249.89 BU. Total, these energy savings translated into monetary savings of worth INR 1,60,720.8 crores and contributed to reduce 280.77 Million Tonnes of CO2 emission.

Table 76: Summary of Energy Saving (2021-22)

Program/ Scheme	Sector	Electricity Savings (BU)	Thermal Savings (MTOE)	Total Energy Savings (MTOE)	GHG Reduction (MtCO2)	Monetary Savings (INR Crore)
PAT- III	Large Industry	0.62	1.59	1.59	5.59	3205.30
PAT- II		36.47	10.95	14.08	68.43	42020.59
PAT- I		3.01	9.25	8.67	31.00	9500.00
PCRA EE Programs		0.01	0.00027	0.0009	0.0044	5.98
PRSF	MSME	0.05	-	0.0041	0.04	28.74
4E		0.03	0.00010	0.0026	0.02	151.87
GFS		0.01	-	0.0009	0.01	128.36
BEE-GEF-EESL		0.0015	0.0018	0.0019	0.009	4.49
BEE-UNIDO-SME		0.00	0.00	0.0057	0.038	36.72
FLCTD	Large/MSME	0.00009	0.000657	0.0007	0.002	1.22
ECBC	Commercial Buildings	0.1609	-	0.0138	0.1303	25.46
BEE Star Rating		0.2492	-	0.0214	0.2019	39.43

Program/ Scheme	Sector	Electricity Savings (BU)	Thermal Savings (MTOE)	Total Energy Savings (MTOE)	GHG Reduction (MtCO2)	Monetary Savings (INR Crore)
Green Building Rating Program (GRIHA)		0.0882	-	0.0076	0.0714	13.96
ENS	Residential Buildings	0.0024	-	0.00021	0.0019	0.38
S&L	Appliances	70.43	0.02	6.06	57.05	42258.92
	Others (AgDSM, SEAC, etc.)	0.4693	-	0.041	0.37	281.57
UJALA	LED Lamps	47.78	0.00	4.11	38.70	19112.00
	LED (Private Market)	82.00	0.00	7.05	67.00	32800.00
SLNP	Municipal	8.52	-	0.73	5.87	5109.60
FAME	Transport	-	0.14	0.14	0.53	1559.88
CAFÉ		-	1.89	1.89	5.69	4436.35
Total		**249.89**	**23.85**	**44.43**	**280.77**	**160720.8**

Highlights from each scheme / programme in FY 2021-22:[149]

Industry Sector

PAT Scheme[150]

Interventions in large industries, DISCOMs, Railways, & Buildings under PAT Scheme has led to total energy savings of 15.674 Mtoe (Thermal energy savings of 12.486 Mtoe and 37.083 BU of the electrical energy savings) under PAT cycle II and III.

Table 77: 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[151]	1.541	0.617	1.594
Total	**12.486**	**37.083**	**15.674**

[149] M&V data for 100 DC under PAT III has been considered
[150] Updated data for Energy saving of PAT Cycle – II is consolidated data for 544 DCs.

[151] Evaluation 'is done on basis of M&V data reported by 95 DCs to BEE

MSME sector

BEE-SME program was focused in six clusters (Gujarat, Assam, West Bengal, Punjab, Tamil Nadu, Uttar Pradesh) during FY 21-22. Energy efficiency and technology upgradation interventions carried out by BEE have led to savings of 1,918.31 toe and emission reduction of 8,592 tonnes of carbon dioxide annually.

BEE-UNIDO program was operational in 23 clusters during FY 21-22. Under the program, several energy efficiency and renewable energy initiatives have led to energy savings of over 5,697.96 toe and has contributed to reduction of 38173.92 tonnes of carbon dioxide emissions annually due to interventions carried out during 2018-22.

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 21-22, there are 10 Mandatory appliances and 20 voluntary appliances. This scheme has led to savings of 70.57 BU of energy annually and remains the largest contributor to electrical energy savings. Direct Cool Refrigerator, Color television, Frost Free Refrigerator and Room Air conditioner contribute to the maximum share of energy savings, among the labeled appliances. This programme has led to a reduction of 57.05 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 78: Energy Savings in FY 21-22 for appliances sold during FY 2018-22 [152]

S. No	Appliance	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22	Total Savings (FY 2018-22)	Annual Savings (Million Rs)
1	Frost Free Refrigerator	2178	2372	2384	1561	8494.98	50970
2	TFL	365	278	303	95	1041.31	6248
3	Room Air Conditioner (Fixed Speed)	1794	2076	1376	839	6085.04	36510
4	Direct Cool Refrigerator	5072	5648	4806	2749	18274.38	109646
5	Distribution Transformer	628	379	758	499	2263.56	13581
6	Color Television	3749	3534	3451	2040	12774.21	76645
7	Stationary Type Water Heater	563	665	676	507	2411.71	14470
8	Room Air Conditioner (Variable Speed)	999	1359	2386	866	5609.62	33658
9	LED Lamps*	695	1527	1525	1045	4792.32	28754
10	Submersible Pump set	3017	1405	888	768	6078.30	36470
11	Open well pumps		632		186	818.84	4913
12	Ceiling Fan	156	139	275	233	802.64	4816

[152] Energy saving estimated form LED considered under UJALA programme during 2018-21 are discounted tin the total saving figure

S. No	Appliance	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22	Total Savings (FY 2018-22)	Annual Savings (Million Rs)
13	Washing Machine	-	46	34	744	823.16	4939
14	Computer	-	-	0	0	0.00	0
15	Monoset Pump	50	46	35	35	166.07	996
16	Chiller	-	2	5	3	10.49	63
17	Deep Freezer	0	0	0	119	119.26	716
18	Light Commercial AC				1	0.95	6
	Total Savings (BU)	**19.27**	**20.11**	**18.90**	**12.29**	**70.57**	**423401**

Saving of domestic LPG stoves is presented in the table below:

Table 79: Thermal saving due to sale of Domestic LPG stoves during 2018-22

Year	Q1	Q2	Q3	Q4	Total (TOE)
2018-19	330	600	558	1232	2720
2019-20	793	1937	974	580	4284
2020-21	1184	2505	2196	1426	7310
2021-22	1812	1213	1141	309	4475
Total (2018-22)					**18,789**

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 2022, 173 buildings have been registered under ECBC. The 173 constructed and ECBC compliant buildings with total area of 5.51 Million square meter have led to energy savings of 79.19 MU.

Table 80:Energy Saving for ECBC compliant completed buildings FY 18-22

Financial Year	No. of Buildings	Energy Savings in MU	Total Area in Mn. Sqm
2018-20	192	59.3	3.29
2021-22	173	19.89	2.22
Total	**365**	**79.19**	**5.51**

BEE Star Rating for Buildings

Under the BEE star rating scheme, existing buildings are being labeled as per their actual Energy Performance Indices (EPI) on a scale of 1 to 5 stars. The sets of standard EPI bandwidths developed to rate buildings under this scheme for different climatic zones indicate

the range of variations. Till the end of March 2022, total 264 buildings have been awarded Star Rating under this programme. On account of the total number of star-rated buildings in the last 5 years, the total energy (electrical) saved by these commercial establishments in the year 2021-22 is 261.57 MU. This has led to a reduction of 0.2065 Tonnes of CO_2.

Table 81:Energy-saving summary of Star rated scheme

Building Type	Energy Savings in MU						CO_2 Emission Reductions (MtCO2)
	2017-18	2018-19	2019-20	2020-21	2021-22	Total	
Offices	6.2	7.9	51.5	14.3	12.8	92.77	0.0732
BPO	28.6	40.8	86.2	0.0	0.0	155.6	0.1229
Hospital	0.0	3.5	0.9	0.0	0.0	4.4	0.0034
Mall	0.0	8.9	0.0	0.0	0.0	8.9	0.0070
Total	**34.8**	**61.0**	**138.6**	**14.3**	**12.8**	261.57	0.2065

UJALA

EESL, under UJALA programme, is promoting energy efficiency through LED lamps, Energy efficient tube lights and energy efficient fans. EESL has sold 7.6 crore LED lamps during the FY 2018-22. This programme has saved over 9.8 BU and has led to avoidance of 9,734 million units of energy savings annually.

Table 82: Energy savings from UJALA programme

Year	Energy savings (MU): LED lamps	Energy savings (MU): LED Tube lights	Energy savings (MU): EE Fans
FY 18-19	7,436	57	55
FY 19-20	1,533	8.7	10
FY 20-21	630	4.52	3.96
FY 21-22	135.32	2.30	5.25
Total	**9734**	**73**	**74**

SLNP

Street Lighting National Programme (SLNP) is being implemented in 29 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 6.74 BU and has led to avoidance of 0.371 Mn tonnes of carbon dioxide emissions annually.

Agriculture

BEE has made significant efforts towards mandating the use of EE pumps in agriculture by involving state regulatory commissions. Under AgDSM programme, BEE is organizing training programs for pump technicians who have a major role to play in replacing old inefficient pumps

with BEE star rated pump sets. BEE and ICAR has signed an MoU to conduct training and awareness programs for farmers to promote the use of EE agricultural pump sets

Under AgDSM programme EESL has been retrofitting BEE star rated pump sets in Andhra Pradesh, Karnataka, and Uttar Pradesh, during FY18-22. A total of 78,977 BEE five star rated agricultural pump sets have been installed, which has led to energy savings of 0.01 BU and avoidance of 0.005 Mn tonnes of carbon dioxide emissions.

Transport

Corporate Average Fuel Economy (CAFE)

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

The standard for a manufacturer is set in terms of gasoline-equivalent liters per 100 kilometers (L/100 km) based on vehicle curb weight. This intervention has led to energy saving of 0.38 Mtoe during FY 21-22 and 1.09 million tonnes of CO_2 reduction.

Faster Adoption and Manufacturing of Electric Vehicles (FAME)

FAME I and FAME II have been developed to promote electric vehicles (EV) and Public EV charging infrastructure towards cleaner road transport. This program has led to energy savings of 0.042 Mtoe and 0.269 Mn tonnes of carbon dioxide emission reductions during FY 21-22.

BEE is also supporting various projects to promote Public 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.

12.1. Impact of various energy efficiency measures undertaken during 2021-22

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. Per capita energy consumption of India is estimated as 0.58 Mtoe and the energy intensity of Indian economy is 53.66 per INR.[153]

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 33.35 Mtoe in the demand side energy consumption. A comparison of the energy savings across various sectors of the economy is presented in Table 83.

Table 83: Sector wise energy savings vis-à-vis energy consumption in demand-side sectors

Sector	Energy[154] savings in FY 2021-22 (Mtoe)
Industry (Excluding TPP, DISCOMs, and Refineries)[155]	20.33
Domestic (S&L and UJALA)	10.21
Commercial Buildings	0.043
SLNP	0.73
Transport	2.03
Total	**33.35**

[153]https://www.mospi.gov.in/sites/default/files/publication_reports/Energy_Statistics_2023/EnergyStatisticsIndia2023.pdf
[154] Total energy including thermal and electrical energy
[155] Energy Savings from TPP, Refineries & DISCOMs is not considered for demand side energy savings

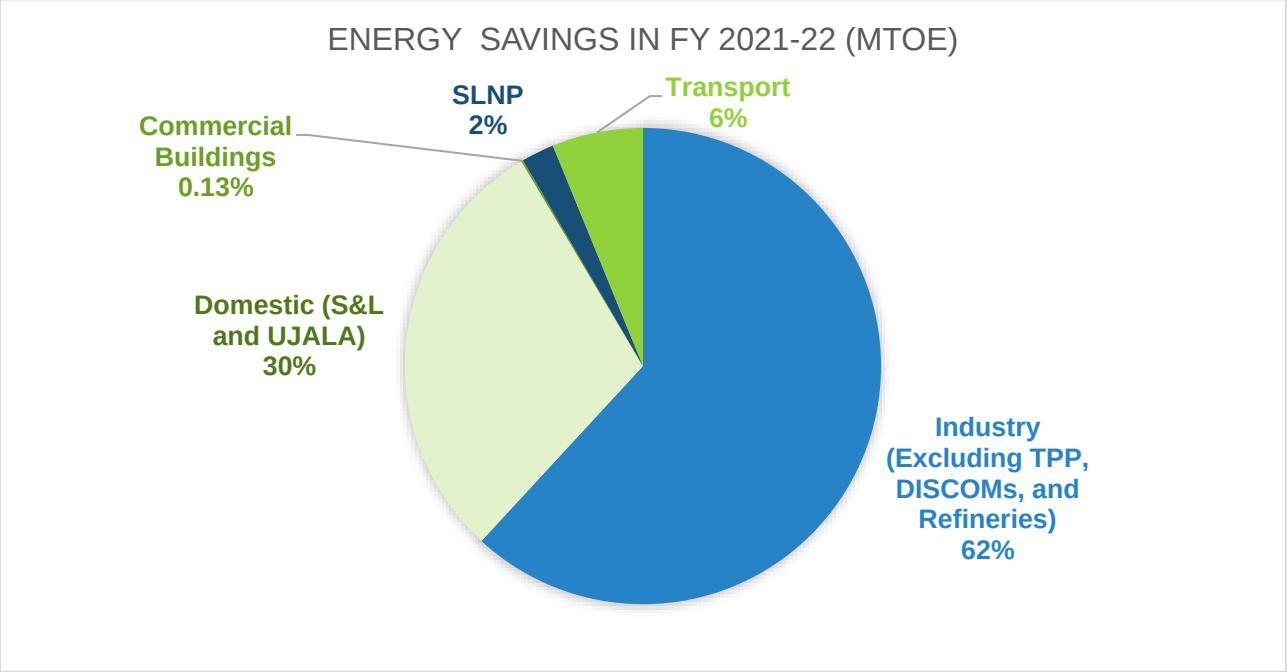


Figure 83: Share of Energy Savings across sectors of the economy

Industry sector has contributed to 61% of the total energy savings while domestic sector has contributed to 30% of the total savings achieved during FY 21-22. While remaining sectors contributed to around 8.13% of total energy savings for 2021-22.

Electrical energy Savings (Consumption Side)

The electricity consumption by all the sectors during the FY 2021-22 was 12,96,300 GWh. Out of the total consumption of electricity in 2021-22, the industry sector accounted for the largest share (41.16%), followed by domestic (25.77%), agriculture (17.67%) and commercial sectors (8.29%).[156]

Adoption of energy efficiency schemes/programmes as considered for this study has reduced the overall electricity consumption by 249.89 BU. This has led to the reduction of 19.28% of the electrical energy requirement (1296.3 TWh) across various sectors of the economy in the FY 21-22.

Table 84: Sector wise electrical energy savings (BU) vis-à-vis consumption in demand-side sectors

Sector	Electrical Energy Savings 2021-22 (BU)
Industry (Excluding TPP, DISCOMs, & Refineries)[157]	40.19
Domestic (S&L and UJALA)	200.21
Commercial Buildings (Including buildings under PAT)	0.5007
Agriculture (Star Rated Pumps)	0.46
Others (Including Municipal)	8.52

[156] Source: Energy Statistics Report 2023, MoSPI
[157]Electrical savings from DISCOMs, & Refineries are considered for supply side and not considered here

Sector	Electrical Energy Savings 2021-22 (BU)
Total	**249.89**

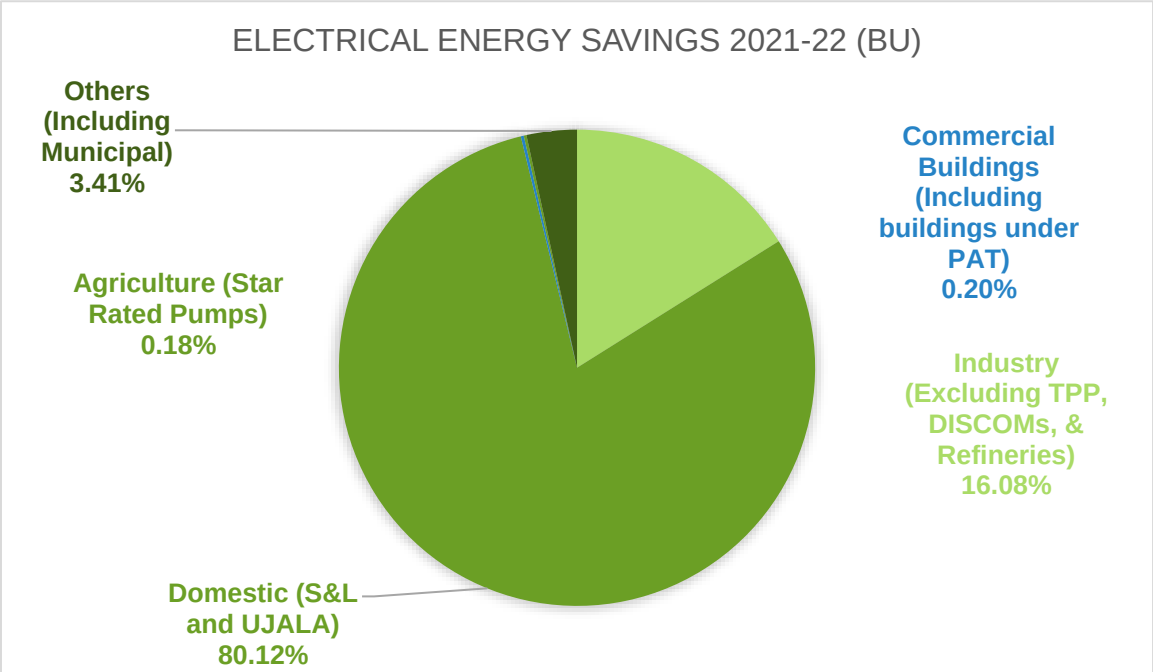


Figure 84: Share of Electrical Energy Savings across sectors of the economy

Domestic sector has the highest contribution (80.12%) in the total electrical energy savings from all energy efficiency interventions carried out during FY 2021-22.

12.1.1. Way Forward

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. India has committed to combat climate change by ensuring the regulatory framework is in place to ensure growth and development of the economy along low carbon pathways towards reducing 1 billion tonnes of projected emissions till 2030 and achieve net-zero by 2070. India's had developed various missions to combat the impact of Climate Action through implementation of eight National Missions.

Government recently approved India's Updated Nationally Determined Contribution (NDC), which translates the COP26 announcements into enhanced climate targets. The G20 presidency places India on the global stage and allows it to establish its priorities and narratives within the international agenda. India is also expeditiously moving forward on its energy transition journey and government's plan to establish a National Hydrogen Mission is a step in the right direction.

India has made the commitment to the Paris climate agreement which includes a pledge to reduce carbon emissions by 45% by 2030 (from 2005 levels), as well as a commitment to 50%

percent of power generation from renewable sources. India has made steady investments in renewable energy resources and created jobs in that sector, but the country also faces critical constraints and has not moved away from relying on coal as a major source of energy. Looking ahead, the Government has laid out an ambitious vision to bring secure, affordable, and sustainable energy to all its citizens.

BEE has critical role in accelerate the pace of energy efficiency in the country. BEE has designed various policies and programmes with primary objective to reduce energy intensity the country such as Standards and Labelling, the Energy Conservation Building Code (ECBC), and the Perform, Achieve and Trade (PAT) scheme etc.

In view of above, BEE has established a dedicated Energy Data Management Unit (EDMU) to compile and publish data regarding the supply and consumption of energy in various sectors of economy. EDMU will develop comprehensive and unified approach for energy statistics and enhance their dissemination to facilitate advancements in energy policy.

Acknowledgement

The study “Impact of Energy Efficiency Measures for the year 2021-22” is the outcome of the collaborative efforts of the Bureau of Energy Efficiency (BEE) and Deloitte Touche Tohmatsu India, LLP (‘Deloitte India’) subsequent to engagement between BEE and Deloitte India. The performance of Deloitte India’s services and the report issued to BEE are based on and subject to the terms of the engagement contract with BEE.

The Deloitte India- Risk Advisory team extends its profound thanks to **Mr. Abhay Bakre**, Director General (BEE), for his leadership and guidance during the execution of the assignment. Deloitte India acknowledges the co-operation and the support extended by **Mr. Arijit Sengupta,** Director (BEE) for supervising the assignment throughout the execution phase. The project team appreciates **Ms. Deepshikha Wadhwa,** Senior Sector Expert (BEE)**,** and **Mr. Manish Kumar**, Project Engineer (BEE), for their support in coordination with various ministries and agencies.

This study was carried out under the guidance of Mr. Ajay Kumar Pillai, Partner, Risk Advisory (Deloitte India) and Ms. Amrita Ganguly (Executive Director, Deloitte India) who led the project activities, and under their leadership, Deloitte Consultants Mr. Akash Vajpai, Mr. Puneet Khare, Mr. Saqib Khan and Ms. Mansi Khurana who carried out the stakeholder consultations, data collection, and energy saving estimations for measuring the impact of energy efficiency measures for the FY 2018-22.

Deloitte India would like to acknowledge and express our gratitude to all the stakeholders who have provided valuable inputs, suggestions and support during the course of the study. Their insight and suggestions have helped us put together the findings and results of the energy savings obtained through various EE programmes/schemes being implemented in India.

Deloitte India also acknowledges the support provided by the government ministries and agencies during the stakeholder consultation. The list of Ministries and agencies include Ministry of Power (MoP), Central Electricity Authority (CEA), Ministry of Micro, Small and Medium Enterprises (MoMSME), Ministry of Statistics and Programme Implementation (MOSPI), Ministry of Railways, Department of Heavy Industries (DHI), International Centre for Automotive Technology (ICAT), Energy Efficiency Services Limited (EESL), and others.

Disclaimer

This Impact of various energy efficiency measures undertaken during 2021-22 on the energy consumption of the country report dated May 2023 (“Report”) has been prepared for the sole use and benefit of Bureau of Energy Efficiency (BEE) pursuant to a contract entered into between Deloitte Touche Tohmatsu India LLP (“Service Provider”) and Bureau of Energy Efficiency.

In the event any party other than Bureau of Energy Efficiency (“THIRD PARTY”) is accessing this report, then by reading or retaining such copy of this report, such third party shall be deemed to have accepted the following terms of this notice, intending to be legally bound by the same:

1. No third party is entitled to use or rely on this Report for any purpose whatsoever and Service Provider accepts no responsibility or duty of care or liability to such third party. In the event that any third party uses the Report for any purposes whatsoever, it shall do so at its own risk, without recourse to Service Provider and Service Provider shall not be directly or indirectly liable for any losses, damages, costs or expenses, whether in contract, tort or otherwise, suffered by such third party.
2. Any content of the Report shall not be re-produced or copied
3. Service Provider will not be responsible and obligated to discuss, explain or reply to queries raised by any person or entity other than BEE.
4. Service Provider makes no representations as to the sufficiency or even appropriateness of the Report for the purposes of any third party.
5. Access to the Report is not a substitute for the third party undertaking its own appropriate inquiries and procedures in relation to the matters covered in the Report.
6. Third party unconditionally and irrevocably releases Service Provider and its personnel from all claims, liabilities, losses, damages, costs and expenses relating to or arising out of the Report or the access to or use of the Report by the third party and any assertion of reliance in relation thereto. Third party will not bring any claim against Service Provider in relation to the Report.
7. The Report is prepared basis information obtained from public domain or external sources and Service Provider takes no responsibility for the authenticity, accuracy or completeness of such information

References

1. Energy Statistics 2023, Ministry of Statistics and Programme Implementation

   https://www.mospi.gov.in/sites/default/files/publication_reports/Energy_Statistics_2023/EnergyStatisticsIndia2023.pdf

2. Energy Efficiency Services Limited Annual Report 2021-22

   https://eeslindia.org/wp-content/uploads/2022/09/Annual-Report-FY-2021-22.pdf

3. Ministry of Micro, Small and Medium Enterprises Annual Report 2021-22

   https://msme.gov.in/sites/default/files/MSMEENGLISHANNUALREPORT2021-22.pdf

4. Indian Railways Annual Report & Accounts 2021-22

   https://iritm.indianrailways.gov.in/instt//uploads/files/1680252554005-Indian%20Railways%20Annual%20Report%20&%20Accounts%20English%202021-22_web_Final.pdf

5. Ministry of Road Transport and Highways Annual Report 2021-22

   https://morth.nic.in/sites/default/files/Annual%20Report_21-22-1.pdf

6. Ministry of Heavy Industries Annual Report 2021-22

   https://heavyindustries.gov.in/writereaddata/UploadFile/Annual%20Report%202021-22%20English637823518398879406.pdf

7. CO2 Baseline Database for the Indian Power Sector

   https://cea.nic.in/wp-content/uploads/baseline/2023/01/Approved_report_emission__2021_22.pdf

8. India Brand Equity Foundation (IBEF)

   https://www.ibef.org/download/1673935106_Automobile-Nov2022.pdf

9. FAME II - Ministry of Heavy Industries

   https://fame2.heavyindustries.gov.in/content/english/16_1_Timeline.aspx

10. India's Updated First Nationally Determined Contribution Under Paris Agreement

    https://unfccc.int/sites/default/files/NDC/2022-08/India%20Updated%20First%20Nationally%20Determined%20Contrib.pdf

11. Indian Railways environmental sustainability

https://indianrailways.gov.in/railwayboard/uploads/directorate/Environment_Management/2022/ENHM%20Booklet.pdf

12. International Energy Agency- Agricultural Demand Side Management (AgDSM) Programme

    https://www.iea.org/policies/7460-agricultural-demand-side-management-agdsm-programme

13. Project Profile “Street Light Fittings” by Ministry of MSME, Government of India

    http://dcmsme.gov.in/Street%20light%20fittings.pdf

BUREAU OF ENERGY EFFICIENCY
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan, R.K. Puram, New Delhi - 110066
Website: www.beeindia.gov.in

@beeindiadigital beeindiadigital