MINISTRY OF POWER
GOVERNMENT OF INDIA

UPNEDA

STATE ENERGY EFFICIENCY ACTION PLAN (SEEAP)

UTTAR PRADESH - ACTION PLAN

JANUARY 2025

श्रीकांत नागुलापल्ली, भा.प्र.से.
अपर सचिव, एमओपी एवं महानिदेशक, बीईई
SRIKANT NAGULAPALLI, IAS
Additional Secretary, MoP & Director General, BEE

सत्यमेव जयते

Azadi Ka Amrit Mahotsav

ऊर्जा दक्षता ब्यूरो
(विद्युत मंत्रालय, भारत सरकार)
BUREAU OF ENERGY EFFICIENCY
(Ministry of Power, Government of India)

Foreword

The Bureau of Energy Efficiency (BEE), under the Ministry of Power, Government of India, has been actively working to promote energy efficiency across various sectors of the Indian economy through initiatives like the National Strategic Plan for Energy Efficiency and the National Mission ROSHANEE. These efforts align with India's commitment to doubling its energy efficiency improvement rate by 2030, as declared at the G20 summit.

To harness the vast potential for energy efficiency in sectors such as industry, buildings, agriculture, and transport, the State Energy Efficiency Action Plan (SEEAP) has been developed. SEEAP aims to establish clear state-wise focus areas and develop actionable strategies to mainstream energy efficiency interventions.

This report provides valuable insights for policymakers, government agencies, and other stakeholders to implement effective programs and achieve India's climate goals. It also serves as a platform for knowledge sharing and scaling up energy efficiency activities nationwide.

I am pleased to announce that most States/UTs have formed State Level Steering Committees (SLSCs) under the leadership of Chief Secretaries. These committees will play a crucial role in developing mechanisms to implement the identified action plans.

I encourage all stakeholders to review this document and contribute their valuable feedback to further enhance its effectiveness in promoting energy efficiency at the state level.

October, 2024

(Dr. Srikant Nagulapalli)

चौथा तल, सेवा भवन, आर.के. पुरम, नई दिल्ली-110066 / 4th Floor, Sewa Bhawan, R.K. Puram, New Delhi-110 066
दूरभाष / Tel. : 91 (11) 26766701, 20867389, फैक्स / Fax : 91 (11) 20867396
ई-मेल / E-mail : dg-bee@nic.in, वेबसाईट / Website : www.beeindia.gov.in

ACKNOWLEDGEMENT

The development of "State Energy Efficiency Action Plan (SEEAP)" is an important step towards the Central-State collaboration for mainstreaming energy efficiency at the State/UT level to achieve India's climate commitments. This strategic document has been prepared based on collaboration of Bureau of Energy Efficiency, Ministry of Power, Government of India along with State Designated Agencies and different stakeholder and ministries in the State/UT level.

The ASSOCHAM team extends its profound thanks to Shri Pankaj Agarwal, Secretary, Ministry of Power, Government of India and Shri Srikant Nagulpalli, Director General, Bureau of Energy Efficiency (BEE), for their leadership and guidance during the execution of the assignment. The ASSOCHAM team recognizes and extends its sincere gratitude to Shri Milind Deore, Secretary, BEE, for his invaluable input provided during the execution of the assignment. The team acknowledges the co-operation and the support extended by Shri Abhishek Sharma, Director, BEE for supervising the assignment throughout the execution phase. The team appreciates Shri Vikash Kumar Jha, Project Engineer, BEE for his continuous support in coordination with various stakeholders.

The ASSOCHAM team extends its sincere gratitude to Shri Narendra Bhooshan (IAS), Principal Secretary, Additional Sources of Energy, Govt. of UP, Shri Anupam Shukla (IAS), Director and Shri Pankaj Singh, PCS, Secretary & Chief Project Officer, Uttar Pradesh New & Renewable Energy Development Agency (UPNEDA), Govt. of UP, Shri Ashish Tiwari (IFS), Secretary, Department of Environment, Forest & Climate Change, Govt. of UP for their valuable guidance towards the execution of the assignment. We also acknowledge the support provided by Shri Rakesh Agarwal, Senior Project Officer (I), UPNEDA, Shri Girish Kumar, SEC, UPNEDA for their extended support for successfully completing the project. The team also extends its sincere thanks to all the state government departments and stakeholders of the state of Uttar Pradesh for their valuable input towards the completion of the earmarked project tasks.

The ASSOCHAM team extends its sincere gratitude to all government and private sector participants of the physical survey whose inputs have been considered as part of the report. The team also extends its gratitude to the industry associations, building sector professionals and other stakeholders who were extensively consulted as part of the project.

Finally, ASSOCHAM is grateful to the in-house team of ASSOCHAM for their consistent efforts in bringing this report to fruition.

Associated Chambers of Commerce and Industry of India (ASSOCHAM)

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1. INTRODUCTION 13
1.1. Background 1
1.2. India's Nationally Determined Contributions (NDCs) 2
1.3. About SEEAP 3
1.4. State Profile 4
1.5. State Energy Scenario 5
1.6. Energy Consumption Scenario (TFEC) 11
1.7. Overview of Institutional Framework and Stakeholder Mapping 16

2. IDENTIFICATION OF FOCUS SECTORS 19
2.1. Methodology of Focus Sector Identification 20
2.2. Identified Focus Sectors 20

3. PROJECTIONS AND FORECASTING 23

4. FOCUS SECTOR 1 – INDUSTRY 26
4.1. Current Scenario 27
4.2. Energy Efficiency Strategies in the Industry Sector 29
4.3. Energy Saving Targets & Monitoring Mechanism 58

5. FOCUS SECTOR 2 – BUILDINGS 61
5.1. Current Scenario 62
5.2. Energy Efficiency Strategies in the Buildings Sector 63
5.3. Energy Saving Targets & Monitoring Mechanism 81

6. FOCUS SECTOR 3 – TRANSPORT 84
6.1. Current Scenario 85
6.2. Energy Efficiency Strategies in the Transport Sector 88
6.3. Energy Saving Targets & Monitoring Mechanism 96

7. FOCUS SECTOR 4 – AGRICULTURE 99
7.1. Current Scenario 100
7.2. Energy Efficiency Strategies in the Agriculture Sector 100
7.3. Energy Saving Targets & Monitoring Mechanism 112

8. MARKET POTENTIAL IN FOCUS SECTORS 115

9. THE WAY FORWARD 117

10. FINANCIAL MECHANISMS 121

11. BIBLIOGRAPHY 128

LIST OF FIGURES

Figure 1: *Map of Uttar Pradesh 4*
Figure 2: *Source-Wise Installed Power Plant Capacity....5*
Figure 3: *Installed capacity historic trend – FY 2015 – FY2023 ....6*
Figure 4: *Ownership wise installed power capacity 7*
Figure 5: *Share of installed capacity of renewable energy power plants – FY2020....8*
Figure 6: *Source-wise Total Final Energy Consumption (TFEC) – FY 2015 – FY2023 ....12*
Figure 7: *Source-wise TFEC – FY 2020....12*
Figure 8: *Oil products consumption trend – FY 2015 – FY2023....14*
Figure 9: *Total Supplied Gas – FY 2015 – FY2023....15*
Figure 10: *Electricity Consumption Trend in GWh and Mtoe 15*
Figure 11: *Stakeholders identified in various sectors of Uttar Pradesh. 17*
Figure 12: *Sub-categorization of Uttar Pradesh's industry sector 19*
Figure 13 *Sectoral Share of TFEC (Mtoe) for FY 2020....21*
Figure 14 *Sectoral GSDP Contribution - FY2020....22*
Figure 13: *Uttar Pradesh GSDP – actual and projected 24*
Figure 14: *Figure showing projection of GSDP vis-a-vis TFEC 25*
Figure 15: *Classification of Industries in PAT and non-PAT sectors....28*
Figure 16: *Growth of total electricity consumption vis-a-vis residential and commercial consumption. .62*
Figure 17: *Energy Consumption in Buildings Sector....63*
Figure 18: *Total registered vehicles in the state from 2017-2021....85*
Figure 19: *Projected number of registered vehicles in Uttar Pradesh by 2030 ....86*
Figure 20: *Category-wise share of registered vehicles (2021) 86*
Figure 21 *Total Energy Saving Potential 115*

LIST OF TABLES

Table 1: *Moderate and ambitious scenarios for deepening and widening of PAT scheme for sugar and cement industry....31*
Table 2*: Table showing key reduction potential in brick Industry 37*
Table 3*: Table showing key reduction potential in Glass Industry 41*
Table 4 *Table showing key reduction potential in Paper Industry 45*
Table 5: *Table showing key reduction potential in Foundry Units 49*
Table 6 *Moderate and ambitious scenarios energy savings for Industry sector 58*
Table 7: *List of mandatory and voluntary appliances under S&L Programme....71*
Table 8: *Appliances taken into consideration for the S&L strategy 73*
Table 9 *Moderate and ambitious scenarios for deepening of S&L Programme....74*
Table 10: *Moderate and ambitious scenarios energy savings for building sector 81*
Table 11: *EV transition considerations for moderate and ambitious scenarios....89*
Table 12*: Energy Savings and Emission Reduction Potential 89*
Table 13 *Moderate and ambitious scenarios for Ethanol & Biodiesel blending....95*
Table 14: *Moderate & ambitious scenarios for transition of diesel & electric to solar pumps 103*
Table 15 *Energy Savings from Agriculture Sector 112*
Table 16 *Energy Saving Summary....116*

Abbreviations

AAGR - Average Annual Growth Rate
ASSOCHAM - The Associated Chambers of Commerce and Industry of India
AgDSM - Agriculture Demand Side Management
AMRUT – Atal Mission for Rejuvenation and Urban Transformation
BEE - Bureau of Energy Efficiency
BLDC - Brushless Direct Current
CAGR - Compound Annual Growth Rate
CEA- Central Electricity Authority of India
DISCOM - Distribution Company
DSM - Demand Side Management
ECBC - Energy Conservation Building Code
ECSBC – Energy Conservation & Sustainable Building Code
EE - Energy Efficiency
EESL - Energy Efficiency Services Limited
EIA - Energy Information Agency
ENS – Eco Niwas Samhita
ESCO- Energy service companies
FY - Financial Year
GSDP - Gross State Domestic Product
KUSUM - Kisan Urja Suraksha Evam Utthaan Mahabhiyan
LED - Light Emitting Diode
UPNEDA – Uttar Pradesh New and Renewable Energy Development Agency
UPRVUNL– Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited
UPPCL- Uttar Pradesh Power Corporation Limited
MVVNL– Madhyanchal Vidyut Vitran Nigam Limited
PVVNL– Paschimanchal Vidyut Vitran Nigam Limited
DVVNL– Dakshinanchal Vidyut Vitran Nigam Limited
PuVVNL– Purvanchal Vidyut Vitran Nigam Limited
KESCO – Kanpur Electricity Supply Company Limited
UPREV- Uttar Pradesh Renewable and EV Infrastructure Limited
NOIDA- New Okhla Industrial Development Authority
BIDA- Bundelkhand Industrial Development Authority
MNRE - Ministry of New and Renewable Energy
MOSPI - Ministry of Statistics and Programme Implementation
Mtoe - Million Tonne of Oil Equivalent
MU - Million Unit of Electricity (in kWh)

MuDSM - Municipal Demand Side Management
NEMMP - National Electric Mobility Mission Plan
NHPC - National Hydroelectric Power Corporation
NMEEE - National Mission on Enhanced Energy Efficiency
PMKSY - Pradhan Mantri Krishi Sinchai Yojana
RBI – Reserve Bank of India
SLNP – Street Light National Programme
SEEAP - State Energy Efficiency Action Plan
SEEI - State Energy Efficiency Index
UNNATEE - Unlocking National Energy Efficiency Potential

Executive Summary

Increasing energy demand naturally strains the country's resources and impacts the environment. This warrants decoupling the country's economic growth and energy demand. This is also echoed through India's Intended Nationally Determined Contribution submitted in the run-up to the Paris Climate Conference, where the government has highlighted energy conservation as a key mitigation strategy. The Government of India in the 26th session of the Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Glasgow, United Kingdom in 2021, presented the five nectar elements (Panchamrit) of India's climate action including the target of net-zero emissions by 2070 and get 50% of its energy from renewable resources by 2030. In meeting the national level targets, States/UTs play a vital role in transitions to low-carbon development pathways. Bureau of Energy Efficiency under the guidance of Ministry of Power developed state specific energy efficiency action plan to ensure that the allocation of resources as per the requirement of State that will help in meeting state-specific goals on sustainable development.

The State Energy Efficiency Action Plan for a particular State/UT developed by identifying focus sectors of the State/UT and estimate the potential of energy conservation in sectors which are predominant in the region. The State Energy Efficiency Action Plan is developed for short term-plan for a tenure of 5 years and a long-term plan targeting high-impact energy efficiency by the year 2031.

For the State of Uttar Pradesh, SEEAP was developed under the guidelines of Bureau of Energy Efficiency, Ministry of Power, GOI and Uttar Pradesh New & Renewable Energy Development Agency (UPNEDA) and inputs & suggestions from various government departments and sector experts were considered. The objective of the State Energy Efficiency Action Plan is to arrive at sector-specific approaches for energy efficiency for the State of Uttar Pradesh.

In FY 2020, Uttar Pradesh has total final energy consumption (TFEC) 49.37 Mtoe in which Non-power or Industrial coal consumption was 23%, followed by 38% oil consumption, 4% consumption in terms of coal in captive plants, 18% in terms of imported coal and 16% in terms of electricity. Based on energy consumption and economic growth of state total final energy consumption of state is projected and it is estimated that TFEC of Uttar Pradesh in FY 2031 will be 266.50 Mtoe. On the basis of projected GSDP of the state and projected energy consumption, Industry, Buildings, Transport and Agriculture sectors were identified as focus sectors and sector specific strategies were analyzed. List of sector specific focused strategies to ensure that the allocation of resources as per the requirement of the State is listed below:

Industry Sector:

- Deepening and Widening of PAT Scheme
- Energy Efficiency Interventions in Bricks Clusters
- Energy Efficiency Interventions in Glass Clusters
- Energy Efficiency Interventions in Papers Clusters
- Energy Efficiency Intervention in Foundry Clusters
- Clean Energy Transition in Thermal Power Plant

Buildings Sector:

- Effective Implementation of Energy Conservation & Sustainable Building Code (ECSBC)
- Replacement program for inefficient appliances
- BEE Star Rating and Shunya Rating of Building.

Transport Sector:

- Infrastructure development for EV charging stations and incentives to consumers for quick transition to EVs.
- Ethanol Blending and Biodiesel blending program
- Promotion of Standard and Labelling program of Tyres for Fuel Efficiency in Vehicles

Agriculture Sector:

- Replacement of old pumps (10 years old) or less efficient pumps (non-star rated) with 5 Star rated Pumps along with smart control panel
- Transition of Electric Pumps to Solar Powered Pumps
- Issuance of notification or government directive that all the new pumps installed in the state should be either energy efficient 5 star rated pumps or solar pumps
- Sustainable Agriculture through Micro Irrigation
- Solarization of Agriculture Feeder
- Promotion of smart agriculture practices and energy efficient farm machineries

This action plan will result in a total energy consumption reduction of 10.16 Mtoe in the moderate scenario and 19.26 Mtoe in the ambitious scenario in FY 2031. This plan will also create awareness at the mass level and create a market potential of approximate rupees 35,446 Crore in the field of energy efficiency and reduce the CO_2 emission by 31.81 $MtCO_2$ in moderate scenario and 60.29 $MtCO_2$ in ambitious scenario by FY 2031.

While the implementation of this plan may pose challenges, the targets for each focus sector are achievable through strategic efforts and active stakeholder engagement.

Industrial Sector:

For instance, under Strategy #4: Energy Efficiency Interventions in Paper Clusters, the target is set at 0.03 Mtoe. Based on current performance data from the Perform, Achieve, and Trade (PAT) scheme, the average energy saving for a paper industry is approximately 0.0176 Mtoe per tonne. Applied to the 13 PAT-designated paper industries, this results in an estimated saving of 0.0244 Mtoe. In ambitious scenarios, where industries exhibit enhanced performance, cumulative savings by FY 2031 indicate the feasibility of achieving or exceeding the set targets.

Transport Sector:

In the transport sector, Strategy #1: Energy Savings from EV Transition has shown promising progress. The registration of EVs increased by 71% from 2022 to 2023, compared to a 10% increase in petrol vehicle registrations during the same period. The net energy savings from the EV transition is estimated to be over 6 Mtoe, surpassing the

ambitious target of 5.53 Mtoe. This trend strongly suggests the potential to meet or exceed the energy-saving targets for the state by FY 2031.

Therefore, the ambitious targets established for each focus sector and their corresponding strategies are thoroughly substantiated, formulated with due diligence, and supported by stakeholder consultations. These targets, derived from comprehensive and robust calculations, are both realistic and achievable. Achieving the outlined energy savings will necessitate sustained efforts, coordinated implementation, and proactive engagement with all relevant stakeholders.

1. Introduction

1.1. Background

India's economy is characterized by an emerging and developing market. In 2019, India became the fifth-largest economy in the world in nominal terms, surpassing United Kingdom and behind the United States, China, Japan and Germany. The size of the Indian economy in Fiscal Year (FY) 2020 was estimated to be INR 145 Lakh Crores at constant prices of 2011-12. With the growth of the Indian economy, the demand for energy has increased significantly, resulting in high energy levels in some sectors and increase in the country's emissions.

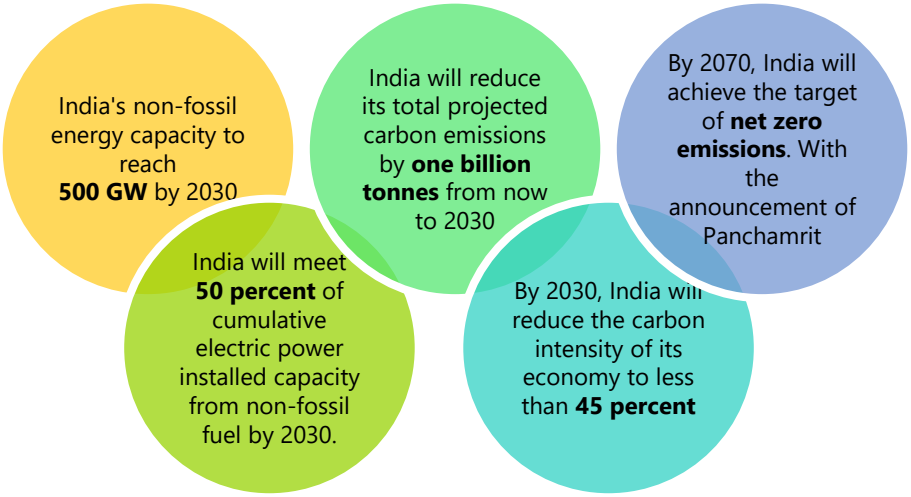
As per International Energy Agency's (IEA) World Energy Outlook 2021 report, India currently has a share of 6.1% in the global primary energy consumption, which is projected to increase to 9.8% by the year 2050. India's Final Energy Consumption in FY 2020 was recorded at 533.44 Mtoe (as per Domestic Conversion Factors), with coal and crude oil being the largest contributors to the total energy consumption. India's per capita energy consumption and per capita emissions are well below the global average per capita emissions. However, India continuously taking steps to reduce the energy consumption and emissions and ensure sustainable growth of nation.

India has set ambitious economic goals for the future and achieving these goals is expected to result in significant increase in the country's energy demand and emissions. In view of this, India has also set ambitious goals for energy and climate performance. The country has also emphasized on the importance of energy transition towards decarbonization of the economy and has recently emerged as one of the world leaders in Energy Transition. States and Union Territories of the country have a key role to play in the fulfilment of these goals. The key strategy adopted by the Government of India is the efficient use of energy resources and their conservation. This is essential since the efficient use of energy and its conservation is the least-cost option to meet the

increasing energy demand, reduce wasteful consumption and in leading the country's economic growth in sustainable manner.

1.2. India's Nationally Determined Contributions (NDCs)

In the 2016 Paris Climate Conference, India in its Nationally Determined Contributions (NDCs) had committed that it will reduce the emission intensity of its GDP by 33% to 35% by 2030 from 2005 level. In the Conference of Parties (COP -26) at Glasgow, UK, India announced the Panchamrit, which lists down five ambitions:



India's earlier target of 33% to 35% reduction in emission intensity from 2005 level by 2030 has been revised to approximately 45%. In view of the enhanced target under Panchamrit, India's energy efficiency efforts need to be increased and States and UTs have a vital role in India's energy efficiency policy implementation and in meeting state-specific goals on sustainable development in the most energy-efficient way. It is imperative that the States and UTs actively participate in the schemes to facilitate the achievement of the overall goal of reducing the energy intensity of the country.

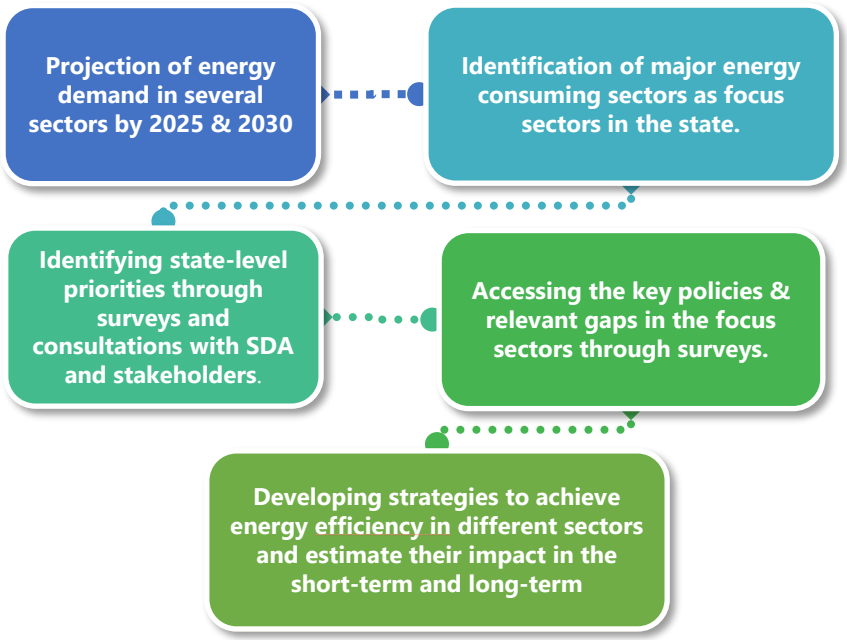
On 1st November 2021, during the 26th United Nations Climate Change Conference of the Parties (COP26) in Glasgow, Prime Minister Narendra Modi introduced the idea of 'Lifestyle for the Environment (LiFE)'. He urged individuals and institutions across the world to support LiFE as a global movement, aimed at promoting mindful and deliberate utilization instead of mindless and destructive consumption to safeguard the

environment. This means making choices that are better for the environment, such as using renewable energy sources, reducing waste, and conserving resources. The program aims to teach people about the impact their daily actions have on the environment and provide them with the tools and resources they need to adopt more eco-friendly practices.

1.3. About SEEAP

The State Energy Efficiency Action Plan for Uttar Pradesh is being developed by identification of focus sectors, to ensure that the allocation of resources as per the requirement of Uttar Pradesh and estimate the potential of energy conservation in sectors that are predominant in Uttar Pradesh. The State Energy Efficiency Action Plan has been developed in two parts, a short term-plan for a tenure of 5 years and a long-term plan targeting high impact energy efficiency by the FY 2031 to achieve the targets committed in COP-26. This State Energy Efficiency Action Plan has been developed under the guidance and support of stakeholder departments/agencies of Uttar Pradesh and will be implemented by them in the state after its adoption.

Expected Outcomes of State Energy Efficiency Action Plan (SEEAP)



1.4. State Profile

Uttar Pradesh is one of the most populous states in India with a population of 19.98 crores according to the 2011 Census of India. The population of the state in the year 2020 was projected to be 22.79 Crores, having a share of 16.52% in India's total population. Uttar Pradesh shares its borders with Nepal on the north, Uttarakhand and Himachal Pradesh on the northwest, Haryana, Delhi and Rajasthan on the west, Madhya Pradesh on the south, Chhattisgarh and Jharkhand on the southeast, and Bihar on the east. The state constitutes of 75 districts spread across an area of 2,40,928 sq. km. Majority of the state's population resides in the rural areas, which constitutes 78% of the state's total population.

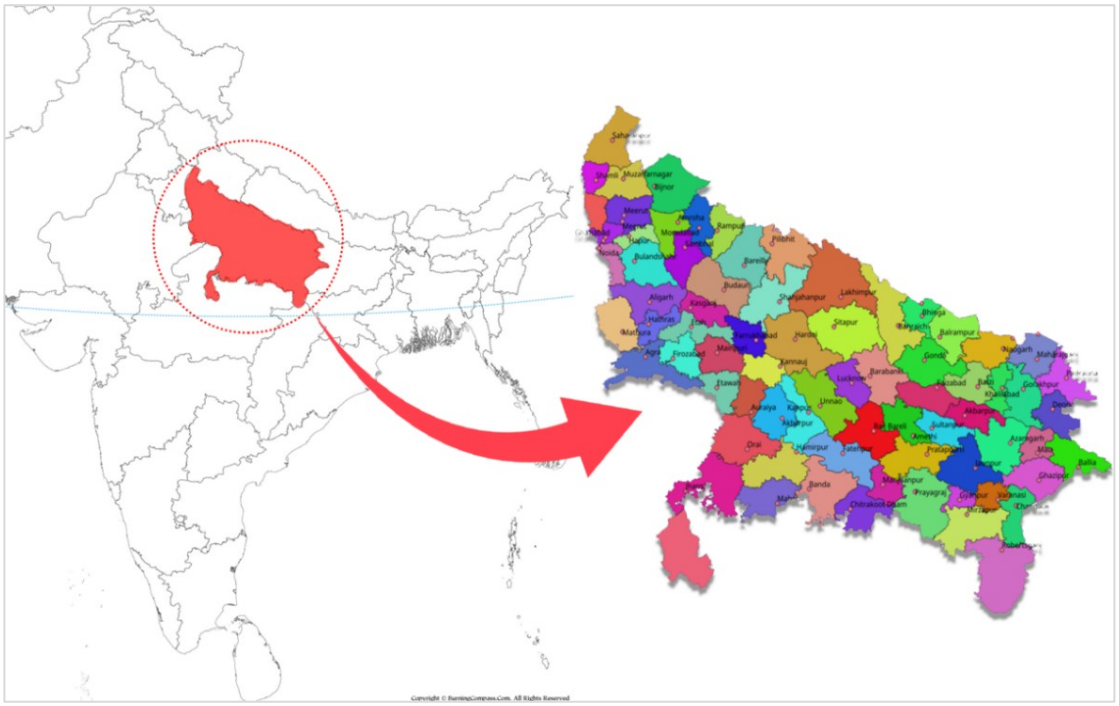


Figure 1: Map of Uttar Pradesh

Uttar Pradesh's Gross Domestic Product (GDP) for the Fiscal Year (FY) 2020 was recorded at INR 17 Lakh crore, having increased from INR 10.11 Lakh Crore in FY 2015 at a CAGR of 11.47%. The share of Uttar Pradesh's GDP in India's overall GDP is 8.3%.

The state had a total installed power plant capacity of 31.74 GW as of March 2020, which constitutes 8.58% of the country's total installed capacity. In line with the country's goals

and the increasing shift to clean energy sources, Uttar Pradesh also has a key focus on promoting renewable power in the state. The state's installed renewable energy capacity of 3.29 GW as of March 2020 constitutes 2.8% of India's installed renewable energy capacity of 132.73 GW during the same period. The main sources of renewable energy in the state are namely Biomass, Solar energy and Hydro including Large and Small Hydro power plants.

1.5. State Energy Scenario

The State of Uttar Pradesh has seen a significant growth in power demand in the past decade. The installed power plant capacity of the state inclusive of renewable and non-renewable sources has increased from 23,049 MW in FY 2015 to 31,746 MW in FY 2020 and 36,276 MW in FY 2023. The state largely relies on coal-based thermal power plants for electricity generation, with coal-based power plants making up nearly approx. 80% of the state's total installed capacity. Renewable Energy is being fast adopted by the state, with a share of 10% in the total capacity and an installed capacity of 3,713 MW in FY 2020, having increased from 2,450 MW in FY 2015 with a CAGR of 8.67%.

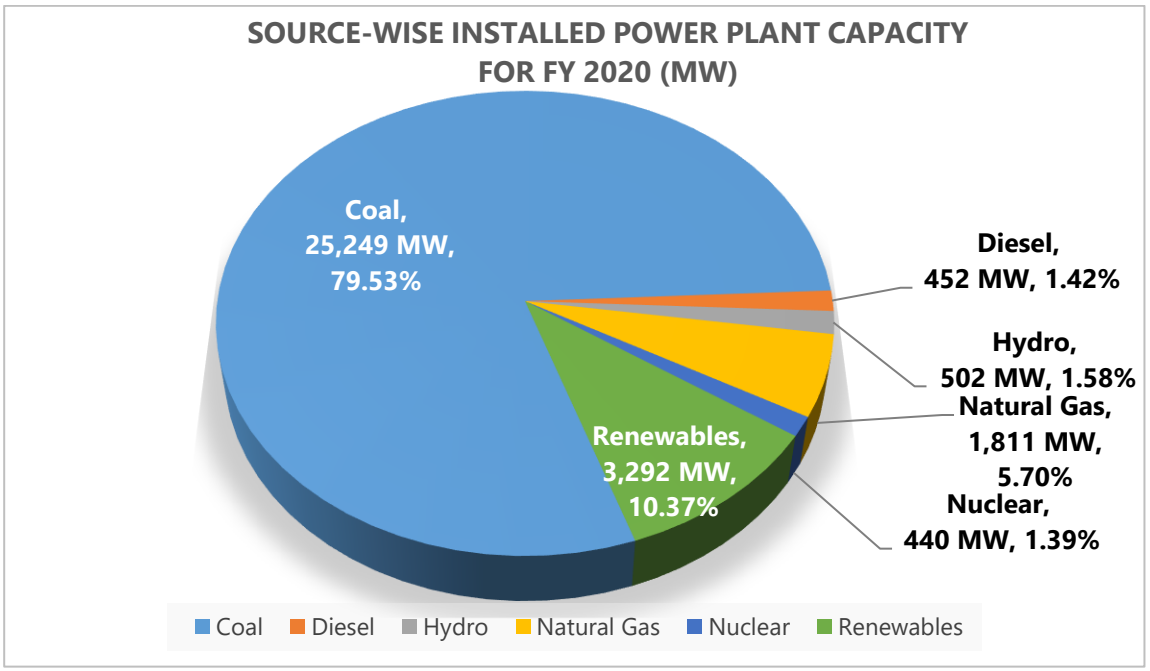


Figure 2: Source-Wise Installed Power Plant Capacity

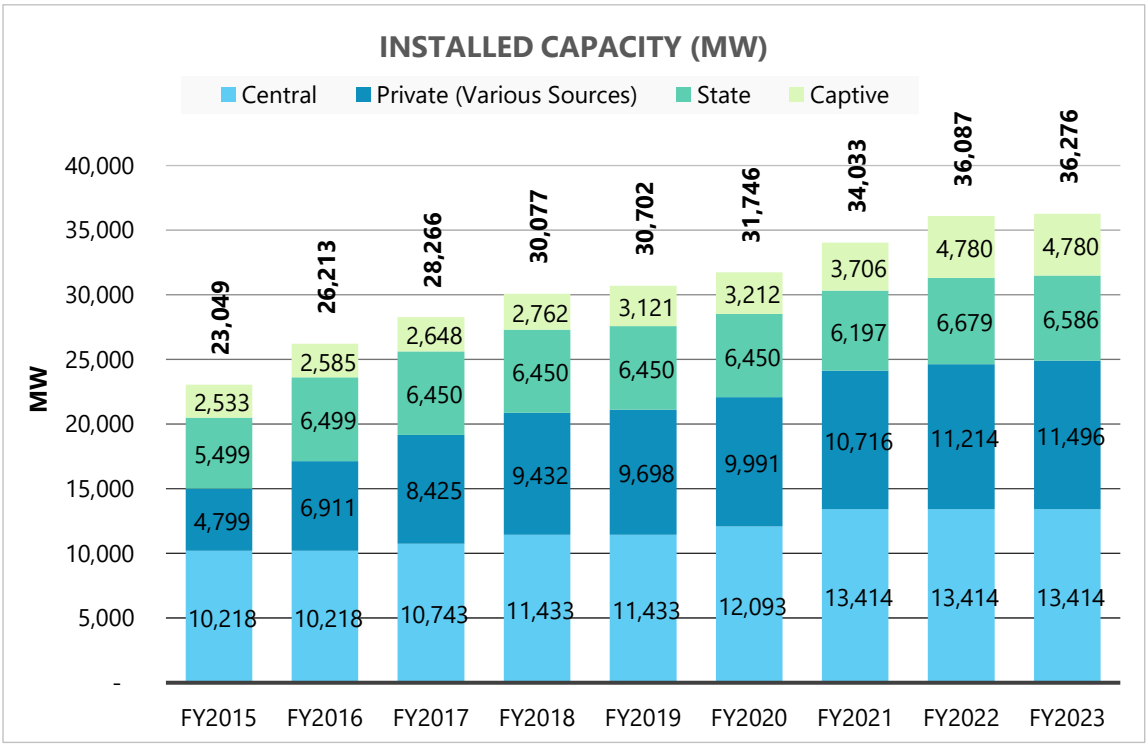


Figure 3: Installed capacity historic trend – FY 2015 – FY2023

The total generation is from various sources including centrally owned thermal and hydro power plants, state-controlled thermal power plants, Independent Power Producers (IPPs), Open Access (OA), and Renewable Energy Sources (RES). Above shows the share of ownership by these stakeholders in the installed capacity of Uttar Pradesh. The largest share of installed capacity of power plants are center controlled, while the state has a 20% share in the total installed capacity catering to the electricity demand of Uttar Pradesh.

Much of the increase in capacity for meeting the ever-increasing demand has taken place over the past two decades after the formation of Energy Conservation Act, 2001. As per the Annual Report of MNRE FY 2021, the State of Uttar Pradesh has a potential of 22.83 GWp of power generation capacity through renewable systems. Uttar Pradesh is also one of the largest producers of sugarcane and rice in India, the by-product bagasse and rice husk form abundant raw materials base for power production in the state. Biomass-based power generation currently has the highest share in installed capacity of renewable energy-based power plants in the state, at 57%. Installed capacity from renewable sources has increased nearly 52% from its 2015 levels. The state is fast progressing to increase the mix of renewable energy in power generation. This can be seen by the fact that between FY 2015 and FY 2020, the installed capacity of RE-based power generation has increased with a CAGR of 8.67%, while the total installed capacity of the state inclusive of RE and Non-RE sources has increased with a CAGR of 6.61%. Co-generation power plants utilizing biomass play an important role in renewable generation for the State of Uttar Pradesh. These plants are beneficial in the industries where both thermal processes and electric energy is required like the pulp and paper mill industries.

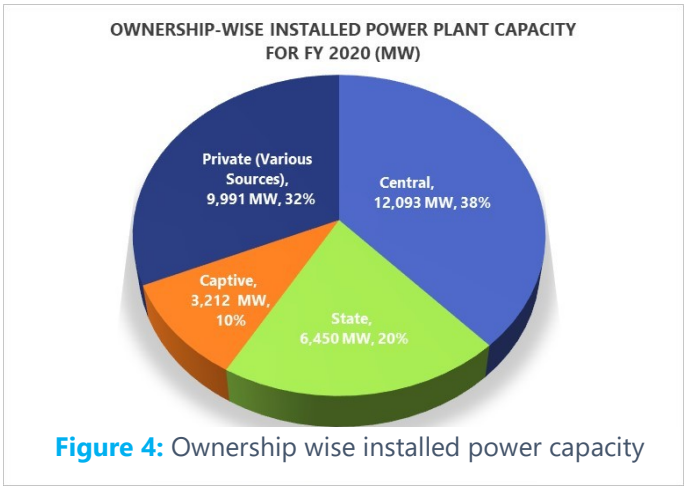


Figure 4: Ownership wise installed power capacity

However, there exists a vast gap between current production and estimated production potential, signifying huge investment opportunities in the renewable energy sector in the state. The state has commissioned 1,095 MW of grid connected solar projects as of FY 2020.

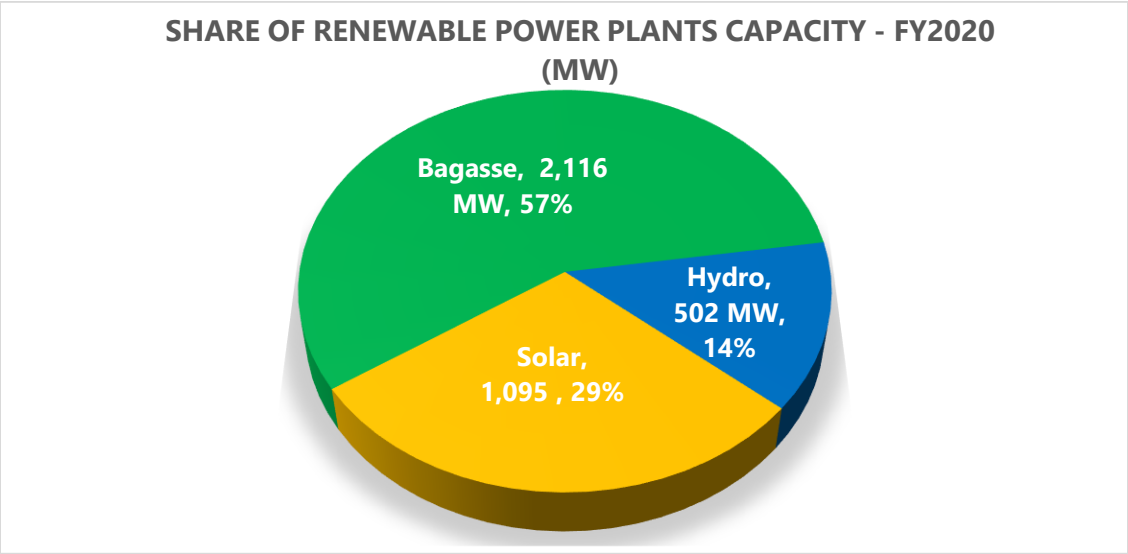


Figure 5: Share of installed capacity of renewable energy power plants – FY2020

The share of Hydro power (502 MW) with respect to the total installed capacity (31,746 MW) is 1.58%. However, the share of hydro power (502 MW) with respect to the total renewable capacity (3,713 MW) is 14%.

The state has a number of policies and programmes to promote renewable energy in the state:

- **Uttar Pradesh Solar Energy Policy 2022 –** Through this policy the state aims to achieve a target of 22,000 MW of solar power projects by 2026-27, also to generate the employment for 30,000 nos., the policy aims to promote the solar energy by developing the solar parks. Ayodhya to be pilot model solar city, thereafter sixteen Nagar Nigam cities to be developed as solar cities. Solarization of segregated agriculture feeders and grid connected private tube wells.
- **Mini Grid Policy 2016–** The policy has an operative period of 10 years and aims to encourage the implementation of mini grid projects in the state with the help of state government subsidies, restrictions on use of electricity based on type of application, and modifications in electricity tariff.
- **Bio Energy Policy 2022** - UPNEDA has implemented a number of bioenergy projects in the state, namely biogas-based power generation projects, biogas-based cogeneration projects, and industrial waste-based projects.

- **Bio Energy Enterprises Promotion Programme** – This programme was launched by UP Bioenergy Development Board with the objective of creating a sustainable bioenergy ecosystem in the state. The policy aims to ensure enough availability of feedstock for processing biofuels and to encourage establishment of bio energy projects such as biodiesel, bioethanol, biomass, compressed biogas, methanol, producer gas, pellets and briquettes. The policy offers a number of financial incentives such as capital subsidies, stamp duty exemptions, SGST reimbursements, etc.
- **Waste to Energy:** NTPC Vidyut Vyapar Nigam (NVVN) Limited, a wholly owned subsidiary of NTPC Ltd, has signed an agreement with Varanasi Nagar Nigam for setting up a Waste to Energy (WTE) Plant worth Rs 180 crores. This project has to convert 600-800 tons of municipal solid waste per day into torrefied charcoal. This torrefied charcoal, resembling natural coal, can be blended with traditional fuels in thermal power plants to generate electricity. The process is environmentally friendly, operating at lower temperatures to prevent toxic emissions. This initiative aims to improve waste management and promote sustainable energy production. Also, the Directorate of Local Bodies plans to install waste-to-energy plants in Varanasi and Gorakhpur, along with 11 waste-to-gas plants under the PPP model.
- **The Uttar Pradesh Green Hydrogen Policy 2024:** It aims to establish the state as a leader in green hydrogen and ammonia production, targeting a capacity of 1 million metric tons per year by 2029[1] and contributing to India's Net Zero goals by 2070. Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) will act as nodal agency for implementation of this policy. At the UP Global Investors Summit (GIS) 2023, the state netted nearly Rs 2.70 trillion green hydrogen investment proposals from about 20 companies[2]. The policy provides significant incentives, such as a 30% capital subsidy (up to ₹50 crore), interest subvention, stamp duty waivers, and a 10-year electricity duty exemption. UPNEDA will facilitate single-window clearances, with a focus on renewable energy integration and open

[1] https://upneda.org.in/MediaGallery/GreenHPolicyEng.pdf
[2] https://invest.up.gov.in/wp-content/uploads/2024/03/green-hydrogen_110324.pdf

access. The policy emphasizes R&D through Centers of Excellence, collaborations, and advancements in electrolyser and hydrogen storage technologies. It ensures land at concessional rates, industrial water access, and renewable energy resources for hydrogen production. Employment generation and skill development are prioritized, with state and district committees ensuring effective implementation. This initiative accelerates decarbonization, economic growth, and industrial development in Uttar Pradesh. The green hydrogen policy has been set for 5 years. Industries establishing themselves within this timeframe will receive subsidies and other incentives totaling Rs 5,045 crore[3].

- **Solar Energy Program:** Uttar Pradesh's recent Solar Energy Policy targets 22,000 MW of solar power by 2026-27[4], with a focus on utility-scale projects and residential solar adoption. Under the new solar policy, the UP government offers a solar subsidy in addition to the Central Financial Assistance (CFA). The incentive was introduced to promote grid-connected rooftop solar installations in the residential sector. UPNEDA provides a subsidy of **₹15,000/kW** with a maximum limit of **₹30,000/**– per consumer. The money is reimbursed after the successful installation of the solar plant. UP's current solar capacity is 3.5 GW. However, judging by the initiatives and measures introduced by the UP government in the past 5 years, we can say that the state is on the path to harness its massive solar potential. Under this policy, UP is developing Ayodhya as a solar city and has approved a 40 MW project in the city[5].
- **Kisan Urja Suraksha Evam Utthaan Mahabhiyan (KUSUM):** It is Government of India initiative launched in 2019 to promote the use of solar energy in the agricultural sector. Its primary objectives include reducing farmers' dependence on diesel, providing water and energy security, increasing farmers' income, and mitigating environmental pollution. The scheme supports three different kinds of installations, known as three components of the scheme as given below:

[3] http://www.indiaenvironmentportal.org.in/content/476715/uttar-pradesh-green-hydrogen-policy-2024/
[4] www.invest.up.gov.in/solar-energy-policy-2022/
[5] https://ornatesolar.com/blog/potential-of-solar-power-in-uttar-pradesh

Component A: 10,000 MW of decentralized ground mounted grid connected renewable power plants of individual plant size up to 2 MW.

Component B: Installation of 20 lakh standalone solar powered agricultural pumps.

Component C: Solarization of 15 lakh existing grid-connected Agriculture pumps.

As of December 2023, the scheme has been extended until March 31, 2026, with a target to achieve a solar power capacity addition of 34.8 GW and a total central financial support of ₹34,422 crore[6] at National level.

Regarding the implementation status in Uttar Pradesh, the state has been actively participating in the PM-KUSUM scheme. Under Component-A, total Sanction capacity is 151 MW while under Component-B, the state has installed 53,150 standalone solar pumps. For Component C, the state has been allocated 12,000 pumps under Individual Pump Solarization (IPS) and 94,000 pumps under Feeder Level Solarization (FLS)[7]; however, specific installation data for these components is not available in the provided sources.

1.6. Energy Consumption Scenario (TFEC)

The Total Final Energy Consumption (TFEC) for Uttar Pradesh in FY 2020 accounts for 49.37 Mtoe. The TFEC is an energy consumption indicator that indicates the end use energy consumption in the respective sectors of the state and does not include energy input in the power generation and transmission & distribution (T&D) losses. The TFEC is the total amount of energy consumed by the end-users in all sectors. Coal has the largest share of TFEC at 45%, followed by oil at 38% and electricity at 16% for FY 2020. Gas consumption has the lowest share in the TFEC at 1%. The TFEC of the state has increased with a CAGR of 5% from 38.67 Mtoe in FY 2015 to 49.37 Mtoe in FY 2020 and 49.47 Mtoe in FY 2023

[6] https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1989815
[7] https://pmkusum.mnre.gov.in/

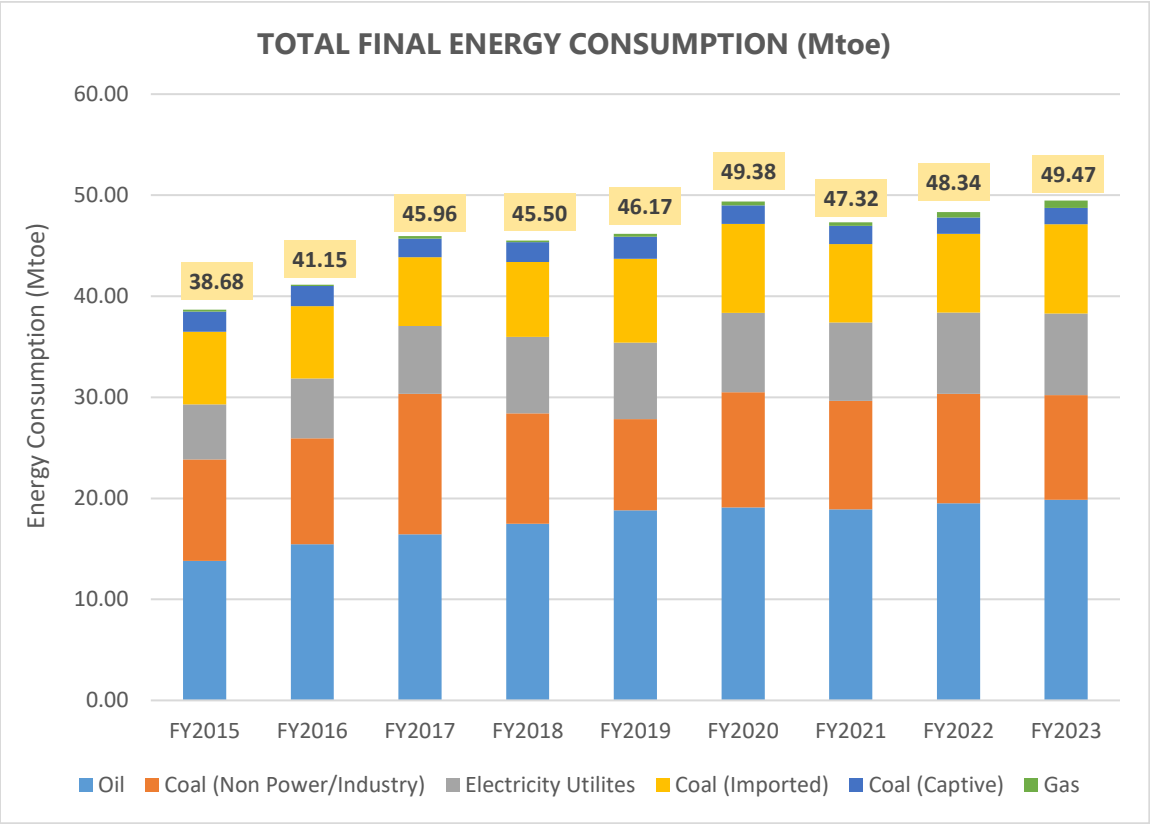


Figure 6: Source-wise Total Final Energy Consumption (TFEC) – FY 2015 – FY2023

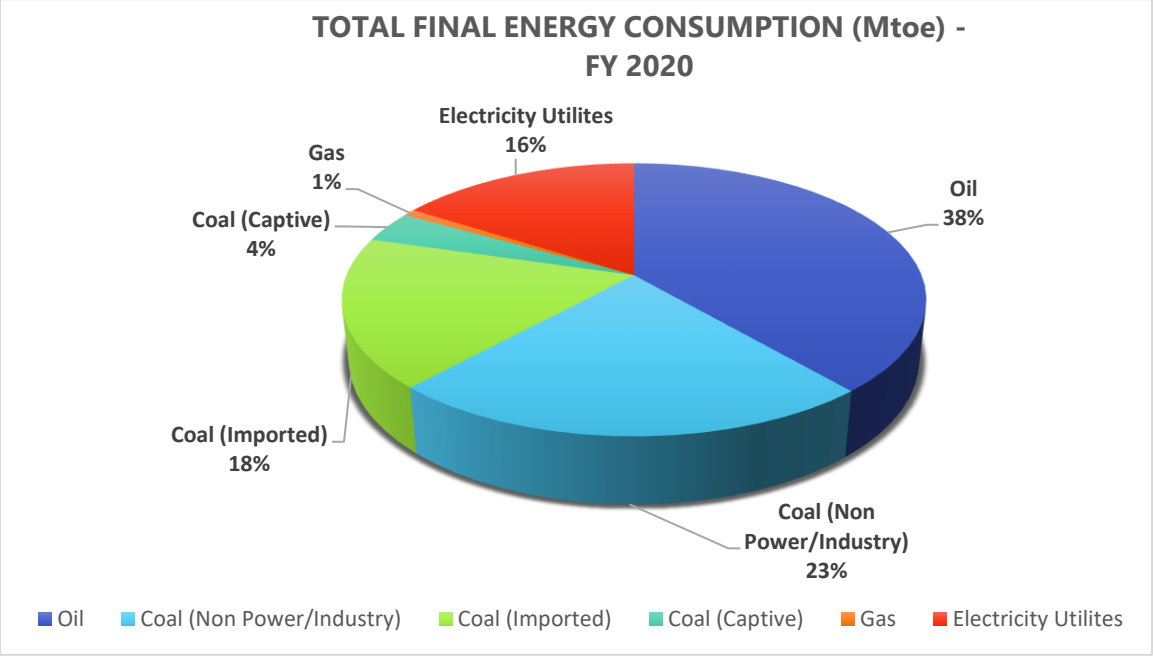
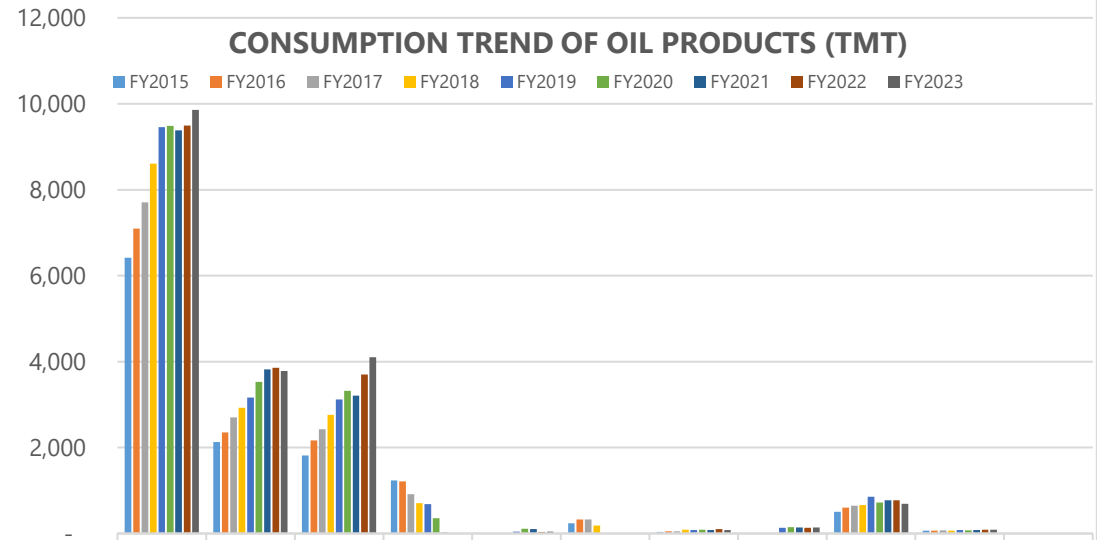


Figure 7: Source-wise TFEC – FY 2020

Coal consumption is classified into 3 different categories based on the purpose and the source of the coal:

1. Captive coal consumption refers to the use of coal by a company for its own consumption, rather than selling it to others. This can include coal used in industries for their own processes, such as in steel manufacturing, cement production, or chemical industries. The share of Captive coal in UP is about 4%.
2. Coal consumption in non-power sectors refers to the use of coal in sectors other than power generation. This can include various industries, such as steel, cement, chemicals, and others. One of the major consumers of Coal in the state is the Brick sector.
3. Imported coal consumption refers to the use of coal that is brought into the country from other countries, rather than being produced domestically. The imported coal consumption for Uttar Pradesh is calculated using the energy output percentage of the industry sector in the state and multiplying it with the total coal import (237 million tonnes) in India. This method provides an approximation of the quantity of imported coal used by the industry sector in Uttar Pradesh. Imported coal forms about 6.37% of national imports.

Oil consumption forms 38 percent of the total final energy consumption in the state. The majority of the oil consumption in the state is in the transport sector. The energy supplied from oil is in the form of different oil products, namely High-Speed Diesel Oil, Liquified Petroleum Gas (LPG), Petrol, Kerosene, Petcoke, Furnace Oil, Aviation Turbine Fuel (ATF), Light Diesel Oil, Low Sulphur Heavy Stock and Naptha. The oil consumption has seen an increased trend from FY2015-2020 with majority of the consumption being High-Speed Diesel, LPG and MS (Petrol). Further, the use of clean cooking practice and aggressive outreach of LPG based cooking stoves leads to reduction in consumption of kerosene, petcoke and furnace oil from FY2015 to FY2020.



	High Speed Diesel	LPG	MS (Petrol)	Kerosene	Petcoke	Furnace Oil	Light Diesel Oil	Low Sulphur Heavy Stock	Bitumen	Lube Grease	Naptha
FY2015	6,420	2,132	1,816	1,238	-	234	36	-	505	64	-
FY2016	7,098	2,351	2,164	1,216	-	329	52	-	605	69	1
FY2017	7,706	2,703	2,423	915	-	327	51	-	644	72	1
FY2018	8,608	2,924	2,760	707	-	188	87	13	661	69	2
FY2019	9,453	3,166	3,119	686	43	7	84	130	854	77	1
FY2020	9,485	3,532	3,320	354	109	-	86	148	722	76	-
FY2021	9,385	3,819	3,210	24	105	-	82	138	776	83	-
FY2022	9,496	3,855	3,696	3	38	-	100	131	770	90	1
FY2023	9,859	3,779	4,103	2	44	-	83	142	690	86	8

Figure 8: Oil products consumption trend – FY 2015 – FY2023

Increase in CNG fueling stations leads to increase in CNG vehicles in states which results in an increased rate of gas consumption in the state, with an AAGR of 2.49% from FY 2015 to FY 2020.

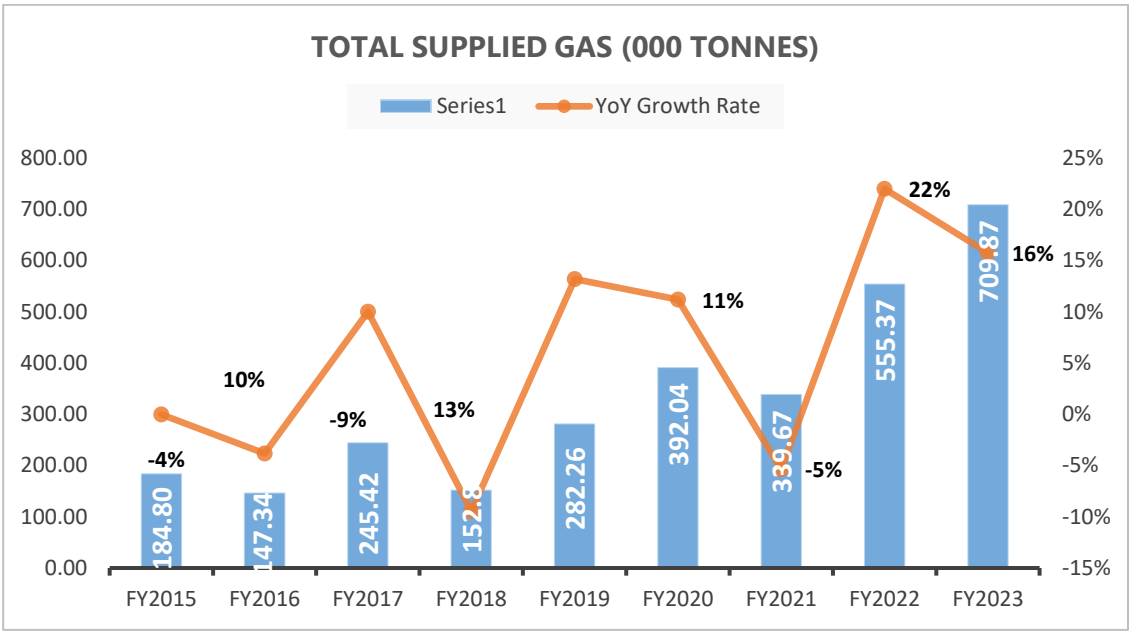


Figure 9: Total Supplied Gas – FY 2015 – FY2023

Electricity demand continues to increase in the state as new industry and building projects are in development and accessibility of electricity to the population is enhanced. The electricity consumption has shown an increase of nearly 48% in FY 2020 from its FY 2015 level, going from 64, 720 GWh in FY 2015 to 94, 930 GWh in FY 2020[8], with a CAGR of approximately 8 percent.

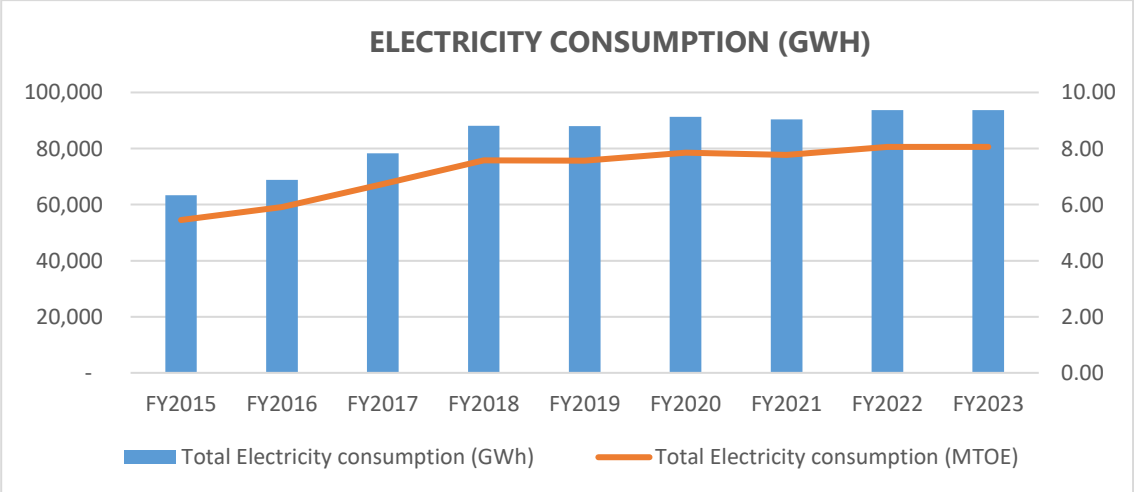


Figure 10: Electricity Consumption Trend in GWh and Mtoe

[8] https://cea.nic.in/wp-content/uploads/general/2020/General_Review_2021.pdf

1.7. Overview of Institutional Framework and Stakeholder Mapping

The Energy Conservation (EC) Act of 2001 establishes a legal framework for developing and executing energy efficiency (EE) policies and programmes.

The Act authorizes the Bureau of Energy Efficiency (BEE) to develop national policies and programmes, and State Designated Agencies (SDAs) to administer EE programmes and enforce EE norms and regulations at the state level. In April 1983, Uttar Pradesh Government created Non- Conventional Energy Development Agency (NEDA) under the department of additional energy sources as an autonomous institution.
The organization has been renamed as "Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA)". From the beginning, the agency is also functioning as nodal agency for implementation of various schemes in the state. UPNEDA is nominated by UP Government in July 2015 to work as UPSDA (UPNEDA).

The Director of the Agency is responsible for formulation and Implementation of the programmes of development of Non-Conventional Sources of Energy in the State and work under the administrative control of the Secretary to the Govt., Department of Additional Source of Energy. The Agency has inter-Alia following functions:

- Propagation of the concept of renewable sources of energy and energy conservation.
- Promoting the use of renewable energy systems and means of saving energy in various sectors.
- Research and development primarily of applied nature in the field of renewable sources of energy and energy conservation.

The agency deals in both, renewable energy and energy efficiency promotion and implementation in the state, and is working in the field of Solar Energy, Wind Energy, Bio Energy, Micro Hydel and Energy Conservation besides energy planning and other aspects of energy management.

The Energy Conservation Amendment Act, 2022 was recently enacted in India and introduces several new provisions to the existing act. Some of the key highlights of the amendment include:

- Setting up of the National Energy Conservation Fund for promoting energy efficiency and conservation initiatives.
- Introduction of a mandatory energy audit for designated consumers.
- Expansion of the scope of energy conservation building codes to cover all new commercial buildings and high-rise residential buildings.
- Introduction of provisions for energy-efficient products and appliances.
- Establishment of a state-level energy conservation fund.

The key stakeholder in the respective sectors were identified for Uttar Pradesh. The stakeholder mapping is presented in the below figure.

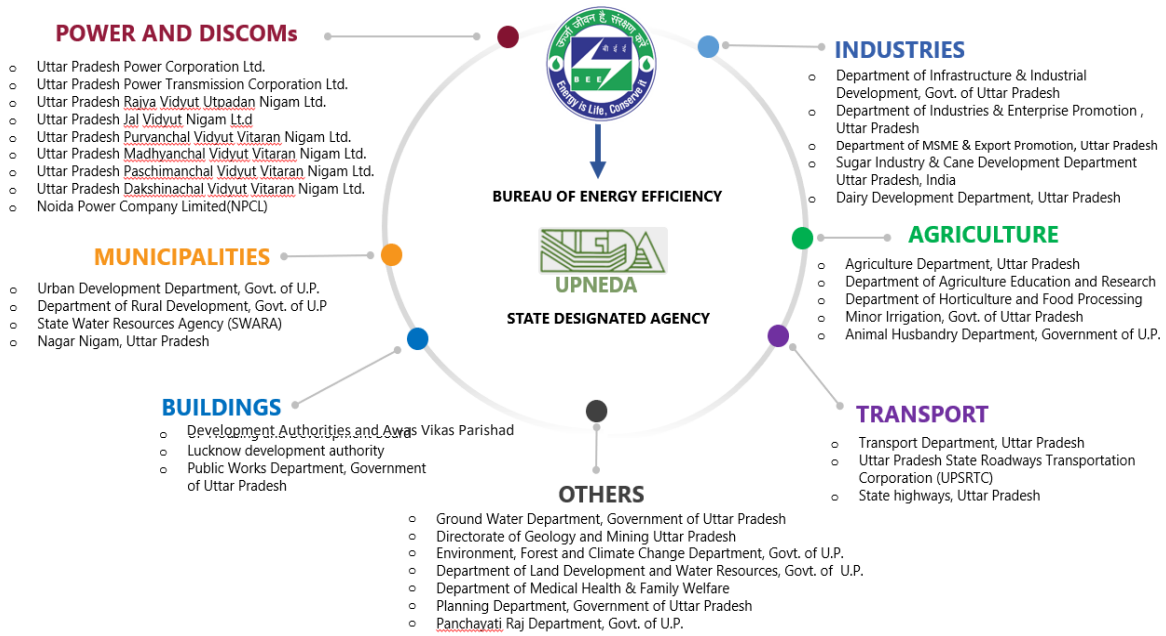


Figure 11: Stakeholders identified in various sectors of Uttar Pradesh.

Stakeholder involvement has been a crucial element in developing the action plan for the state of Uttar Pradesh. Key departments were identified in consultation with UPNEDA, followed by a series of meetings to discuss the plan and gather feedback.

Stakeholder workshops, along with one-on-one discussions, were held to secure support and obtain relevant data. The feedback and data collected were carefully reviewed and integrated into the plan. The insights, concerns, and recommendations provided by these stakeholders have played a significant role in shaping the final action plan.

2. Identification of Focus Sectors

The economic sectors of a state can be broadly classified into the sectors namely Industry, Building, Transport, Agriculture, Municipalities and DISCOMs, and Cross Sectors. These sectors can be further divided into sub-categories, as shown in below:

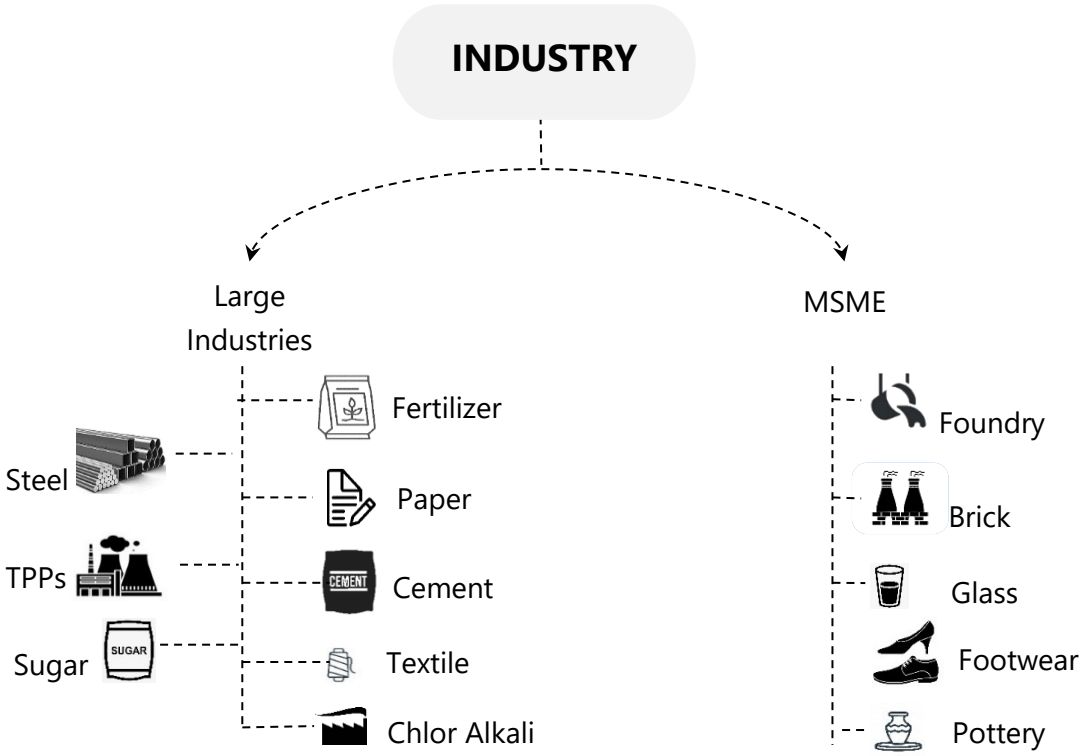


Figure 12: Sub-categorization of Uttar Pradesh's industry sector

Identification of focus sectors or focus areas is important because it is a general characteristic of a state that a major portion of energy is being consumed by few energy-guzzling sectors. Focusing efforts towards these sectors is necessary to ensure that the allocation of resources is as per the state's priorities and towards sectors that have the highest potential of energy savings and emissions reductions.

The focus sectors of the state have been identified based on the share of energy consumption and emissions in the respective sectors, gap analysis of the respective sectors, inputs from stakeholder consultation, and priority areas of a state.

2.1. Methodology of Focus Sector Identification

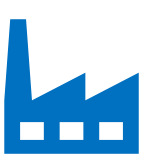
To arrive at the focus sectors, the various factors were analyzed namely the energy consumption, emissions, Gross State Value Added (GSVA). Adding to that, gap analysis in respective sectors, future potential for energy efficiency and emissions reduction, state's planned efforts in prioritized sectors, and SDA and stakeholder inputs have been also being considered to arrive at the focus sectors.

Gross State Value Addition (GSVA)

The Gross State Value Added (GSVA) of different economic categories was sourced from National Accounts Data, prepared by MoSPI. The GSVA sectors are not the same as the end use sectors used for the purpose of this report. However, these sectors have been used to deduce end use sectors for calculating imported coal and the same has been detailed in relevant sections. The GSVA sectors may also oftentimes not be representative of sectoral growth in terms of energy as the link between economic activity and energy use in several sectors is dependent on several factors, analyzing which is beyond the scope of this plan.

2.2. Identified Focus Sectors

Based on the TFEC, electricity consumption in the state and its sectoral distribution, focus sectors have been identified for the state. The focus sectors represent share of energy consumption through available data in Primary and Secondary Energy sources. It also reflects the views and recommendations of the stakeholders, existing and proposed policy infrastructure and vision of the state Government for different sectors. Based on the above parameters and other important considerations, the following have been identified as the focus sectors for devising energy efficiency strategies in Uttar Pradesh.


Industry


Buildings


Transport


Agriculture

Total Final Energy Consumption (TFEC) of the focus sectors (Industry, Buildings, Transport & Agriculture) is estimated at approximately **96%** of the total energy consumption of the state for FY 2020.

The focus sectors for Uttar Pradesh are identified based on their significant share in Total Final Energy Consumption (TFEC), contribution to Gross State Domestic Product (GSDP), potential for energy savings, and alignment with the state's development objectives, including the USD 1 trillion economy target. In FY 2020, Industry accounted for 43% of TFEC and 18% of GSDP, making it a key sector for energy efficiency improvements and economic growth. The buildings sector, with 22% of TFEC and 40% of GSDP, offers significant opportunities for energy savings through sustainable construction and efficient infrastructure. Agriculture, contributing 17% to GSDP and 8% to TFEC, plays a crucial role in rural development and food security, with potential for energy optimization in irrigation and mechanization. The Transport sector, responsible for 23% of TFEC and 12% of GSDP, is pivotal for enhancing connectivity and reducing emissions through electrification and improved public transportation. Targeting these sectors ensures maximum energy efficiency, economic impact, and alignment with the state's strategic goals.

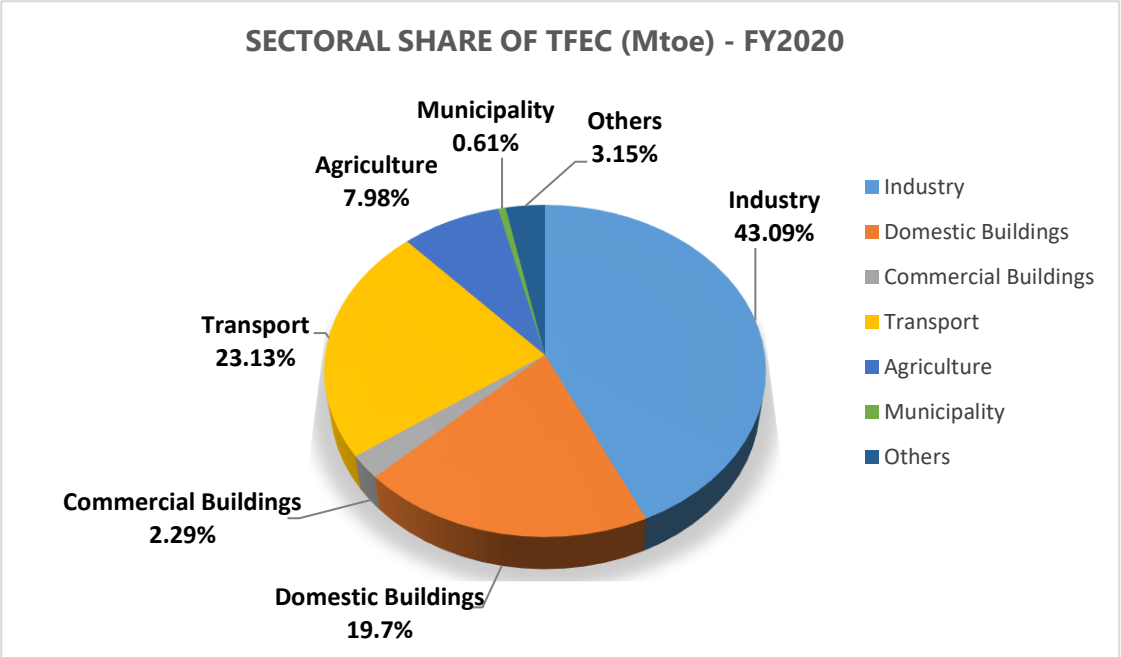


Figure 13 Sectoral Share of TFEC (Mtoe) for FY 2020

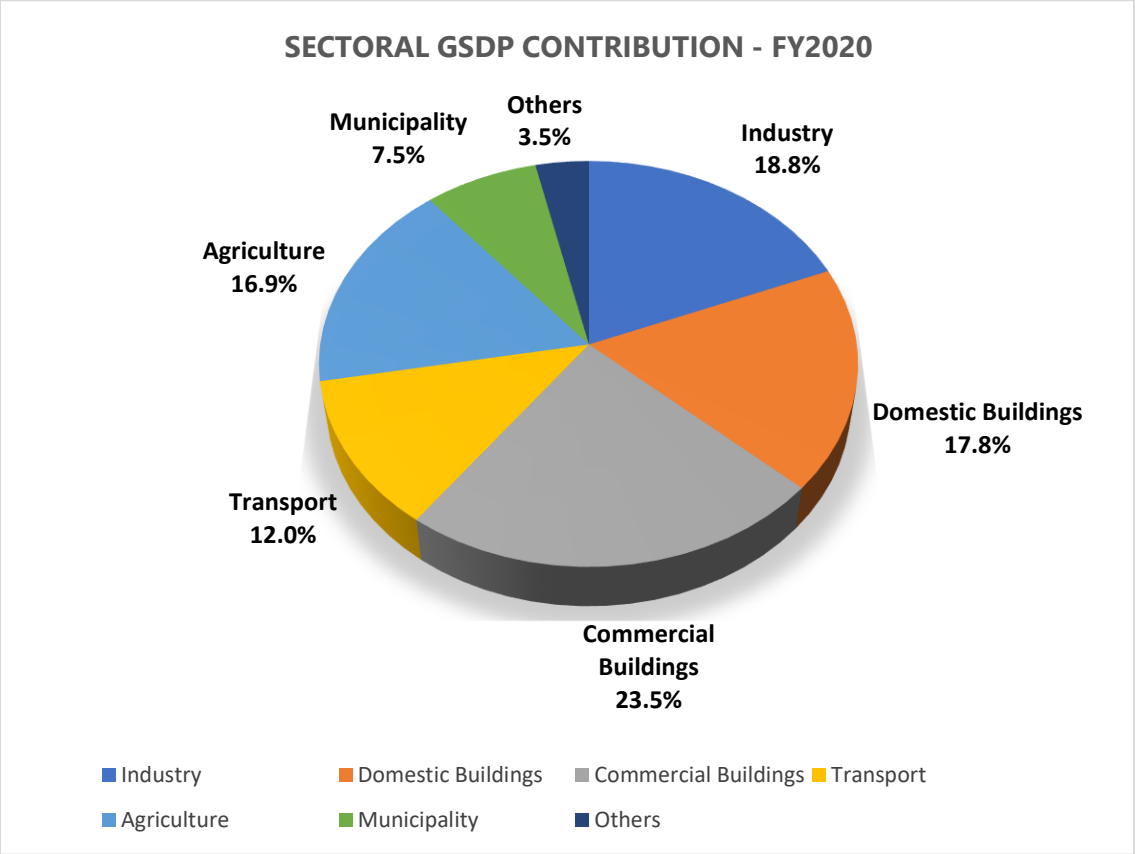


Figure 14 Sectoral GSDP Contribution - FY2020

3. Projections and Forecasting

Economic and energy projections for the state up to the target year FY 2031 are performed in order to predict the future growth patterns of the respective sectors and to assess the impact of possible energy efficiency interventions in these sectors. The Gross State Domestic Product (GSDP) projections and the sectoral energy consumption projections form the basis of the expected emissions and emissions intensity of the state in the target year FY 2031, which is important in developing the emissions reduction targets for the state and in aligning the state with the national goals.

Fiscal Year (FY 2020), implying the period from April 2019-March 2020 has been selected as the base year for projections in this study keeping in view the years FY 2021 and FY 2022 being pandemic years.

The Gross State Domestic Product (GSDP) of Uttar Pradesh was recorded at INR 17 Lakh Crore in FY 2020 and is projected to reach INR 80 Lakh Crore in FY 2031, at current prices of 2011-12. The years FY 2021 and FY 2022 saw a decline in the GSDP, owing to the COVID-19 pandemic affecting the economic activities during this time. The GSDP for the period FY 2023-FY 2030 is forecasted taking the GSDP recorded in the years FY 2015-FY 2020 as the basis for projection. The historic and forecasted GSDP for Uttar Pradesh is shown in below figure.

The Total Final Energy Consumption (TFEC) has been projected for all sectors up to FY 2031 taking into account the historic energy consumption trend from FY 2015 to FY 2020 along with the historic and projected GSDP growth for Uttar Pradesh. The methodology used to project the energy consumption takes into consideration economic aspects along with projections and vision of the state government to contribute USD 1 Trillion to the national GDP.

Using the below-mentioned factors, the Business-as-Usual (BAU) growth rate factors are calculated for all the sectors in order to project the future energy demand by FY2031. The Total Final Energy Consumption of the state in the Business-as-Usual (BAU) scenario

is projected to reach 266.4 Mtoe in FY 2031 from 49.37 Mtoe in FY 2020, with a projected CAGR of 18.36%.

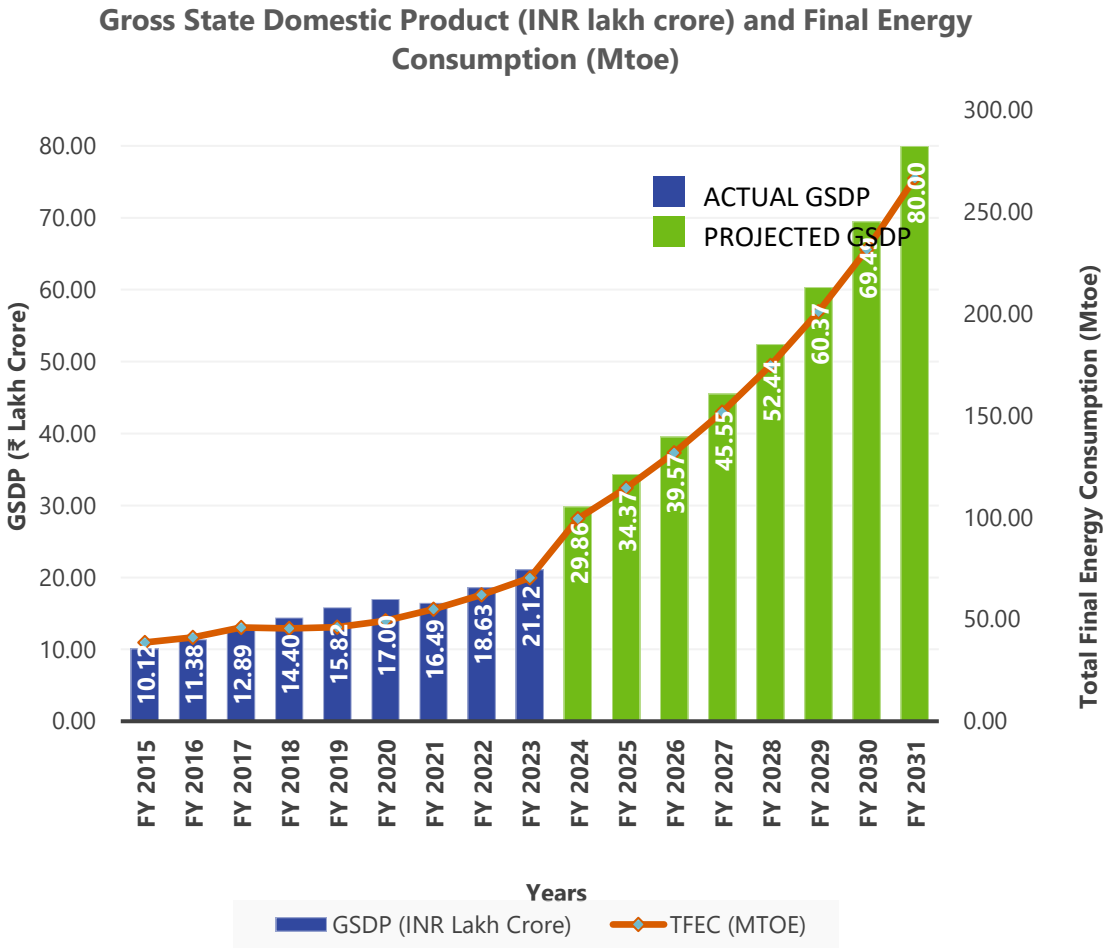


Figure 15: Uttar Pradesh GSDP – actual and projected

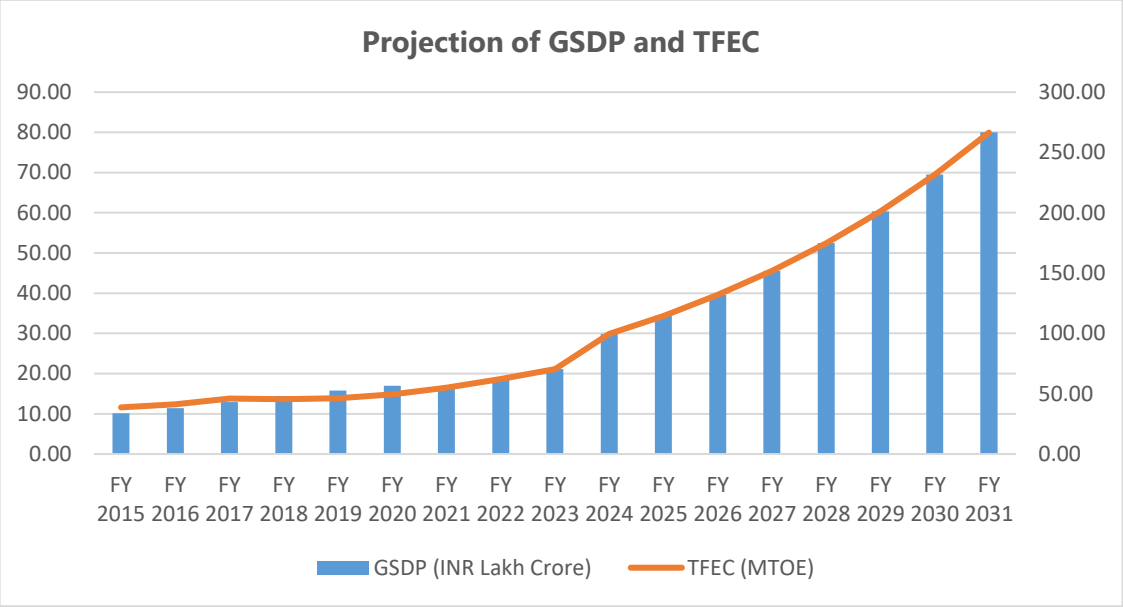


Figure 16: Figure showing projection of GSDP vis-a-vis TFEC

The TFEC is projected based on energy intensity of the state from FY15 to FY20. The average of energy intensity observed between the year 2015 to 2020 is used to project the TFEC for the year 2031. The growth of TFEC is also in conjunction with projected growth of SGDP as per targets of the state Government. The growth is used to arrive at savings and possible reduction in energy intensity by the target year.


INDUSTRY
SECTOR

4. Focus Sector 1 – Industry

4.1. Current Scenario

The State of Uttar Pradesh has witnessed rapid growth of industrialization after the economic liberalization of 1991. As of 2023, the State of Uttar Pradesh has a total of 16,184 no. of factories. With a growth rate of 8%, it is projected to be increased to approximately 25,798 no. of factories by 2030.[9]

Many industries have been developed in the state such as cement plants, sugarcane industry, leather industry, paper industry, Agro & food processing industry, electronics manufacturing, and handloom & textile industry etc. in many regions of the state. Uttar Pradesh is the largest industrial state in India. Kanpur region, Noida region, Gautam Buddha Nagar, Ghaziabad, Jaunpur, Lucknow, Aligarh, Agra, and Meerut region etc. are the major industrial regions of Uttar Pradesh.

The state offers a favorable environment to investors to set up industries by providing infrastructural facilities, 24x7 availability of power to industries with provisions for open access, development of expressways and highways to enable seamless transportation of goods, connectivity with National Capital Region (NCR) on the west and a strategic access to market and resource depth of eastern India, all of which make Uttar Pradesh an industrialization hub.

The State of Uttar Pradesh had the largest number of estimated MSMEs with a share of 14.20% of MSMEs in the country[17].

The prominent industrial sectors in the state in terms of their scale, investment, employment and share in energy consumption are namely Agro & Food Processing including the Dairy and Sugar sectors, Textile and Handloom, Paper and Pulp, Cement, Brick kilns, Glass, Foundry, Footwear, Plastic, and Tannery.

[9] www.mospi.gov.in/state-wise-no-factories-2019-20-annual-survey-industries

The focus area of industry sector is broadly categorized into two categories –

a) Manufacturing industries consisting of Large Industries and MSMEs in the prominent industry sectors of the state on the demand side

b) The industries covered under the PAT scheme of BEE.

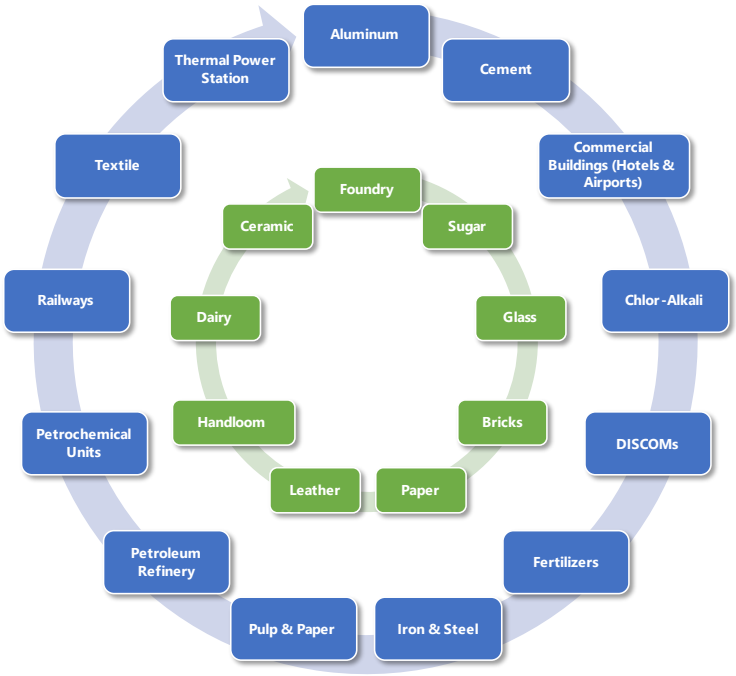


Figure 17: Classification of Industries in PAT and non-PAT sectors

The state has a number of active policies to promote investments in the industry sector and the growth of industries in the state.

There are total 74 Designated Consumers under PAT Scheme in Uttar Pradesh. The Cycle-wise energy saving achievement by DCs under PAT Scheme in the state is as followed:

PAT Cycle	Total DCs	New DCs	DC Removed	Energy Saving Achieved (Million TOE)	CO_2 Red^n (Lakh Ton)
PAT-I	**27**	27	2	0.69	67
PAT-II	**45**	20	1	1.33	128
PAT-III	**2**	2	0	0.06	6
PAT-IV	**2**	2	0	0.083	8
PAT-V	**6**	6	0	0.08	7
PAT-VI	**11**	10	0	0.250	24

S. No.	Sectors	No. of DCs
1	Aluminum	1
2	Cement	9
3	Commercial Buildings	7
4	Chlor-Alkali	1
5	DISCOMs	6
6	**Fertilizer**	8
7	Iron & Steel	1
8	Pulp & Paper	13
9	Petroleum Refineries	1
10	Petrochemical	1
11	Railways	4
12	Textile	2
13	Thermal Power Plant	20
	Total	74

4.2. Energy Efficiency Strategies in the Industry Sector

This section presents the proposed strategies in the prominent sectors and focus areas identified in the industry sector along with their impact in terms of energy efficiency and emissions reduction. Strategies are proposed with their relevant action items.

Strategy #1: Deepening and Widening of PAT Scheme

Implementation Timeline: Long Term (Till FY 2031)

The analysis performed to determine the coverage of Perform, Achieve and Trade (PAT) in Uttar Pradesh revealed that as of FY 2019, the industries that are PAT DCs excluding thermal power plants make up nearly 43% of the total industrial energy consumption.

In the proposed strategy, it is recommended that the state enhances coverage of energy consumption in PAT industries (DCs) by deepening and widening the PAT scheme in the state. Deepening and Widening of PAT scheme would imply notifying more industries as designated consumers under the current PAT sectors by lowering the threshold limit for eligibility (TOE/annum), as well as the inclusion of new sectors under the PAT scheme.

The introduction of new sectors such as Dairy, Sugar etc. in the PAT scheme can be targeted for Uttar Pradesh where these sectors are prominent.

Moderate and Ambitious SEC assigned to cement non-PAT units, and to Sugar plants units above 3000 TCD. It is assumed that the existing units of both sectors will achieve the moderate SEC target in 50% units and achieve the ambitious SEC target in 70% units. The sugar sector is expected to grow at a CAGR of 4.9% while the Cement sector is expected to grow at a CAGR of 4.8%.

The baseline SEC of Sugar industries (0.0024 toe/tonne) has been taken from the report "Widening the coverage of PAT Scheme Sectoral Manual - Sugar Sector" and the production data of sugarcane has been taken from the Statistical Report of Uttar Pradesh – 2020. The Sugarcane Department also reports that there are 121 operational sugar units in Uttar Pradesh, all equipped with cogeneration units. The operational season lasts for 5 to 6 months and around 65 of these units produce excess power for feeding back to the grid. Additionally, 54 units will be included in the next PAT cycle. The cogeneration plants primarily run on bagasse and supply electricity to the grid during the off-season, with around 1500 MW of electricity being provided by the sugar mills' cogeneration plants. The installed capacity for sugar crushing in Uttar Pradesh is 80 Lakhs tonnes per annum.

The baseline SEC of Cement industries (0.011 toe/ton) has been taken from the average of SEC targets of PAT DCs in Uttar Pradesh. The production of cement is taken from the "Indian Minerals Yearbook 2020". The moderate and ambitious SEC has been assumed by considering the technological interventions & energy savings potential in sugar and cement sector.

Table 1: Moderate and ambitious scenarios for deepening and widening of PAT scheme for sugar and cement industry

Sector	Baseline SEC (koe/tonne)	Moderate SEC (koe/tonne)	Ambitious SEC (koe/tonne)	Production in 2030 ('000 tonnes)	Energy Saving in Moderate Scenario (Mtoe)	Energy Saving in Ambitious Scenario (Mtoe)
Sugar	2.4	1.89	1.61	3,14,513	0.081	0.176
Cement	11.4	9.1	7.7	22,655	0.026	0.058

Actionable items:

A. Financial Category:

1. Partial Risk guarantee program to encourage implementation of latest energy efficient technologies in the sectors (Over and above existing schemes with state contribution)

   A Partial Risk Guarantee (PRG) program can be an effective tool for encouraging the implementation of the latest energy-efficient technologies in various sectors. The program involves providing a guarantee to a lender or investor, which covers a portion of the risk associated with financing the adoption of energy-efficient technologies.

   Under the program, the lender or investor can provide financing at a lower cost, as the risk is partially covered by the guarantee. This helps to reduce the cost of financing for the borrower, making it more affordable to implement energy-efficient technologies.

   BEE, under its existing PRGFEE scheme has already released guidelines for partial risk guarantee that may be adopted by the state for effective implementation.

B. Awareness Category:

1. Capacity Building of Energy Managers and Energy Auditors in PAT DCs and new probable sectors for compliance with scheme and new technologies.

   Though its mandatory to go through a refresher training for all energy auditors and managers, it is important to attain knowledge of changing

schemes and policies that could positively impact large consumers and help them implement schemes in their respective organizations.

C. Technical Category:

1. Mandatory Standardized Energy Audits in every three years for all units that have energy consumption below PAT threshold, in all notified PAT sectors, excluding MSMEs.

   Though separate guidelines are issued for PAT industries, non-PAT, non-MSME industries could also benefit from energy audits. This shall not only ensure their improved energy performance, but also, ensure that if brought under PAT scheme at a later stage, they would be accustomed and more willing to participate in it. The audits will also improve competitiveness of these industries. In current scenario, A monitoring mechanism may be developed to see the impact of energy audits and advise industries in a constructive way from time to time.

   To conduct the energy audit in various sectors, BEE has created a cadre of professionally qualified Energy Managers and Auditors with expertise in energy management, project management, financing and implementation of EE projects, and policy analysis. BEE has regularly conducted the National Certification Examination nationwide for Energy Managers and Energy Auditors since May 2004. As of March 2019, there are a total of 18,684 certified energy managers and auditors out of which 765 auditors are from Uttar Pradesh.

   As per the report “State of Energy Efficiency in India" published by the Energy Efficiency Services Limited (EESL), it is estimated that India will need an additional 3,00,000 energy auditors by 2030.

As Uttar Pradesh has approximately 7 percent[10] share in the number of industries at national level, it will require approximately 21,000 energy auditors and managers by 2030 to carry out the mandatory energy audits in Uttar Pradesh.

2. Development of mechanisms for B2B interaction with global technology suppliers.

   Global technologies are often beyond the reach of domestic industries due to several reasons. A platform to improve competitiveness and efficiency in energy may be provided under a structure to ensure advancement of manufacturing process and improvement in energy efficiency at the same time.

3. Establishment of a collaborative working group between the State Nodal Agency and the Sugar Association

   A collaborative working group should be established between the State Nodal Agency and the Sugar Association to develop and achieve energy efficiency goals. This partnership will facilitate the sharing of expertise, resources, and best practices to enhance energy conservation within the sugar industry. By working together, the group can identify specific targets, monitor progress, and implement innovative solutions to improve overall energy efficiency. This joint effort will not only benefit the industry but also contribute to the state's sustainability objectives.

D. Cost Benefit Analysis

Under the BEE PAT scheme, designated consumers in energy-intensive sectors are required to achieve specific energy-saving targets over a certain period. These designated consumers are large energy-consuming industries like steel, cement,

[10] https://www.ceicdata.com/en/india/manufacturing-industry-nic-2008-by-state-uttar-pradesh/manufacturing-industries-uttar-pradesh-factories

aluminium, pulp and paper. The energy-saving targets are determined based on the historical energy consumption of the industry and the specific reduction potential.

The scheme operates on a market-based mechanism where energy-saving certificates, known as PAT (Performance Achievement and Trade) certificates, are issued to industries that exceed their energy-saving targets. These certificates can be traded among the designated consumers, and those failing to meet their targets must buy certificates to comply with the regulations. The BEE PAT scheme has several benefits. Firstly, it incentivizes industries to adopt energy-efficient technologies and practices, leading to reduced energy consumption and carbon emissions. Secondly, it promotes a market for energy-saving certificates, encouraging competition and innovation in energy conservation. Lastly, it helps India achieve its national energy-saving goals and contributes to the country's sustainable development efforts.

Overall, the BEE PAT scheme plays a crucial role in driving energy efficiency improvements in energy-intensive industries, fostering sustainable growth and reducing environmental impact.

Sugar Sector[11]

Following technology interventions can incorporated in the sugar units of Uttar Pradesh to achieve the energy efficiency and energy savings in the industrial units. These strategies have been implemented in the sugar industries in southern India.

1. ***Adoption of the high-pressure Co-Generation system*** **Capacity of the plant:**

Before Implementation:

The cogeneration set up had three low pressure boilers providing steam to the process and turbine generators. Historically the factory has not exported any power to the grid.

[11] Source: Research Gate Paper

After Implementation:

High pressure boiler co-generation system was installed with below mentioned capacity.

Boilers	Turbines
1 x 120 TPH, 87 kg/cm2	1 x 22 MW
Surplus power exposed to grid per hour	15 MWh
Power exported to grid per year	401 Lakh kWh
Revenue from power export per year	1253 Lakh Rs
Actual investment	800 lakh Rs
payback period	< 1 year

2. *Heat Recovery from boiler blow down.*

Capacity of the plant: 5000 TCD

The high pressure blows down water from boiler is being flashed in a vessel and the vapour generated is taken to the deaerator for heating purpose. The hot blow down water at 97 degrees Celsius was let into ETP after natural cooling. The quantity of blow down water is 2.5 TPH. This heat can be utilized to raise the temperature of turbine condensate that will reduce the extraction steam consumption in deaerator.

Before Implementation:

Blow down water temperature = 97 Deg Celsius

Turbine condensate temperature = 58 Deg Celsius

After Implementation:

Blow down water temperature = 68 Deg Celsius

Turbine condensate temperature = 66 Deg Celsius

Rise in turbine condensate temperature = 8 Deg Celsius

Turbine Condensate Quantity = 30 TPH

2.5 ATA steam requirement to raise the condensate temperature to 105 Deg Celsius

Without Preheating = 30*(105-58)/650

= 2.178 TPH

After Preheating = 30*(105-66)/650

= 1.80 TPH

Saving in 2.5 ATA steam = 0.37 TPH

Revenue while considering Electrical Energy

Increase in power generation = 0.37 * (1/4.5 – 1/5.75) * 1000.

= 17.85 KW

For 270 days operation = 17.85 * 24 * 270
= 115668 kWh

Annual Increase in revenue = Rs.3.6 lakhs

Cement Sector

The following technology interventions can be incorporated in the cement industries in the state of Uttar Pradesh for achieving energy efficiency and energy savings.

1. **Cooler Hot Air Recirculation (HAR) to Increase Waste Heat Power**[12]

   To improve waste heat recovery from the cooler vent and increase power generation, implement Cooler Hot Air Recirculation (HAR). Recirculating hot air from the cooler vent stack back to the cooler enhances the available heat at the boiler inlet. This can be achieved by either increasing the mass flow at a constant temperature or maintaining a constant mass flow with increased temperature.

   This method leverages the additional mass flow and/or higher temperature to improve the overall efficiency of the heat recovery process, ultimately boosting power generation.

   The installation of HAR system is possible in all waste heat recovery system and installation of HAR is feasible which would result in increased power generation from waste heat recovery.

Parameter	Values
Improved Power Generation	10,040 kWh/day
TOE equivalent savings	1,127 TOE
Total benefit	Rs 1.67 Cr
Investment	Rs 1.5 Cr
Payback	1 Year
GHG reduction	3,850 tCo2

[12] Cement_Sector_Report_2018.pdf (keralaenergy.gov.in)

Strategy #2: Promoting Energy Efficiency Interventions in Brick Clusters

Implementation Timeline: Short Term (Till FY 2026) for lower coverage; Long Term (Till FY 2031) for higher coverage.

This strategy is proposed for the one of the prominent clusters in Small and Medium Enterprises (SME) sector which is brick cluster. A PAT-like scheme is proposed under this strategy for the unorganized and small brick sector which would not meet the threshold energy consumption under the conventional PAT scheme. This strategy would involve the implementation of energy efficient technologies and new & innovative decarbonization technologies in the market to enable SMEs to meet their energy saving targets.

The energy savings were calculated for the brick cluster with the assumption that 60% of brick kilns in the moderate scenario and 80% in the ambitious scenario would adopt the strategy. The baseline SEC and production data of brick clusters have been taken from the "Sameeeksha" report and moderate and ambitious scenarios were developed based on the potential technological interventions in the various clusters. The strategy is expected to result in energy savings of 0.79 Mtoe and 2.96 Mtoe in the moderate and ambitious scenarios respectively.

Table 2: Table showing key reduction potential in brick Industry

Sector	Baseline SEC (toe/tonne)	Moderate SEC (toe/tonne)	Ambitious SEC (toe/tonne)	Production in 2030 ('000 tonnes)	Energy Saving in Moderate Scenario (Mtoe)	Energy Saving in Ambitious Scenario (Mtoe)
Bricks	0.04	0.04	0.03	2,64,435	0.79	2.96

Implementing agency(s) – Infrastructure and Industrial Development Department, Uttar Pradesh; UPNEDA

Actionable items:

A number of action items will need to be adopted by the relevant departments and implementing agencies to achieve the energy savings estimated for this strategy. These action items include:

A. Technical Category:

1. **Carrying out energy and resource-mapping studies in MSME clusters –** For the industries not covered under PAT, there is a challenge in reporting accurate energy consumption data for individual clusters or sub-sectors. Understanding of energy consumption patterns in the clusters in necessary to ensure optimized allocation of resources and assess the feasibility of technology implementation in a particular cluster. Energy and resource-mapping studies are comprehensive studies on MSME clusters and sub-sectors that can give insights into the current status of technology implementation in the cluster, set benchmark energy consumption, design threshold limits for a PAT-like scheme, and analyze the future potential of technology implementation in terms of energy and cost savings. Energy and resource-mapping studies are proposed to be carried out in the prominent MSME clusters and industry sub-sectors of the state annually to set benchmarks and track progress in the implementation of this strategy.

1. **Implementation of Demonstration Projects on energy efficient technologies in SME clusters –** Demonstration projects are proposed to be carried out every year on a periodic basis in all prominent SME clusters to promote these technologies and make stakeholders aware about the monetary and energy performance impact of these technologies.
2. **Technical assistance for transition from Bull Trench Kiln to Zig-Zag Kilns -** As bricks are key industries in the MSME sector, upgradation of technology will unlock large potential of energy savings. As brick industries include several small sized units, technical assistance to upgrade in key energy consumption sectors will create a large impact.

3. **Issuance of directives for biomass blending in coal-fired brick kilns and strengthening the supply chain -** Alternate fuels such as agro-residue biomass, bagasse, rice husk and mustard stalk can be mixed with coal in a 10%-15% ratio for co-firing of bricks. This can result in significant emission reductions by offsetting a part of the coal energy. Biomass blending in brick kilns is proposed under an ambitious scenario and will be a key strategy as the state endeavors to lower its carbon emissions. It is important to thus issue directives to ensure implementation and strengthen the supply chain.

B. Awareness Category:

1. **Workshops on technology interventions for energy conservations in MSMEs –** It is proposed to organize cluster wise workshops for MSMEs on technology interventions that can be implemented in respective industries. It is important to disseminate technical information about new technologies among owners and maintenance team of MSMEs so that they can implement the latest technologies in their units.

C. Financial Category:

1. **Periodic standardized energy audits for MSMEs on load basis and reimbursement of energy audit cost with a maximum cap** – Government of Uttar Pradesh shall develop a standard format of energy audit and issue notification for conducting mandatory periodic (in every 3 Years) energy audits by every unit above a certain limit of connected load. The government can also provide reimbursement of energy audit cost with a maximum cap of INR 75,000. Monetary support to small industries and MSMEs can be provided to maintain the standard of conducted energy audit.
2. **Sector-specific policy development for financial assistance on implementation of ECMs suggested in energy audit-** A policy shall be developed at state level to provide the financial assistance for implementation of ECMs recommended in the energy audits. Policy development shall consider the sector specific requirements, energy saving potential of sector and its importance in state level GSDP.

D. Cost Benefit Analysis:

Brick Cluster:[13]

The energy efficiency interventions for the cluster listed below are being incorporated in the state of Uttar Pradesh.

1. **Adopting zigzag firing in place of conventional firing process**

   Conventional firing process followed in brick kilns generally leads to poor combustion and higher surface heat losses resulting in higher fuel consumption of the kiln. In place of conventional firing, zigzag firing process can be adopted. In zig-zag firing, the kiln has long firing zone, and the travel path of fire is increased with modified pattern of brick stacking. The stacking pattern results in creating turbulent conditions which help in optimal air-fuel mixing. Some of the benefits of adopting zig-zag Conventional firing process followed in brick kilns generally leads to poor combustion and higher surface heat losses resulting in higher fuel consumption of the kiln. In place of conventional firing, zigzag firing process can be adopted. In zig-zag firing, the kiln has long firing zone, and the travel path of fire is increased with modified pattern of brick stacking. The stacking pattern results in creating turbulent conditions which help in optimal air-fuel mixing. Some of the benefits of adopting zig-zap technology include:

   - Better combustion of fuel due to enhanced circulation of air and improved mixing of fuel and air leading to reduced coal consumption.
   - Reduced surface heat losses
   - Reduced CO and particulate emissions

   About 10% of fuel saving can be achieved with adoption of zigzag firing equivalent to 18,678 tonne of coal (~ 10,825 toe) at cluster level.

[13] Source: Sameeksha Brick Cluster Profile

Strategy #3: Promoting Energy Efficiency Interventions in Glass Clusters

Implementation Timeline: Short Term (Till FY 2026) for lower coverage; Long Term (Till FY 2031) for higher coverage.

This strategy is proposed for another prominent cluster in Small and Medium Enterprises (SME) sector which is glass cluster. A PAT-like scheme is proposed under this strategy for the unorganized and small industries sectors which would not meet the threshold energy consumption under the conventional PAT scheme. The strategy would involve the implementation of energy efficient technologies and new & innovative decarbonization technologies in the market to enable SMEs to meet their energy saving targets.

The energy savings were calculated for glass clusters with the assumption that 50% of glass industries in the moderate scenario and 70% in the ambitious scenario would adopt the strategy. The baseline SEC and production data of glass clusters have been taken from the "Sameeeksha" report and moderate and ambitious scenarios were developed based on the potential technological interventions in the various clusters. The strategy is expected to result in energy savings of 0.08 Mtoe and 0.21 Mtoe in the moderate and ambitious scenarios respectively.

Table 3: Table showing key reduction potential in Glass Industry

Sector	Baseline SEC (toe/tonne)	Moderate SEC (toe/tonne)	Ambitious SEC (toe/tonne)	Production in 2030 ('000 tonnes)	Energy Saving in Moderate Scenario (Mtoe)	Energy Saving in Ambitious Scenario (Mtoe)
Glass	0.27	0.22	0.18	3,047	**0.08**	**0.21**

Implementing agency(s) – Infrastructure and Industrial Development Department, Uttar Pradesh; UPNEDA

Actionable items:

A number of action items will need to be adopted by the relevant departments and implementing agencies to achieve the energy savings estimated for this strategy. These action items include:

A. Technical Category:

1. **Carrying out energy and resource-mapping studies in MSME clusters –** For the industries not covered under PAT, there is a challenge in reporting accurate energy consumption data for individual clusters or sub-sectors. Understanding of energy consumption patterns in the clusters in necessary to ensure optimized allocation of resources and assess the feasibility of technology implementation in a particular cluster. Energy and resource-mapping studies are comprehensive studies on MSME clusters and sub-sectors that can give insights into the current status of technology implementation in the cluster, set benchmark energy consumption, design threshold limits for a PAT-like scheme, and analyze the future potential of technology implementation in terms of energy and cost savings. Energy and resource-mapping studies are proposed to be carried out in the prominent MSME clusters and industry sub-sectors of the state annually to set benchmarks and track progress in the implementation of this strategy.
2. **Implementation of Demonstration Projects on energy efficient technologies in SME clusters –** Demonstration projects are proposed to be carried out every year on a periodic basis in all prominent SME clusters to promote these technologies and make stakeholders aware about the monetary and energy performance impact of these technologies.
3. **Technical assistance for Improved Tank Furnaces in glass sector –** Since glass are key industries in the MSME sector, upgradation of technology will unlock large potential of energy savings. As these industries include several small sized units, technical assistance to upgrade in key energy consumption sectors such as furnaces will create a large impact.

B. Awareness Category:

1. **Workshops on technology interventions for energy conservations in MSMEs –** It is proposed to organize cluster wise workshops for MSMEs on technology interventions that can be implemented in respective industries. It is important to disseminate technical information about new technologies

among owners and maintenance team of MSMEs so that they can implement latest technologies in their units.

C. Financial Category:

1. **Periodic standardized energy audits for MSMEs on load basis and reimbursement of energy audit cost with a maximum cap** – Government of Uttar Pradesh shall develop a standard format of energy audit and issue notification for conducting mandatory periodic (in every 3 Years) energy audits by every unit above a certain limit of connected load. The government can also provide reimbursement of energy audit cost with a maximum cap of INR 75,000. Monetary support to small industries and MSMEs can be provided to maintain the standard of conducted energy audit.
2. **Sector-specific policy development for financial assistance on implementation of ECMs suggested in energy audit-** A policy shall be developed at state level to provide the financial assistance for implementation of ECMs recommended in the energy audits. Policy development shall consider the sector specific requirements, energy saving potential of sector and its importance in state level GSDP.

D. Cost Benefit Analysis:

The following energy interventions can be incorporated in the Firozabad glass cluster.

1. **Energy Efficient Motors:**

   The rating of the motors used in the glass industry varies from 1 hp to 40 hp depending on the application, capacity, and operation. Most of these motors operate on low loads. Also, the installed motors are of standard efficiency class, with several rewound multiple times. Motor efficiency drops 1–5% each time a motor is rewound. Energy savings is possible in motor systems by replacing the under loaded and rewound motors with premium efficiency (IE3) motors. The average efficiency improvement by doing this will be in the range of 3%-7%.

Energy Saving Measure	Existing Scenario	Proposed Scenario	Energy Saving Potential (%)	Payback period
Replacement of underloaded motors with optimum capacity IE3 Motors	Motor loading is low	New energy efficient motor with optimum loading	5% - 7%	18-24 Months
Replacement of rewound motors with IE3 motors	Many motos rewound more than 3 time	Replacement with IE3 motors	3% - 7%	18-24 Months

2. Installation of energy efficient screw compressor system
3. Improvement in insulation and use of high-quality refractories
4. Improved instrumentation for monitoring & control
5. Automatic damper system to control furnace draft.
6. Augmentation of furnace melting capacity by adopting Electrical boosting hybrid furnace
7. Replacement inefficient pumps with energy efficient pumps

Strategy #4: Energy Efficiency Interventions in Paper Clusters

Implementation Timeline: Short Term (Till FY 2026) for lower coverage; Long Term (Till FY 2031) for higher coverage.

This strategy is proposed for another prominent cluster in Small and Medium Enterprises (SME) sector which is paper cluster. A PAT-like scheme is proposed under this strategy for the unorganized and small industries sectors which would not meet the threshold energy consumption under the conventional PAT scheme. The strategy would involve the implementation of energy efficient technologies and new & innovative decarbonization technologies in the market to enable SMEs to meet their energy saving targets.

The energy savings were calculated for paper clusters with the assumption that 50% of industries in the moderate scenario and 70% in the ambitious scenario would adopt the strategy for the paper cluster. The baseline SEC and production data of paper clusters have been taken from the "Sameeeksha" report and moderate and ambitious scenarios were developed based on the potential technological interventions in the various

clusters. The strategy is expected to result in energy savings of 0.01 Mtoe and 0.03 Mtoe in the moderate and ambitious scenarios respectively.

Table 4 Table showing key reduction potential in Paper Industry

Sector	Baseline SEC (toe/tonne)	Moderate SEC (toe/tonne)	Ambitious SEC (toe/tonne)	Production in 2030 ('000 tonnes)	Energy Saving in Moderate Scenario (Mtoe)	Energy Saving in Ambitious Scenario (Mtoe)
Paper	0.24	0.22	0.20	1,391	0.01	0.03

Implementing agency(s) – Infrastructure and Industrial Development Department, Uttar Pradesh; UPNEDA

Actionable items:

A number of action items will need to be adopted by the relevant departments and implementing agencies to achieve the energy savings estimated for this strategy. These action items include:

A. Technical Category:

1. **Carrying out energy and resource-mapping studies in MSME clusters –** For the industries not covered under PAT, there is a challenge in reporting accurate energy consumption data for individual clusters or sub-sectors. Understanding of energy consumption patterns in the clusters in necessary to ensure optimized allocation of resources and assess the feasibility of technology implementation in a particular cluster. Energy and resource-mapping studies are comprehensive studies on MSME clusters and sub-sectors that can give insights into the current status of technology implementation in the cluster, set benchmark energy consumption, design threshold limits for a PAT-like scheme, and analyze the future potential of technology implementation in terms of energy and cost savings. Energy and resource-mapping studies are proposed to be carried out in the prominent

MSME clusters and industry sub-sectors of the state annually to set benchmarks and track progress in the implementation of this strategy.

2. **Implementation of Demonstration Projects on energy efficient technologies in SME clusters –** Demonstration projects are proposed to be carried out every year on a periodic basis in all prominent SME clusters to promote these technologies and make stakeholders aware about the monetary and energy performance impact of these technologies.
3. **Technical assistance for technology upgradations in boilers in paper sector –** Papers are key industries in the MSME sector, upgradation of technology will unlock large potential of energy savings. As these industries include several small sized units, technical assistance to upgrade in key energy consumption sectors will create a large impact.

B. Awareness Category:

1. **Workshops on technology interventions for energy conservations in MSMEs –** It is proposed to organize cluster wise workshops for MSMEs on technology interventions that can be implemented in respective industries. It is important to disseminate technical information about new technologies among owners and maintenance team of MSMEs so that they can implement latest technologies in their units.

C. Financial Category:

1. **Periodic standardized energy audits for MSMEs on load basis and reimbursement of energy audit cost with a maximum cap** – Government of Uttar Pradesh shall develop a standard format of energy audit and issue notification for conducting mandatory periodic (in every 3 Years) energy audits by every unit above a certain limit of connected load. The government can also provide reimbursement of energy audit cost with a maximum cap of INR 75,000. Monetary support to small industries and MSMEs can be provided to maintain the standard of conducted energy audit.
2. **Sector-specific policy development for financial assistance on implementation of ECMs suggested in energy audit-** A policy shall be

developed at state level to provide the financial assistance for implementation of ECMs recommended in the energy audits. Policy development shall consider the sector specific requirements, energy saving potential of sector and its importance in state level GSDP.

D. Cost Benefit Analysis:[14]

Following technology interventions are being incorporated in the Muzaffarnagar paper cluster:

- **Boiler feed water pump efficiency improvement**

Description:

The case study involved measurement of boiler feed water flow, head delivered by the pump, power consumption and pressure drop. At many instances it was observed that the pump is operating on lower efficiency range. The pumps installed are old and new high efficiency pumps are available. The boiler feed water pump considered under the study was a high-pressure pump with following specifications

Flow	**m^3/hr**	**60**
Suction Pr	m	+ve
Discharge Pr	m	900
Rated Capacity of Drive	kW	250

The boiler feed water pump operating parameters were observed as follows:

Flow	**m^3/hr**	**44.9**
Suction Pr	m	12
Discharge Pr	m	900
Power Consumption	kW	261

Benefits:

Replacement of the present low efficiency pump with a higher efficiency pump will lead to energy savings. The high efficiency pump will consume less electricity as compared to the present low efficiency pump. It is possible to operate the new efficient pump at an efficiency level of around 60% which is available up to 68% Design efficiency. This will lead to an energy saving of approximately 60 kW.

[14] https://www.sameeeksha.org/pdf/dpr/Muzaffarnagar_Paper.pdf

S.No.	Description	Value
1	Present Efficiency Level	46%
2	Present Electricity Consumption (kW)	261
3	Proposed Efficiency Level	60%
4	Proposed Electricity Consumption (kW)	201
5	Electricity Savings (kW)	60
6	Annual Operating Hours	8,000
7	Energy Savings (kWh/yr)	4,77,736
8	Monetary Savings (Rs. /year) @ Rs. 3.91 per kWh	18,67,948
9	Estimated project cost (Rs.)	22,50,000
10	Payback Period (Years)	1.20

Strategy #5: Energy Efficiency Interventions in Foundry Clusters

Implementation Timeline: Short Term (Till FY 2026) for lower coverage; Long Term (Till FY 2031) for higher coverage.

This strategy is proposed for foundry cluster in Small and Medium Enterprises (SME) sector. A PAT-like scheme is proposed under this strategy for the unorganized and small industries sectors which would not meet the threshold energy consumption under the conventional PAT scheme. The strategy would involve the implementation of energy efficient technologies and new & innovative decarbonization technologies in the market to enable SMEs to meet their energy saving targets.

The energy savings were calculated for foundry clusters with the assumption that 50% of industries in the moderate scenario and 70% in the ambitious scenario would adopt the strategy for the foundry cluster. The baseline SEC and production data of foundry clusters have been taken from the "Sameeeksha" report and moderate and ambitious scenarios were developed based on the potential technological interventions in the various clusters. The strategy is expected to result in energy savings of 0.001 Mtoe and 0.002 Mtoe in the moderate and ambitious scenarios respectively.

Table 5: Table showing key reduction potential in Foundry Units

Sector	Baseline SEC (toe/tonne)	Moderate SEC (toe/tonne)	Ambitious SEC (toe/tonne)	Production in 2030 ('000 tonnes)	Energy Saving in Moderate Scenario (Mtoe)	Energy Saving in Ambitious Scenario (Mtoe)
Foundry	0.17	0.15	0.14	67	0.001	0.002

Implementing agency(s) – Infrastructure and Industrial Development Department, Uttar Pradesh; UPNEDA

Actionable items:

A number of action items will need to be adopted by the relevant departments and implementing agencies to achieve the energy savings estimated for this strategy. These action items include:

A. Technical Category:

1. **Carrying out energy and resource-mapping studies in MSME clusters –** For the industries not covered under PAT, there is a challenge in reporting accurate energy consumption data for individual clusters or sub-sectors. Understanding of energy consumption patterns in the clusters in necessary to ensure optimized allocation of resources and assess the feasibility of technology implementation in a particular cluster. Energy and resource-mapping studies are comprehensive studies on MSME clusters and sub-sectors that can give insights into the current status of technology implementation in the cluster, set benchmark energy consumption, design threshold limits for a PAT-like scheme, and analyze the future potential of technology implementation in terms of energy and cost savings. Energy and resource-mapping studies are proposed to be carried out in the prominent MSME clusters and industry sub-sectors of the state annually to set benchmarks and track progress in the implementation of this strategy.
2. **Implementation of Demonstration Projects on energy efficient technologies in SME clusters –** Demonstration projects are proposed to be

carried out every year on a periodic basis in all prominent SME clusters to promote these technologies and make stakeholders aware about the monetary and energy performance impact of these technologies.

3. **Technical assistance for technology upgradations by replacement of existing fuel oil based firing system with natural gas firing system in tunnel kiln in foundry sector –** Foundry are key industries in the MSME sector, upgradation of technology will unlock large potential of energy savings. As these industries include several small sized units, technical assistance to upgrade in key energy consumption sectors will create a large impact.

B. Awareness Category:

1. **Workshops on technology interventions for energy conservations in MSMEs –** It is proposed to organize cluster wise workshops for MSMEs on technology interventions that can be implemented in respective industries. It is important to disseminate technical information about new technologies among owners and maintenance team of MSMEs so that they can implement latest technologies in their units.

C. Financial Category:

1. **Periodic standardized energy audits for MSMEs on load basis and reimbursement of energy audit cost with a maximum cap** – Government of Uttar Pradesh shall develop a standard format of energy audit and issue notification for conducting mandatory periodic (in every 3 Years) energy audits by every unit above a certain limit of connected load. The government can also provide reimbursement of energy audit cost with a maximum cap of INR 75,000. Monetary support to small industries and MSMEs can be provided to maintain the standard of conducted energy audit.
3. **Sector-specific policy development financial assistance on implementation of ECMs suggested in energy audit-** A policy shall be developed at state level to provide the financial assistance for implementation of ECMs recommended in the energy audits. Policy

development shall consider the sector specific requirements, energy saving potential of sector and its importance in state level GSDP.

D. Cost Benefit Analysis:

Cost benefit analysis for technology upgradation i.e. Replacement of existing fuel oil-based firing system with natural gas firing system in tunnel kiln is considered for Switchover to Natural gas firing system in tunnel kiln for Khurja Kuttir and Handicraft Welfare Society (CFC), Khurja (Uttar Pradesh).

Existing Conditions	
Production capacity	2.25 tonne per day
Operation	Continuous
Annual operation	250 days
Firing time	24 hour/day
Make of burner	Local
Make off blower	Local
Blower operation	continuous
Number of burners	6
Burner arrangement	3 each on either side of vertical wall
Burner operation sequence	All fire continuously
Burner capacity	NA
Type of control	Manual
Waste heat recovery	Product pre-heating
Refractory compatibility	Limited use of high temperature compatible and insulating refractories leading to higher structural heat losses.
Temperature of kiln chamber	1200ºC
Instrumentation	Temperature indicator for kiln chamber
Draft control	Natural draft with chimney arrangement
Fuel used	Fuel oil
Design fuel consumption	20 L/h

Recommended and Proposed Conditions	
Production capacity	2.25 tonne per day
Operation	Continuous
Firing time	24 hour / day
Make of burner	ITEPL
Make off blower	Local
Blower capacity	Existing
Blower operation	24 hour / day
Number of burners	6
Burner arrangement	3 each on either side of vertical wall
Burner operation sequence	All fire continuously
Burner capacity	14 kW/hr (minimum) and 140 kW/hr (maximum)
Type of Control	Automatic
Make of safety devices	MADAS
Refractory lining	Existing
Temperature of kiln chamber	1200ºC
Instrumentation	Gas flow meter, air flow meter, temperature indicators, pressure gauges
Draft control	Existing
Fuel used	Natural gas
Design fuel consumption	20 SCM/hr

E. The estimated annual energy savings by replacement of existing fuel oil-based firing system with natural gas firing system in tunnel kiln is 23.4 toe equivalent to monetary savings of 15.4 lakhs/year. The investment requirement is Rs 16.7

lakh with a simple payback period of 0.7 years. Detailed calculations are available at DPR (Report ID: KH/04/DPR)[15]

Below table represents the savings and payback calculations:

Operation Details			
Parameter	**Units**	**Existing**	**Proposed**
Fuel in use	-	Fuel Oil	NG
Density of fuel oil	Kg/litre	0.93	0.65
GOV of fuel oil	Kcal/kg	10500	
	Kcal/litre or SM^3	9765	9000
Average combustion efficiency	%	80%	95%
Average cost of fuel	Rs/litre	50	42
No trolley fired	Trolley/day	20	20
Annual working days	Days/year	250	250
Production			
Average weight of product	Kg/piece	0.1	0.1
Production per day	Piece/day	22500	22500
	Tpd	2.25	2.25
	tpy	562.5	562.5
Products per box packaging	pcs/box	96	96
Weight per box package	Kg/box	9.6	9.6
	tonne/box	0.0096	0.0096
Selling rate of class 1	Rs/box	350	350
Selling rate of class 1	Rs/tonne	36458	36458
Selling rate of class 2	Rs/box	330	330
Selling rate of class 2	Rs/tonne	34375	34375

[15] sidhiee.beeindia.gov.in/images/DigitalLibrary/637877029580977292.pdf

Share of class-1 product	%	75	80
Share of class-2 product	%	15	15
Share of rejection of product	%	10	5
Saving from yield			
Cost of total salable yield	Rs in lakh/yr	182.8	193.1
Monetary benefit from yield	Rs in lakh/yr		10.3
Saving from energy cost			
Fuel consumption	Litre/day	400	300
	Litre/year	100000	82500
Fuel costs:	Rs lakh/year	50	34.7
Saving from energy cost	Rs lakh/year		15.4
Summary			
Savings from fuel costs	Rs lakh/year	15.4	
Saving from increased yield	Rs lakh/year	10.3	
Total effective saving	Rs lakh/year	25.6	
Capital investment			
Gas meter	Rs lakh		2.5
Advance for fortnightly billing cycle	Rs lakh		5.19
Gas and air train including on site expenses	Rs lakh		7.98
Miscellaneous expenses at site during system integration plus freight	Rs lakh		1
Total investment	Rs lakh		16.7
Simple payback period	Year		0.7
	Months		7.8

Strategy #6 Clean Energy Transition in Thermal Power Plant

Implementation Timeline: Short Term (Till FY 2026) for lower coverage; Long Term (Till FY 2031) for higher coverage.

Primary energy input in the form coal to thermal power plants for the production of power is expected to continue increasing, despite the government moving to retire old coal-based power plants, in order to meet the projected increase in electricity demand which would not be catered by renewable energy-based power. The state is projected to have a primary energy input of 47.22 Mtoe by FY 2031, which is approximately 49% of the overall projected primary energy input of the state.

There are 5 no of state-owned government Thermal power stations in UP operated by UPRVUNL[16] as follows:

S No	Category	TPS
1	State Owned Govt TPS	Obra Power Station
2		Parichha Power Station
3		Harduaganj Power Station
4		Jawaharpur Vidyut UNL
5		Anpara Power Station

List of Technology Interventions for Energy Efficiency –

- Replacement of the Inefficient ID & FD Fans
- Replacement of the inefficient Burner
- Nano composite surface treatment for condenser in power plant
- ISO 50001 Energy Management System Implementation
- Installation of LP compressor for fly ash unloading
- Installation of energy efficient pumps
- Retro-fitting of the Cooling Tower
- Energy Efficiency LED Lightings

[16] Thermal Power Stations | Uttar Pradesh Rajya Vidyut Utpadan Nigam (uprvunl.org)

The saving potential for the strategy for thermal power plant are as followed –

Particulars	Moderate Scenario	Ambitious Scenario
Saving Potential	2.36	4.72

Implementing agency(s) – UPRVUNL, BEPL, LAPPL, RPSCL etc.

Actionable items:

A number of action items will need to be adopted by the relevant departments and implementing agencies to achieve the energy savings estimated for this strategy. These action items include

A. Technical Category:

1. **Clean Energy Transition in Thermal Power Plants by blending of biomass and co-firing –** In line with the Ministry of Power's guidelines in the "Revised Policy for Biomass Utilization for Power Generation through Co-firing in Coal Based Power Plants", the strategy proposes a 5% and 10% blend of clean fuel, mainly agro-residue based biomass with coal in the moderate and ambitious scenarios respectively.

   The strategy is expected to result in coal energy offset in the plant by Co-firing of agro-based biomass in coal based thermal power plants has dual benefits as it results in significant emissions reductions as well as eliminates the burning of agro-residue in the state.

B. Action Items:

1. **Testing of feasibility of 10% blending of biomass:** Assess the feasibility of maximum possible blending of biomass at the plant. Adopt the maximum blending of the biomass for transition to the clean fuel at the plant.

2. **Strengthening of biomass supply chain infrastructure:** Strengthen the biomass supply chain for the thermal power plant by developing reliable sourcing practices, enhancing transportation networks, and building storage facilities to maintain biomass quality. Invest in advanced processing technologies to optimize biomass conversion and reduce losses.
3. **Mapping of thermal power plants for identification of retrofitting & modernization (R&M) requirements:** Map thermal power plants to identify retrofitting and modernization (R&M) requirements. Conduct detailed assessments to pinpoint inefficiencies and areas needing upgrades. Prioritize plants based on potential energy savings and operational improvements. Develop tailored R&M plans to enhance performance and reduce emissions.
4. **Capacity building of plant maintenance team on Energy Efficiency Potential Assessment with the help of Diagnostic tool (like EBSILON) and best practices of energy efficiencies:** Empower the plant maintenance team by training them on Energy Efficiency Potential Assessment using tools like EBSILON and sharing industry best practices. This training will enable them to skillfully identify energy-saving opportunities and implement effective strategies to enhance plant performance and achieve substantial energy efficiencies.

C. Cost Benefit Analysis:

Cost benefit analysis for technology upgradation i.e. blending of biomass and co-firing has been referenced from Viability study, Dec 2020 - CEA and Japan Coal Energy Center (JCOAL).

The 30% biomass is used and the generation cost for the current generation and the Palletizer based generation system remains same.

S No	Particulars	Values
1	Plant Name	GHTP
2	Plant Capacity	250 MW
3	Annual Generation	2190 MU
4	Capital Cost	110 Cr

S No	Particulars	Values
5	Fuel Cost (Biomass – Cofiring with Palletizer)	3.25 INR/kWh
6	Bio-mass Ratio	30%
7	Fuel Cost (100% Coal Firing)	3.50 INR/kWh
8	Annual Saving Cost	54.75 Cr
9	Payback period	2 Years

4.3. Energy Saving Targets & Monitoring Mechanism

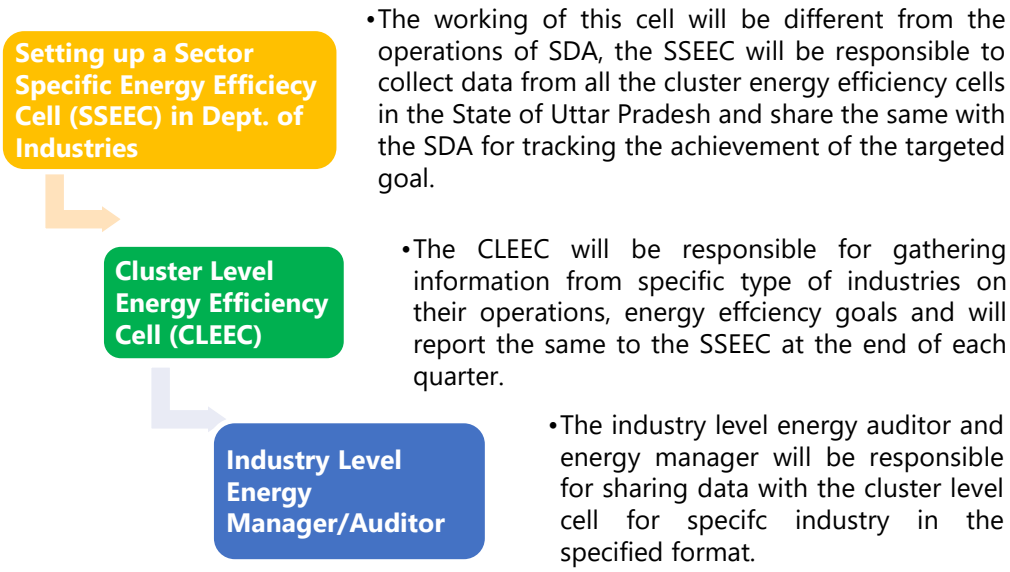
The proposed strategies can together achieve maximum potential energy savings of 3.438 Mtoe by FY 2031. The potential savings under moderate and ambitious scenarios is the overall estimated savings from individual strategies under the respective scenarios and can be considered as the energy saving targets for FY 2031 for the Industry Sector.

Table 6 Moderate and ambitious scenarios energy savings for Industry sector

Action Plan	Energy Savings in 2031 under moderate scenario (Mtoe)	Energy Savings in 2031 under ambitious scenario (Mtoe)
Deepening and Widening of PAT scheme	0.107	0.234
Energy Efficiency Interventions in Bricks Clusters	0.79	2.96
Energy Efficiency Interventions in Glass Clusters	0.08	0.21
Energy Efficiency Interventions in Paper Clusters	0.01	0.03
Energy Efficiency Interventions in Foundry Clusters	0.001	0.002
Clean Energy Transition in Thermal Power Plant	2.36	4.72
Total	**3.34**	**8.15**

Monitoring Mechanism:

The monitoring framework for achieving the target of the industry sector can be easily set up by defining annual reduction targets of the sectoral reduction goal. The reduction target verification can be later done for monitoring the following for each quarter:



To enhance monitoring and ensure transparency, the specific performance metrics should include SEC reduction, the number of new units identified under PAT Deepening and Widening, and the number of energy-efficient demo projects implemented in the Brick, Glass, Paper, Foundry, and Thermal Power Plant sectors. As the relevant departments finalize the monitoring plan, additional metrics may be identified. These metrics will play a crucial role in tracking industrial progress toward achieving target reductions by 2030. Regular analysis will help detect any deviations from the targets early, enabling timely corrective actions and adjustments. The review frequency for each metric will be determined based on the monitoring plan developed by the relevant departments.

The table below outlines the identified performance metrics for the strategies, along with their review frequency.

S No	Sector	Specific Performance Metrices	Review Frequency
1.	Industry	SEC reduction	Yearly
2.		Nos. of new units identified under PAT Deepening	Quarterly
3.		Nos. of new units identified under PAT Widening	Quarterly
4.		Nos. of Energy Efficient Demo projects implemented in the Brick, Glass, Paper, Foundry and Thermal Power Plant Sectors	Half-yearly

BUILDINGS SECTOR

5. Focus Sector 2 – Buildings

5.1. Current Scenario

In the state of Uttar Pradesh, energy efficiency in buildings is critical, given the rapidly increasing population and urbanization. As per the 2019 population trends for Uttar Pradesh, 23.8% of the population of Uttar Pradesh lives in urban areas and the urban areas have grown significantly over the past decade. With such a high concentration of people in urban areas, there is a pressing need to improve energy efficiency in buildings to reduce energy consumption, costs, and environmental impacts. The state government plays a critical role in setting building bylaws and including provisions of energy codes such as the Energy Conservation Building Code (ECBC) in Unified Building Byelaws. However, the implementation of the ECBC code in Uttar Pradesh is still in its early stages, and there is a need to improve its enforcement to ensure effective implementation. Additionally, BEE's Eco-Niwas Samhita (ENS) can set minimum standards for residential buildings' energy efficiency. The ENS provisions can be incorporated into the state's building bylaws to ensure effective implementation.

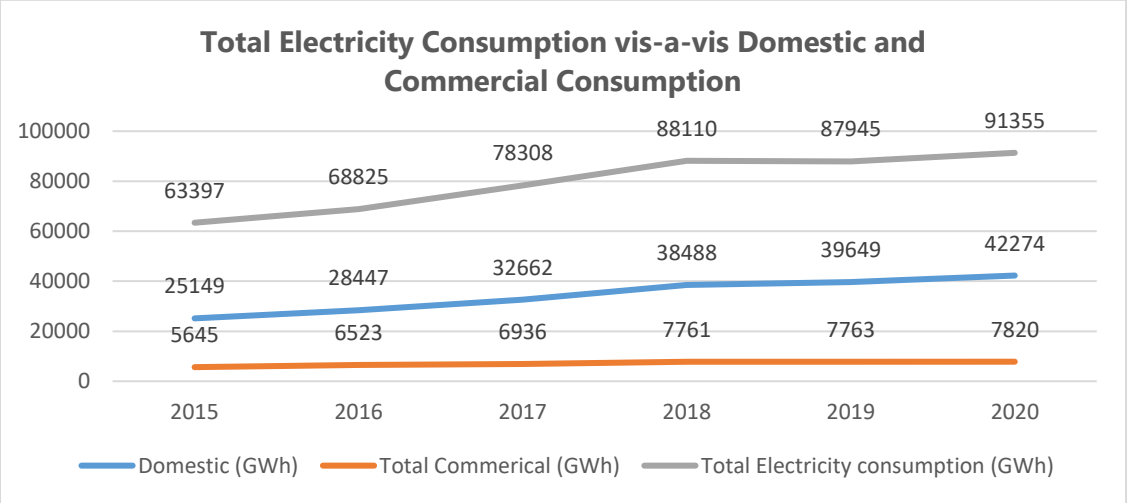


Figure 18: Growth of total electricity consumption vis-a-vis residential and commercial consumption.

In the above-mentioned figure, the grey line represents the total electricity consumption in each year which includes all the sectors, whereas the blue and orange line represents the electricity consumption of domestic and commercial buildings respectively. The commercial sector supports urbanization in the state of Uttar Pradesh, but still caters to only about 15.61% of the total electricity consumption in the building sector as of 2020. The domestic sector on the other hand, retains 84.39% of the electricity consumption, this indicates that Uttar Pradesh, requires a policy to encourage energy efficiency in the domestic sector in both urban and rural areas.

The sharing pattern of electricity consumption of the commercial and domestic sector for FY 2020 is represented in the following figure:

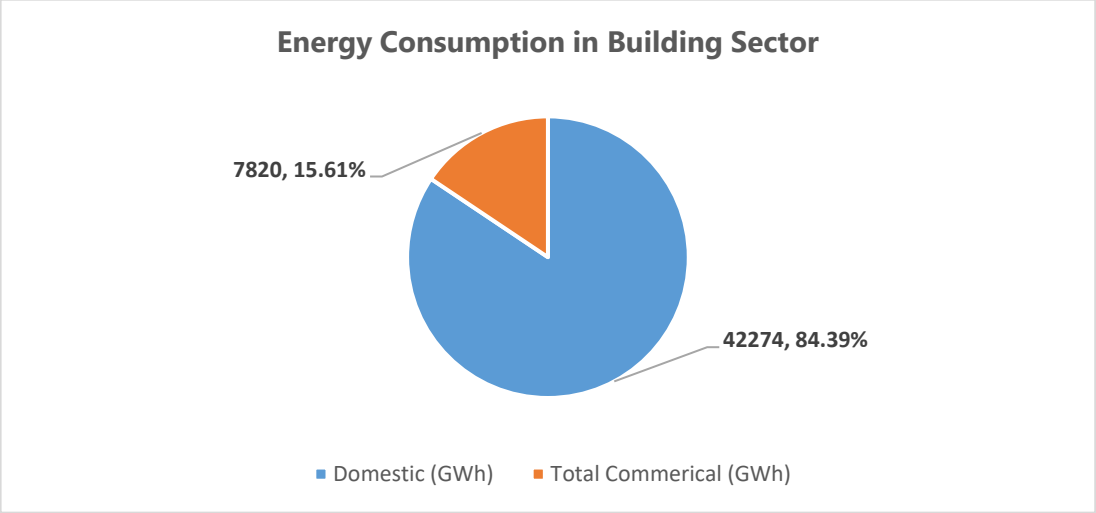


Figure 19: Energy Consumption in Buildings Sector

5.2. Energy Efficiency Strategies in the Buildings Sector

This section presents the proposed strategies in the domestic buildings and commercial buildings sector along with their impact in terms of energy efficiency and emissions reduction. The following strategies are proposed in the industry sector, as part of the State Energy Efficiency Action Plan:

1. **Effective Implementation of ECSBC**
2. **Replacement program for inefficient appliances**
3. **Promotion of BEE Star Rating and Shunya Rating of Buildings**

Although programs like Standards & Labelling and ECBC are prevalent in the state, the proposed strategies focus on enhancing the extent of their implementation by increasing the penetration of technology into the population and rate of implementation of these strategies.

Strategy #1 Effective Implementation of ECSBC (previously known as ECBC & ENS)

Uttar Pradesh is a leading state in the country in terms of notifying Energy Conservation Building Code (UP-ECBC 2018). ECBC has also been incorporated in the building by-laws in January 2019. The state is also in the process of adopting Eco-Niwas Samhita for residential buildings. However, in a recent EC Act Amendment 2022, unified code "Energy Conservation and Sustainable Building Code" (ECSBC) is introduced which will cover both commercial and residential buildings. Till the implementation of ECSBC in states, ECBC and ENS will be known as ECSBC.

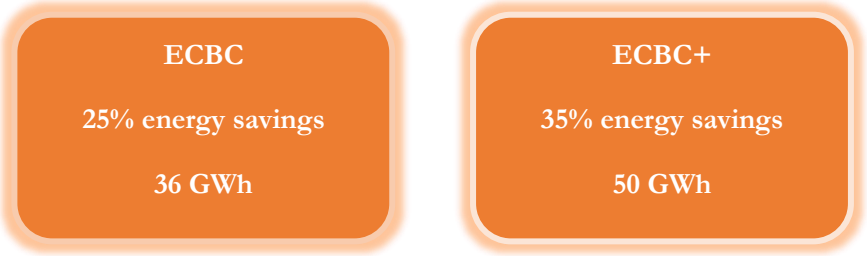
Effective implementation of Energy Conservation Building Code (ECBC) and ENS by increasing the penetration of ECBC and ENS compliant buildings in the state is proposed for upcoming commercial and domestic buildings in the state as a strategy for energy savings in the building sector.

In order to estimate the savings through ECBC, the electricity consumption of the commercial buildings sector was projected till FY 2031. After forecasting the energy demand in the commercial building sector from FY 2023 to FY 2031, the annual increment in the electricity consumption in the commercial buildings sector was projected.

The total incremental electricity consumption for the commercial buildings in the state is projected to be 2, 842 GWh between FY 2023 to FY 2031. This increment in electricity consumption accounts for all the categories of commercial buildings of varying loads. The Energy Conservation Building Code (ECBC) sets minimum energy standards for commercial buildings having a connected load of 100 kW or more. It has been taken into consideration that around 5% of the buildings in the state have connected load of

100 kW or more. Considering this percentage, the Total Incremental Electrical Consumption contributing to buildings having load >100kW is estimated to be almost 142 GWh.

Based on the energy savings percentage from ECBC and ECBC+, the moderate and ambitious savings in the commercial building sector are found to be **36 GWh** and **50 GWh** respectively.



Making houses energy efficient is conclusively one way to avoid long-term frivolous electricity consumption in the residential building sector. Effective implementation of ENS can aid in this process of energy savings in the residential sector.

In the residential sector, by FY 2031, the electricity consumption is projected to be around 93, 079 GWh. The overall incremental electrical consumption is estimated to be 59, 893 GWh based on the anticipated household electricity demand by FY2031. To assess the savings that can be achieved from successful implementation of ENS, it is assumed that 40% of all the residential building stock would be ENS compliant by 2031. The strategy is expected to result in electricity savings of 287.4 GWh in the moderate scenario and that of 359.3 GWh in the ambitious scenario.

The cumulative energy savings and emissions reduction expected from the enhanced implementation of ECBC and ENS in the state is shown in below table:

Particulars	Moderate Scenario	Ambitious Scenario
Energy Saving Potential (Mtoe)	**0.028**	**0.035**

Implementing Agency: Uttar Pradesh Housing and Urban Development Authority as the nodal agency for ECSBC, Municipal Corporations, Industrial Development Authority (NOIDA, BIDA)

Actionable Items:

A. Technical Category:

1. **Setting-up of effective enforcement plan with ULBs and SDA as monitoring agencies-** Effective implementation of ECBC and ENS depends on the effectiveness of rules & regulation adopted by the State. To ensure the same role & responsibility of all concerned departments, check points, monitoring mechanism and penalties must be properly defined in ECSBC rules & regulations.

   SDA being an extended arm of Bureau of Energy Efficiency shall monitor the process of ESCBC compliance and record the data of total energy savings achieved through the implementation of ECSBC.

2. **Development and maintenance of ECSBC compliance portal, directory of energy efficient materials/technologies** – For effective and aggressive implementation, it is proposed that the state shall has its own ECSBC online portal to aid in quick ECBC & ENS approval and monitoring process online. The portal would ensure a faster process of compliance application, third party verification and certification. The portal may also contain educational resources, directory of materials and vendors and user-friendly guides for enhanced awareness and capacity building of developers and professionals. Investment would be needed in the development and annual maintenance of the ECSBC portal for which UPNEDA will be the implementing agency.

3. **Periodic upgradation of PWD Schedule of Rates (SoR) to incorporate latest energy efficient materials and technologies**

   Regular upgradation of PWD Schedule of Rates (SoR) to incorporate latest energy efficient materials and technologies is required as technologies in the field of energy efficiency is developing on some very regular intervals.

Adoption of new innovative technologies become easier if it is mentioned in PWD Schedule of Rates (SoR) document.

4. **Pilot projects for Super ECBC buildings as case studies (initial 20 Buildings)** – It is proposed that the state government also undertake the development of Super-ECBC buildings in the state and publish its case studies for the understanding of stakeholders. Initially upcoming government building can be taken as a pilot project and best energy efficient technologies can be implemented to achieve the Super ECBC level. Case Study can be published in social media to encourage developers and other stakeholders to make Super ECBC compliant buildings.

B. Awareness Category:

1. **Market Outreach for ECBC compliant Products, Radio Jingles, Social Media Awareness** – Market outreach for ECBC compliance products or products utilized in sustainable construction such as building materials used in passive building design would enable a conducive market for such materials which will promote construction practices necessary to comply with ECBC and ENS guidelines. The market outreach can take place through professional conventions and seminars, radio jingles and awareness campaigns on social media.
2. **Inclusion of curriculum on energy efficiency in buildings, in universities and Schools**

   Raising awareness about energy conservation among children is crucial. To instill a fundamental understanding of this concept and promote a behavioral shift in children, it is suggested that the curriculum on energy efficiency and conservation be developed and integrated into schools and universities in Uttar Pradesh.

C. Financial Category:

1. **Home Energy Auditor Training, compliance structure and incentive on energy savings for first few residential projects** – BEE has developed a Home Energy Auditing tool. SDA may run awareness and capacity

development programs in the State of Uttar Pradesh to train building professionals about the benefit of auditing and implementation of Energy Conservation Measures (ECMs) in residential houses. SDA may encourage RWAs by providing some incentive based on energy savings on implementation of ECMs in their societies. These action items will help in the promotion of ENS in Uttar Pradesh and create technical capacity of the professionals.

D. Cost Benefit Analysis:

Case Study – UPERC Building [17]

The Energy Conservation Building Code (ECBC) case studies provide real-world examples of buildings that have successfully implemented energy-efficient measures and achieved significant energy savings. These case studies serve as practical examples and inspiration for architects, engineers, and building owners who are interested in designing and constructing energy-efficient buildings. The purpose of these case studies is to demonstrate the feasibility and benefits of energy-efficient building practices and to showcase the potential for significant energy savings. They often highlight the financial and environmental advantages of implementing energy-efficient measures, including reduced energy costs, improved occupant comfort, and reduced greenhouse gas emissions. ECBC case studies cover a wide range of building types, including residential, commercial, institutional, and industrial buildings. They showcase various energy-saving features, such as efficient lighting and appliances, effective insulation and air sealing, optimized HVAC systems, renewable energy integration, and smart building controls.

In this case study, we will examine the energy savings achieved by the UPERC building, which holds the distinction of being the first green building in the state of Uttar Pradesh and is fully compliant with the Energy Conservation Building Code (ECBC). The study focuses on comparing the energy performance indicators (EPIs) of the UPERC

[17] Source: http://upsavesenergy.com/Documents/SDA_Activities/ECBC-building-case-study.pdf

building with different material options, including the minimum requirements outlined by ECBC as the base case. The objective is to determine the most energy-efficient materials for the UPERC building.

The following information highlights the material selection for each option considered, along with the corresponding energy savings percentage:

Component	Option 1: As-is case	Option 2	Option 3
Wall	1. Outside plaster 15 mm 2. External AAC wall 200 mm 3. Inside Cement Plaster 12mm 4. XPS Insulation 50 mm	1. Outside plaster 15 mm 2. External Fly Ash wall 230 mm 3. Inside plaster 12 mm 4. XPS Insulation 100 mm	1. Outside plaster 15 mm 2. External Clay Brick wall 230 mm + 100mm cavity +230 mm clay brick wall 3. Inside plaster 12 mm
Roof	1. RCC roof Slab 125 mm 2. PUF Insulation 50mm thick 3. Suitable water proofing membrane 4. Screed Plaster 40mm 5. Internal Ceiling Plaster 6mm	Landscaped terrace 1. RCC Slab 2. PCC 75 mm 3. Water Proofing sheet 4. Gravel 100 mm 5. Geo fabric membrane 6. Sweet Soil	1. RCC roof Slab 2. PCC 40mm (1:2:4) 3. 50mm screed 4. Tile 20mm
Glass	SKN 744II	Planitherm - Mint Green (PLT TG) Planilux	Envision 765II, Planilux (Clear Glass)
HVAC	VRV system for the entire building	Radiant cooling with Chilled Beams for the entire building	Chilled Water System
Lighting	All LED lights, Occupancy Sensors for Corridor & office area, Daylight Controls for regularly occupied day lighted area	All LED lights, Occupancy Sensors for Corridor & office area, Daylight Controls for regularly occupied day lighted area	All LED lights, Occupancy Sensors for Corridor & office area, Daylight Controls for regularly occupied day lighted area
Renewables	70 kW Solar Photovoltaic (About 713.6 sqm considered for installation of PV cells)	70 kW Solar Photovoltaic (About 713.6 sqm considered for installation of PV cells)	70 kW Solar Photovoltaic (About 713.6 sqm considered for installation of PV cells)
EPI	67.7 kWh/m2/year	81.9 kWh/m2/year	90.7 kWh/m2/year
Savings	**51%**	**41.5%**	**35.1%**

These details showcase the relationship between the chosen materials for each option and the resulting energy savings percentages.

The table below presents the calculated EPIs for each case:

	BASE CASE	OPTION – 1	OPTION – 2	OPTION – 3
EPI (kWh/m^2/year)	123.2	86.67	100.75	109.50

By analyzing the EPIs for each material option, we can determine the level of energy efficiency achieved by the UPERC building and identify the material selection that offers the highest energy savings potential. The following table presents the energy savings percentage, cost savings on the electricity bill, extra cost inclusion, and estimated payback time for each case:

Options	Energy Savings	Money On Electricity Bill Saved Each Year (Rs.)	Extra Cost Incurred (Rs)	Payback Time (Years)
Option 1	399.23 x 10^3 (51%)	27,94, 610	1,28,63,825	4.6
Option 2	361.55 x 10^3 (41.5%)	25,30,850	2,24,17,877	8.8
Option 3	335.95 x 10^3 (35.1%)	21,34,650	2,09,42,827	9.8

In the table, the energy savings percentage represents the reduction in energy consumption compared to the baseline case. The cost savings on the electricity bill indicate the monetary savings achieved through energy efficiency measures. The extra cost inclusion refers to any additional expenses associated with implementing the specific material option.

Case Study – ENS (Eco Niwas Samhita)

The primary objective of ENS is to establish minimum energy performance standards and guidelines for various aspects of building design, construction, and operation. It provides a comprehensive framework for energy-efficient building practices, covering areas such as building envelopes, lighting, HVAC systems, electrical systems, renewable energy integration, and water management.

The code outlines the technical specifications, design parameters, and performance targets for different building components and systems. It also provides guidelines for energy audits, rating systems, and certification processes to encourage the adoption of energy-efficient practices in the construction industry. The implementation of ENS helps in reducing the energy demand and associated environmental impacts of buildings, as well as in achieving energy security and sustainability goals. It supports the government's initiatives to promote energy conservation, mitigate climate change, and create a sustainable built environment in India.

With the compliance of the ENS in a residential building, an aggregate of 20% savings can be achieved. Consider the example:

Average Electricity Consumption = 5.7 kWh/day
Annual Electricity Consumption = 5.7*365
= 2080.5 kWh

20% of Energy Savings from ENS Compliance	=	20% * 2080.5 kWh
	=	416.1 kWh
Cost of 1 kWh residential sector in UP	=	Rs. 6.5/kWh
Cost Savings against energy savings	=	Rs. 6.5/kWh * 416.1 kWh
	=	Rs. 2704.65

Consider, a case where ENS is implemented in 1% of the Uttar Pradesh urban households, then the total energy savings can be achieved = 39 MU

Total Cost Savings = Rs. 25 Crores

Strategy #2 Replacement program for inefficient (below than 3 Star Rated) appliances

Implementation Timeline: Long Term (Till FY 2031)

The Standards & Labelling (S&L) Programme of Bureau of Energy Efficiency (BEE) has seen a successful implementation across the country, leading to significant savings in energy through mandatory and voluntary use of energy efficient electrical appliances by consumers in a wide range of applications. The S&L programme encompasses appliances and equipment that have applications in multiple sectors, however the buildings sector is the most widely covered sector in terms of types and number of appliances. At present, the S&L Programme covers the 38 appliances, with 16 appliances subject to mandatory regulation and the remaining 22 appliances subject to voluntary regulation. The list of mandatory and voluntary appliances is given in below table:

Table 7: List of mandatory and voluntary appliances under S&L Programme

Mandatory Appliances	Voluntary Appliances
1. Room Air Conditioners	1. General Purpose Induction Motors
2. Frost-free refrigerators	2. Agriculture Pump Sets
3. Tubular Florescent Lamps	3. LPG Stove
4. Distribution Transformer	4. Office Equipment's (Printers & Copier)
5. Room Air Conditioner (Cassette, Floor Standing)	5. Ballast
	6. Computers (Laptop/Notebooks)

6. Direct Cool Refrigerator 7. Color TV 8. Electric Geysers 9. Variable Capacity Inverter Air Conditioners 10. LED Lamps 11. Ceiling Fans 12. Light commercial AC 13. Deep Freezers 14. Washing Machine 15. Chillers 16. UHD Color TV	7. Diesel Engine driven mono set pumps 8. Solid State Inverter 9. Microwave Oven 10. Solar Water Heater 11. Diesel Generator Set 12. Grid Connected solar Inverter 13. Commercial Beverage Coolers 14. Air Compressor 15. High Energy Li-Battery 16. Side by Side/Multi Door Refrigerator 17. Pedestal Fan 18. Induction Hob 19. Tires 20. Solar Photovoltaic 21. Table/Wall Fan 22. Packaged Boiler

The current strategy has been proposed for the domestic buildings sub-sector, which is having a share of 94% in the buildings sector's electricity consumption. Further, a majority of the mandatory and voluntary appliances have a significantly higher penetration in the domestic buildings sector than in the commercial buildings sector.

The electricity consumption pattern varies greatly between urban and rural areas. This is due to the variation in type and number of appliances being used by urban and rural residents. This entails the inclusion of number of urban and rural households in the savings calculation. Based on the estimated population of the state as per the report "Population Projections for India and States 2011 – 2036" and Household Size as per census, the number of households were estimated out for urban and rural regions. Different categories of appliances have different penetration among the urban and rural households, based on the usage pattern. Some appliances viz. Fans, refrigerators, washing machines, CFLs, and microwave have higher penetration as compared to other

appliances. Taking into account the study given in the report "Impact Assessment of BEE's Standard & Labeling Program", penetration of different appliances among urban and rural areas was estimated. Table shows appliance penetration considerations

Table 8: Appliances taken into consideration for the S&L strategy

Window AC	Colour TV - LCD/Plasma/LED
Split AC	Washing Machines
Refrigerator-DC	TFL (Tubular Flourescent Light)
Refrigerator-Frost Free	Electric Geysers
Ceiling Fans	LPG Stoves
Color TV CRT	Computer/Laptop/Notebooks

According to the study conducted by CLASP (Collaborative Labeling and Appliance Standards Program) to assess consumer awareness of energy labelling, 48% of consumers are aware of the scheme and 15% have some knowledge of it. Appropriate number of 3-Star rated appliances have been taken from the calculation of total number of appliances. Saving strategies in the moderate scenario include prompting/educating 3-star rated equipment users to switch to 5-star rated appliances, whereas in the ambitious scenario, promoting/educating users to switch to 3-star rated equipment has been considered as a saving strategy. The percentage savings achieved upon transitioning from 3-Star to 5-Star Labelled equipment (efficiency) were taken into account for calculating savings in above mentioned scenarios.

The strategy is estimated to result in energy savings of 0.43 Mtoe in the moderate scenario and 0.558 Mtoe in the ambitious scenario till FY 2031.

Table 9 Moderate and ambitious scenarios for deepening of S&L Programme

Particulars	Moderate Scenario	Ambitious Scenario
Energy Saving Potential (Mtoe)	0.43	0.558

Implementing Agency: Bureau of Energy Efficiency (BEE)

Actionable Items:

A. **Financial Category:**

1. **Development of state-specific implementation models and identification of relevant agencies-** A detailed phase-wise plan need to layout based on consumer's priority and reachability. It is important to develop a transparent model that can reach out to every household in the state. Financial implications will play a major role in replacement scheme so ESCOs and PPA models can we analyzed in details. UJALA scheme is a successful case study in this area, can be referred for the development of state specific plan. Identification of implementing departments and agencies and listing of ESCOs in the state is required.

B. **Technical Category:**

1. **Issuance of directive to government offices and buildings in the State to replace all existing inefficient appliances (lower than 3 Star Rated) with BEE 5-star rated appliances-** State Government shall issue directives to all government offices and buildings owned by state government to replace all appliances which are lower than 3 star rated or purchased/installed before 2015 with BEE 5-Star rated appliances.
2. **Phase-wise plan for replacement of existing inefficient appliances (lower than 3 Star Rated) with BEE 5-star rated appliances in all buildings, through DSM schemes** Development of phase-wise Demand Side Management (DSM) plan based on the consumer's priority and market scenario shall be developed in consultation with DISCOMs. Implementation

can be done with support of DISCOM's and various ESCOs listed with state government.

3. **Recommendation of energy optimization strategies by relevant departments/authorities**

   Relevant departments will issue a comprehensive directive that mandates the implementation of radiant cooling, passive design strategies, evaporative cooling, and other related measures. This directive aims to significantly reduce the power load of buildings by promoting the use of energy-efficient cooling methods and sustainable architectural designs. By adopting these advanced techniques, buildings can achieve enhanced thermal comfort while minimizing their overall energy consumption.

C. Awareness Category:

1. **Workshops & Campaigns on behavioral change interventions for energy conservation –** Capacity building of these stakeholders is key to develop a market environment for energy efficient appliances. State Government shall organize workshops at various levels to encourage people for behavioral change and run mass campaigns to reach out maximum people to increase awareness about benefits of behavioral changes and promote Lifestyle for Environment (LiFE). Workshops and campaigns shall be carried out to target maximum people by organizing through online platforms, print media, social media, nukkad nataks, and radio jingles etc.

D. Cost Benefit Analysis:

The program is a mandatory labelling scheme that provides consumers with information on the en

rgy efficiency and performance of products, enabling them to make informed choices and contribute to energy conservation.

The BEE S&L program covers a wide range of products, including air conditioners, refrigerators, televisions, electric motors, pumps, lighting products, and more. The program sets minimum energy performance standards for these products, which manufacturers must adhere to before their products can be sold

in the market. The standards are periodically updated to encourage continuous improvement in energy efficiency.

The BEE S&L program has been widely successful in India, significantly influencing consumer preferences and encouraging manufacturers to innovate and produce more energy-efficient appliances and equipment. It has contributed to substantial energy savings and environmental benefits, making it an integral part of India's energy conservation efforts.

Considering the following example:

Replacement program for Inefficient Appliances				
Appliances	**Savings % - 3 Star**	**Savings % - 5 Star**		
AC	20%	30%		
Refrigerator	25%	40%		
Washing Machine	30%	40%		
Televisions	15%	30%		
Tubular Fluorescent Light (TFL)	30%	50%		
Ceiling Fans	30%	50%		
Electric Geysers	30%	50%		
Average Electricity Consumption	Consumption in a day (kWh/day)	Consumption in Year (kWh)	Savings (3 Star)	Savings (5 Star)
AC	3.5	1277.5	255.5	383.25
Refrigerator	1.5	547.5	136.875	219
Washing Machine	0.4	146	43.8	58.4
Televisions	0.6	219	32.85	65.7
Tubular Fluorescent Light (TFL)	0.44	160.6	48.18	80.3
Ceiling Fans	0.6	219	65.7	109.5
Electric Geysers	6	2190	657	1095
Total (kWh)	13.04	4759.60	1239.91	2011.15
	3-star	**5-Star**		
1% of the total households in UP	376849 Nos			
Total Energy Savings through 1% of household	**467.26 MU**	**758 MU**		
Cost Savings	**INR 303**	**INR 492**		

Strategy #3 Promotion of BEE Star Rating and Shunya Rating of Buildings

Implementation period: Long Term (Till FY 2031)

The Star Rating and Shunya Rating of buildings is currently at a voluntary stage which is used as a benchmarking system for buildings in order to classify them in terms of 'Star-Rating' & 'Shunya Rating' on the basis of their energy performance. It is proposed that to promote Star Rating & Shunya Rating in all government & commercial buildings and conduct an assessment for their energy performance along with the ECBC Compliance process. Assessment of buildings on a scale of 1-5 stars or Shunya Rating will promote the development of energy efficient buildings in the state. Certification of Star Rating or Shunya Rating can be provided based on this assessment.

The implementation of the said rating can lead to savings as per table below:

Particulars	Moderate Scenario	Ambitious Scenario
Energy Saving Potential (Mtoe)	0.0004	0.0006

Implementing Agency: Bureau of Energy Efficiency; UPNEDA; Department of Housing & Urban Development

Actionable Items:

A. **Technical Category:**

1. **Issuance of directives to all government departments to conduct energy audits and target to achieve BEE Star Rating for their buildings**-
   State Government shall issue directives to all government departments and buildings owned by state government to conduct energy audit and implement energy conservations measures and target to achieve BEE Star Rating or Shunya Rating for their buildings.
2. **Periodic energy audits for commercial buildings on load basis and incentives on achieving specific level of star rating for buildings**-

A notification from State Government shall be issued for conducting mandatory energy audits of commercial buildings based on their connected load and incentives can be given on the achievement of star rated energy efficient buildings to encourage more building owners to reduce their EPI and save more energy.

3. **Mandatory minimum set point of 24 degrees for air conditioners in all government buildings –**

   The Bureau of Energy Efficiency has been raising awareness on the energy savings and cost benefit of lowering the operating set point of air conditioners and have advised consumers across the country to maintain set point on or above 24 degrees Celsius to ensure optimal temperature and energy consumption from the use of air conditioners. It is recommended that government departments take lead in the implementation of this practice across the state.

4. **Transformation of iconic government buildings to Net-Zero energy buildings –**

   Transforming government buildings to net zero will ensure maximum energy performance of these buildings. It will further boost the market and professional environment of sustainable construction products, energy efficient appliances, and energy audit and consulting services. The SOR of government construction projects can be regularly updated with energy efficient and climate responsible materials through the help of this strategy.

B. Awareness Category:

1. **Capacity Building of Architects & Building Professionals and Developers**- Capacity building programs of Architects & Building Professionals and Developers will ensure to increase the technical capacity of and awareness about innovative technologies. Capacity building of these stakeholders is key to develop a market environment for energy efficient buildings. The capacity building programs can be taken up periodically, preferably quarterly. Capacity building workshops may be carried out either

district-wise or zone-wise and target maximum stakeholder to participant in these programs.

2. **Market Outreach for Star & Shunya Rating by Radio Jingles, Social Media Awareness-**

   Promotion of the Star & Shunya Rating is an important part to promote energy efficiency in buildings. In order to increase awareness about these rating program, promotion campaigns shall be carried to reach masses by advertising in print media, social media, conduct nukkad nataks, plays and run radio jingles etc.

C. Cost Benefit Analysis:

Case Study – Indira Paryavaran Bhawan[18]

Indira Paryavaran Bhawan, situated in South Delhi on Jor Bagh Road, serves as the office building for the Ministry of Environment and Forest (MoEF). It was constructed based on the concept of a Net Zero Energy Building (NZEB), aiming to minimize changes to the existing structure and minimize disruption to the surrounding ecosystem. The Central Public Works Department (CPWD) and sustainable design consultants, Architects and Planners, were involved in the building's design. The primary goal was to maximize energy efficiency and generate sufficient renewable energy on-site to meet the building's operational needs. Special attention was given to reducing energy demand through the incorporation of natural lighting, shading elements, landscaping to mitigate ambient temperatures, and the use of energy-efficient active building systems.

Material and Construction Techniques used in the buildings: Building constructed with the use of low embodied energy and a recycled content-based product like AAC blocks with fly ash, fly ash-based plaster & mortar. The building has been constructed by providing. Local stone flooring, bamboo jute composite doors, frames, and

[18] Source: https://ijcrt.org/papers/IJCRT22A6858.pdf

flooring. These products are of low embodied energy. High-efficiency glass, high VLT, low SHGC & Low U-value, optimized by appropriate shading which helps in energy efficiency. Light shelves have been provided for diffused sunlight. Stone and Ferro cement jaalis used.

The EPI of the building is 44 kWh/m^2/year, the climate type witnessed by the locality is composite.

Energy Efficiency – Eco – Friendly Features:

The building has been made energy efficient through onsite solar power generation, reduction of conventional lighting load by enabling 75% daylight use, generation of energy by deploying thin film transparent PV modules on space frame over the terrace and central courtyard, use of high efficiency lighting fixtures, astronomical/time switches and occupancy sensors.

- Geothermal heat exchange system
- Regenerative lifts
- Fully automated car parking in basements
- Building orientation in E-W direction
- Blocks connected with corridors and central courtyard.
- Building envelope designed to ensure daylight in 75% occupied areas.
- Plantation and grassing in more than 50% area.
- Grass pavers in circulation areas
- Terrace garden
- Energy efficient air conditioning system and lighting
- Conversion of braking energy into electricity in lifts
- Chillers and AHUs with VFDs, heat recovery wheels and thermostat controls for HVAC
- LED lights, occupancy, and Lux level sensors
- 930 KWP rooftop solar power plant
- Low discharge water fixtures
- Landscaping with no hard paving eliminating heat island effect.
- Sewage treatment plan for 30kld capacity

5.3. Energy Saving Targets & Monitoring Mechanism

The proposed strategies can together achieve maximum potential energy savings of 0.36 Mtoe by FY 2031. The energy saving and emissions reduction targets for the short term (till FY 2026) and long term (till FY 2031) for the industry sector under the two scenarios are shown in below table:

Table 10: Moderate and ambitious scenarios energy savings for building sector

Strategy	Energy (Mtoe)	
	Moderate	**Ambitious**
S&L	0.425	0.558
ECBC	0.003	0.004
ENS	0.025	0.031
ECSBC total	0.028	0.035
BEE Star Rating and Shunya Rating	0.0004	0.0006
Domestic Buildings Savings	0.450	0.589
Commercial Buildings Savings	0.003	0.005
Buildings (Total)	**0.454**	**0.594**

Monitoring Mechanism:

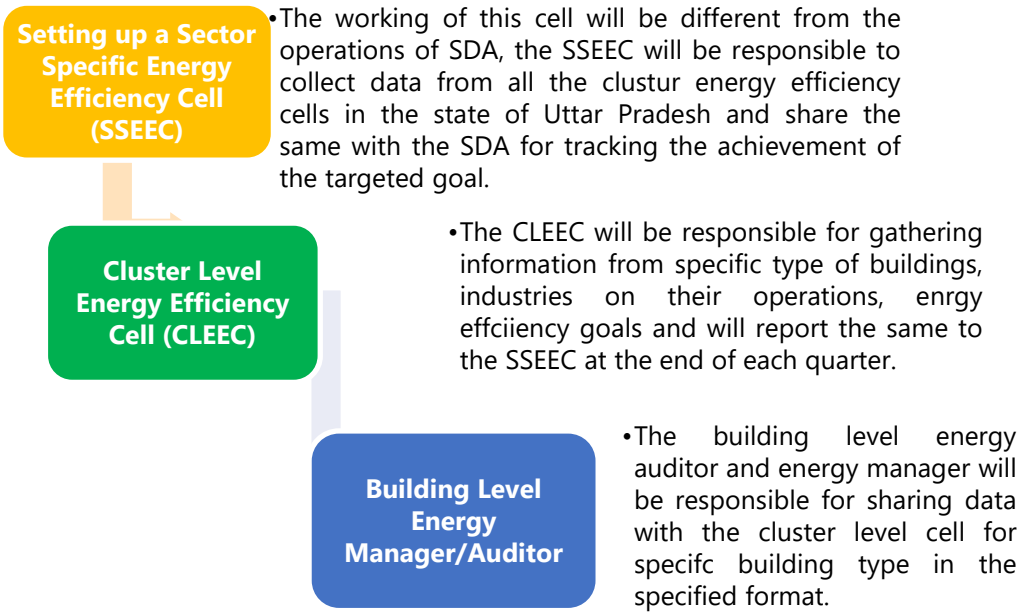
The monitoring framework for achieving the target of the building sector can be easily set up by defining annual reduction targets of the sectoral reduction goal. Monitoring of points mentioned below through the dashboard will support in monitoring of energy efficiency initiatives in the state.

- Development of strategy-specific dashboards to monitor the impact and track progress of ECBC buildings, ENS buildings, Net Zero buildings in the state and the energy savings achieved from these strategies.
- Regular reporting and updating of dashboard can be done with the support of UPNEDA or ECBC/ENS cell.

  Development of dashboard to monitor the sale of different star-labelled appliances sold in a year categorize according to star rating level.

- Installation of smart meters by relevant departments funded through the RDSS (Revamped Distribution Sector Scheme) and REC (Rural Electrification Corporation) resources, with the goal of achieving 100% coverage by 2026. This comprehensive initiative is designed to significantly enhance energy efficiency and improve billing accuracy across the board. By implementing smart meters, the department will enable precise monitoring of energy consumption, which will lead to more efficient energy use, reduce wastage, and provide consumers with detailed insights into their energy usage patterns. This transformation will not only benefit consumers by ensuring fair and accurate billing but also strengthen the overall energy sector by fostering greater operational efficiency and reliability.

Mechanism for data collection and reporting from various clusters and various energy efficiency initiatives may be done through Setting up a Sector Specific Energy Efficiency Cell (SSEEC), Cluster Level Energy Efficiency Cell (CLEEC) and Building Level Energy Manager/Auditor.



To enhance monitoring and ensure transparency in the building sectors, the specific performance metrics should include the number of ECSBC Compliant Buildings, the number of Super ECBC or Net Zero Buildings, the number of demo projects implemented, the number of inefficient appliances replaced with BEE 5 Star rated appliances, the number of BEE Star rated buildings, and the number of Awareness Programs conducted related to the energy efficient building code and energy efficient appliances. As the relevant departments finalize the monitoring plan, additional metrics may be identified. These metrics will be vital in tracking progress toward achieving energy efficiency and sustainability goals in the building sector. Regular analysis will help detect any deviations from the targets early, enabling timely corrective actions and adjustments. The review frequency for each metric will be determined based on the monitoring plan developed by the relevant departments.

The table below outlines the identified performance metrics for the building sector strategies, along with their review frequency.

S No	Sector	Specific Performance Metrices	Review Frequency
1.	Building	Nos. of ECSBC Compliant Buildings	Half-Yearly
2.		Nos. of Super ECBC or Net Zero Buildings	Yearly
3.		Nos. of Energy Efficiency Demo projects	Yearly
4.		No of inefficient appliances replaced with BEE 5 Star rated appliances	Quarterly
5.		No of BEE Star rated buildings	Quarterly
6.		Nos. of the Awareness Programs on energy efficient building code and energy efficient appliances	Quarterly

TRANSPORT SECTOR

6. Focus Sector 3 – Transport

6.1. Current Scenario

The Government of Uttar Pradesh is committed to decarbonize the transport sector and have introduced a number of initiatives towards this direction. The Directorate of Urban Transport, Govt. of Uttar Pradesh has laid down various goals in the seven cities i.e., Lucknow, Kanpur, Agra, Mathura, Allahabad, Varanasi and Meerut at State and City level to ensure sustainable urban transportation under the JnNURM scheme of Government of India. Uttar Pradesh aims to attain 100% transition of public transport to electric vehicles (EV) in 17 cities, including Lucknow, by 2030. This goal is in accordance with the new Electric Vehicle Manufacturing and Mobility Policy-2022. The Road Transport Yearbook (RTYB) of FY 2019, observes that the CAGR of Uttar Pradesh for the no. of registered vehicles has been 11.74% when over a timeline from 2009 to 2019, implying a sharp upwards trend in the number of vehicles in the state. This rate further increased in the later years with increased access to transport and better roads. As average income rates increase, a greater part of the population is expected to own a vehicle, which will further drive the growth of vehicles in the state. The data for the number of vehicles has been sourced from the Vahan Dashboard. The number of registered vehicles in the state has increased from 27.3 million in 2017 to 39.4 million in 2021, with an Average Annual Growth Rate (AAGR) of 8.78%.

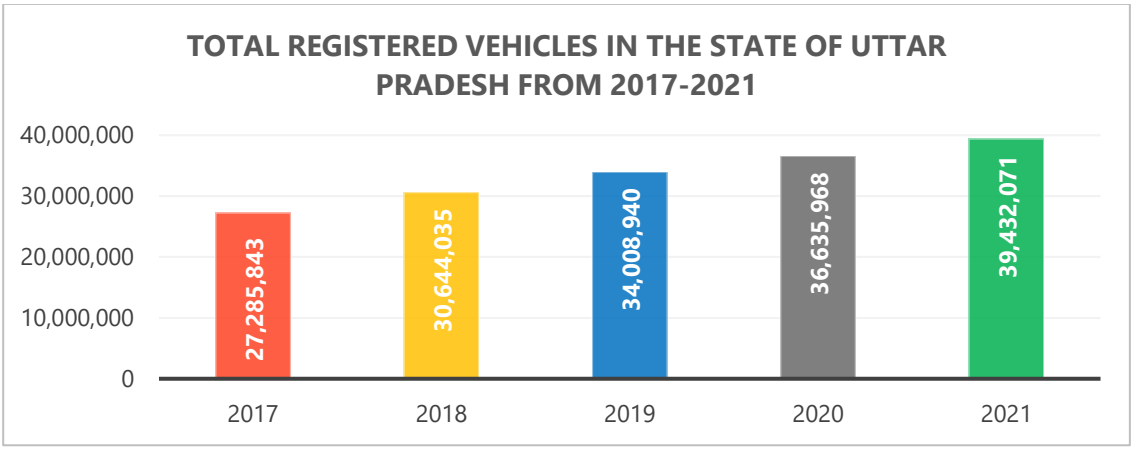


Figure 20: Total registered vehicles in the state from 2017-2021

This AAGR is further treated as CAGR to project the number of registered vehicles by the years 2025 and 2030, with base year as 2021.

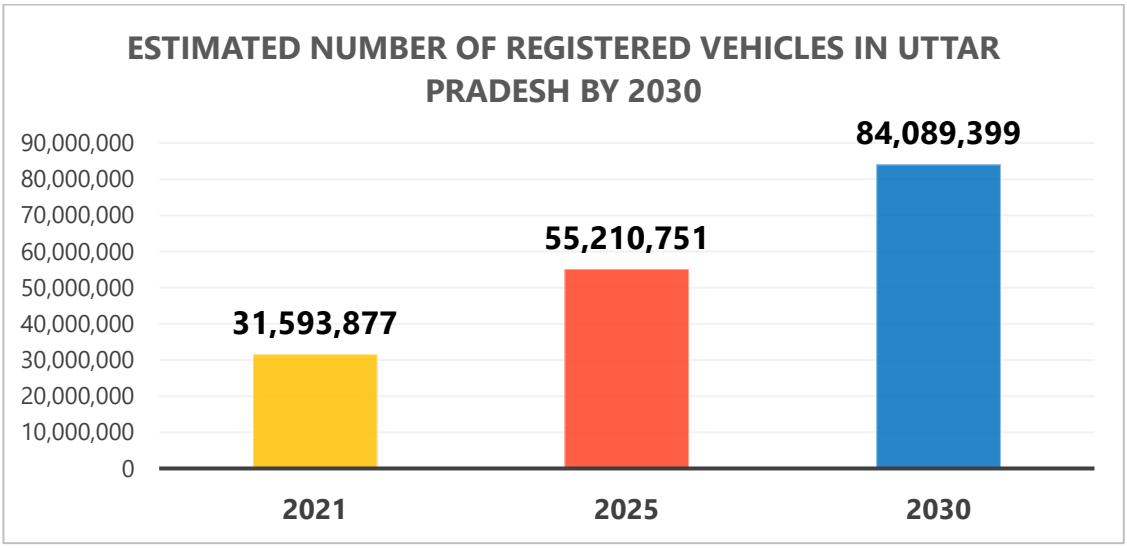


Figure 21: Projected number of registered vehicles in Uttar Pradesh by 2030

The share of vehicles by category type as of 2021 has also been obtained from the Vahan Dashboard as shown below:

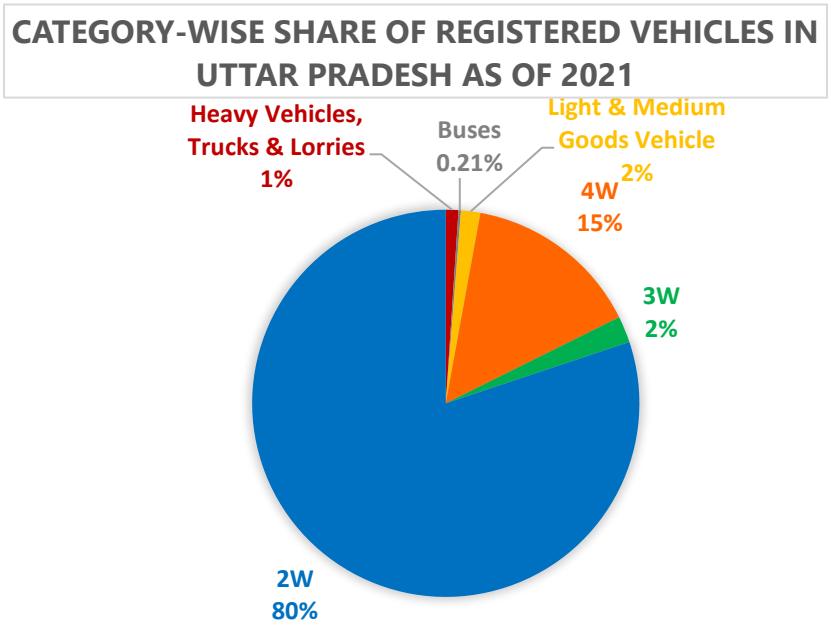


Figure 22: Category-wise share of registered vehicles (2021)

Two-wheelers (80%) make up the largest share in the vehicle category type. The next-highest is four-wheeler vehicles at 15%. Hence, targeting two-wheelers for transition to

electric vehicles can bring about significant reduction in primary energy consumption in the transport sector of Uttar Pradesh.

In line with the broader goals of decarbonizing the transport sector, India's Bharat Stage VI (BS-VI) emission standards, implemented in 2020, are designed to significantly reduce pollutants from vehicles, aligning more closely with the European Union's Euro 6 standards. Both standards limit harmful emissions such as nitrogen oxides (NOx), particulate matter (PM), and carbon monoxide (CO) from internal combustion engine (ICE) vehicles. The BS-VI standards marked a leap in India's efforts to reduce air pollution, as they imposed stricter limits compared to the previous BS-IV standards.

However, the promptness of the transport sector in upgrading emission standards has faced challenges. The slow pace of implementation has been influenced by economic factors, such as the cost sensitivity of the Indian consumer market and the automotive industry's focus on affordability. Additionally, the lack of adequate infrastructure to support cleaner technologies, such as electric vehicles (EVs) and alternative fuels, has slowed the transition. While the BS-VI transition was a major step forward, the sector is now looking at future upgrades, including potentially moving toward BS-VII or Euro 7 standards, which will impose even stricter emission limits.

For further advancement, India's transport sector requires stricter enforcement of existing standards, accelerated adoption of EVs, expanded charging infrastructure, and collaboration with international manufacturers to integrate advanced emission-reduction technologies. Addressing economic, technological, and infrastructural barriers will be essential to ensure the sector's readiness for these upgrades and achieve sustained air quality improvements. Additionally, establishing dedicated R&D facilities for monitoring compliance with emission norms and developing innovative solutions for future standards is highly recommended.

6.2. Energy Efficiency Strategies in the Transport Sector

In line with the UP EV Manufacturing and Mobility Policy 2022 , the long-term strategy for Electric Vehicle Transition has been proposed for Uttar Pradesh. The policy and the proposed strategy encompass a number of aspects of the transport sector ranging from incentives to consumers to undergo EV transition, converting state's bus fleet to electric, electric transition in logistics transport, and development of charging station across the state. Ethanol blending in petrol is proposed as another strategy to bring about emissions reduction in the transport sector. The strategy has been proposed in line with the national policy on ethanol blending.

Strategy #1 Infrastructure Development for EV charging stations and Incentives to Consumers for quick transition to EVs

Implementation Period: Short Term (Till FY 2026)

The transition to Electric Vehicles (EVs) across all segments of vehicles will be instrumental in decarbonization of the sector and in bringing significant savings in fossil-fuel based energy consumption. In this strategy, it is proposed to convert new vehicles registered in the state till FY 2031 to electric vehicles along two different scenario trajectories, namely moderate scenario and ambitious scenario. The highest EV conversion rate is proposed for 2-wheelers because of it having the highest share in registered vehicles and taking into consideration the availability and affordability of 2-Wheeler electric vehicles. The EV conversion considerations for moderate and ambitious scenarios are given in below table:

Table 11: EV transition considerations for moderate and ambitious scenarios

Moderate Scenario	Ambitious Scenario
• 50% of conventional 2-Wheelers convert to electric by 2030 • 30% of conventional 4-Wheelers convert to electric by 2030 • 50% buses in the state to transition to electric buses by 2030 • 50% of 3-Wheelers to convert to electric by 2030 • 30% of heavy vehicles (trucks and lorries) to convert to electric by 2030	• 80% of conventional 2-Wheelers convert to electric by 2030 • 50% of conventional 4-Wheelers convert to electric by 2030 • 100% buses in the state to transition to electric buses by 2030 • 100% of 3-Wheelers to convert to electric by 2030 • 50% of heavy vehicles (trucks and lorries) to convert to electric by 2030

The EV transition strategy can result in potential energy savings of 3.74 Mtoe and 6.74 Mtoe in the moderate scenario and ambitious scenario respectively.

Table 12: Energy Savings and Emission Reduction Potential

Particulars	Moderate Scenario	Ambitious Scenario
Energy Saving Potential (Mtoe)	3.74	6.07

As of March 2023, a total of 6,586 Public Charging Stations (PCS) is operational in India, out of which 406 are operational in the State of Uttar Pradesh.[19] As of August 2023, there are 5,74,967 no. of registered electric vehicles in Uttar Pradesh.[20]

Development of sufficient charging stations will be important to enable the transition to electric vehicles. Development of 2,50,000 EV charging stations by 2025 and 5,00,000 EV charging stations by 2030 across all cities of Uttar Pradesh is proposed as part of the action plan. In the short term (till FY 2026). Out of the 2,50,000 chargers, it is proposed that 2,00,000 chargers will be of Level-1 type for 2-wheelers and 50,000 chargers shall be of Level-2 and DC type for 4-Wheelers and heavy vehicles, keeping in view the high share of 2-Wheelers (80%) in the overall registered vehicles in the state and the

[19] https://pib.gov.in/PressReleasePage.aspx?PRID=1910392
[20] https://pib.gov.in/PressReleasePage.aspx?PRID=1947389

conversion of 75% 2-Wheelers to electric under the ambitious scenario. The installed EV charging stations are proposed to have a part of their charging load to be catered by renewable energy systems which would lead to savings in the upstream costs of the charging infrastructure.

To provide EV Charging infrastructure and services in UP, UPPCL has constituted a new company, UPREV, with 100% ownership. A roadmap is currently being prepared by aggregating data for this transition. At present, work related to Infrastructure Development for EV charging stations in the state is being carried out by UP Invest.

It is further proposed and anticipated that 10 cities, namely Noida, Ghaziabad, Meerut, Mathura, Agra, Kanpur, Lucknow, Allahabad, Gorakhpur and Varanasi shall be priority cities for the installation of EV charging stations. To ensure a shorter period of return of investment (ROI), it is proposed that the EV chargers be installed in places with higher density of vehicles and commuting population such as public recreation places, malls and shopping complexes, public offices, Multi-Level Car Parking (MLCP), parking areas of bus stands, railway stations, metro stations and airports. As of now, there are more than 25 active public charging station in the state of Uttar Pradesh.[21]

Based on data provided by the Municipal Corporation of Lucknow, the transition from diesel vehicles to electric vehicles is actively underway. To date, the corporation has successfully integrated 650 electric vehicles into its fleet. This shift to electric vehicles marks a significant milestone in the corporation's efforts to promote sustainable and environmentally friendly transportation. The adoption of electric vehicles is expected to reduce carbon emissions, improve air quality, and contribute to the overall reduction of the city's carbon footprint. This initiative reflects the corporation's commitment to embracing green technology and enhancing the quality of life for its residents.

[21]Source: https://powermin.gov.in/sites/default/files/uploads/Details_of_Public_Charging_Stations_Installed.pdf

The Lucknow Development Authority is also planning to expand its electric vehicle (EV) infrastructure. They are planning for three charging station as a pilot project. This will operate under the Public-Private Partnership (PPP) model. This expansion aims to significantly increase the availability of EV charging facilities, thereby encouraging the adoption of electric vehicles and supporting the city's transition to greener transportation solutions. By leveraging the PPP model, the authority seeks to combine public oversight with private sector efficiency and investment, ensuring the sustainability and scalability of the EV infrastructure.

Actionable Items:

A. Technical Category:

1. **Establishment of regulatory mechanism to develop EV charging Infrastructure**-

   There are several regulatory mechanisms that can be put in place to develop EV charging infrastructure in Uttar Pradesh. Some possible approaches are mentioned below:

   - Incentives for private companies to install charging infrastructure: The government can provide incentives such as tax breaks or subsidies to private companies that install EV charging infrastructure in State.
   - Public-private partnerships: The government can enter partnerships with private companies to develop and operate EV charging infrastructure. This can include agreements on revenue sharing, investment, and maintenance.
   - Zoning regulations: The government can zone certain areas of the city for EV charging infrastructure, such as near highways or in commercial areas, to ensure that the infrastructure is developed where it is most needed.

- Time-of-use pricing: The government can introduce time-of-use pricing for EV charging to encourage drivers to charge their vehicles during off-peak hours when electricity is cheaper.

By implementing some or all these regulatory mechanisms, the Uttar Pradesh government can encourage the development of a robust EV charging infrastructure that will help to support the transition to electric vehicles in the state.

2. Pilot projects on Battery Swapping stations -

Establishment of a wide network of swappable battery station is a key of success for EV infrastructure in the state. Pilot projects on battery swapping stations can provide valuable information and insights into the feasibility and effectiveness of this technology.

Battery swapping pilots can be tried in key Government offices and through private, especially IT buildings, with large car ownership. As UP has many highways, battery swapping stations could be setup along a major highway to demonstrate how this technology can enable long-distance electric vehicle travel. This pilot project can provide valuable data on how battery swapping affects driving patterns and charging behaviour.

These pilot projects can provide valuable information on the practicality, cost, and user acceptance of battery swapping stations, which can inform the development and implementation of future policy initiatives.

3. Pilot projects on Hydrogen Fuel Cell Vehicles (HCVs)

Pilot projects on hydrogen fuel cell vehicles (HCVs) can be an effective way to explore the potential of this technology and to identify any barriers or challenges to its widespread adoption. The results of the pilot project should be shared with stakeholders, including the public, to raise awareness of the potential of HCVs.

B. Cost benefit Analysis

The cost saving comparison between electric and conventional vehicles has been listed below. The calculation is based for the vehicles to cover 100 kms on daily basis.

2-Wheeler		
Parameters	Electric Vehicle	Conventional Vehicle
Journey Fuel Cost	₹22.55	₹166.13
Cost per Km	₹0.23	₹1.66
Annual Fuel Costs	₹8,229.79	₹60,638.67

4-Wheeler		
Parameters	Electric Vehicle	Conventional Vehicle
Journey Fuel Cost	₹115.36	₹623.00
Cost per Km	₹1.15	₹6.23
Annual Fuel Costs	₹42,106.40	₹2,27,395.00

Parameters	Values
Cost of Fast EV Charging Station	₹12,50,000
Approximate Charging Duration	01 hr
Approximate Vehicle Charged/ per day	16
Approximate Revenue of Fast charging per vehicle	₹500
Electricity Cost per Vehicle	₹ 320
Approximate Revenue Fast charging per year	₹10,51,200
Payback period	1.2 Years

Strategy #2 Ethanol and Biodiesel Blending Program

Implementation Period: Long Term (Till FY 2031)

The proposed Ethanol and Biodiesel Blending Program aims to reduce emissions and offset energy consumption in petrol and diesel by ensuring a fixed ratio of ethanol and biodiesel is mixed into petrol and diesel, respectively. As part of the proposed strategy to achieve the country's goal of 20% ethanol blending in petrol by 2030, a moderate scenario suggests a 10% blending target, while an ambitious scenario suggests a 20% blending target.

The State of Uttar Pradesh has a total of 69 Ethanol Producing Units with an average production capacity of approximately 100 KLD and total production capacity of approximately 6,000 KLD.[22]

Additionally, to achieve the country's goal of 5% biodiesel blending in diesel by 2030, a moderate scenario suggests a 5% biodiesel blending in 50% of total diesel consumption, while an ambitious scenario suggest 5% biodiesel blending in 75% of total diesel consumption by 2030.

A state level biodiesel blending policy shall be introduced ensuring the robust infrastructure for bio-diesel production and supply. Biodiesel production may include the collection of used cooking oil for conversion to biodiesel, and the use of Jatropha and other oil-producing crops. State level policy shall be focused on the points mentioned below:

1. Mandate blending of 5% biodiesel with diesel in all government-owned vehicles and machinery.
2. Encourage private vehicle owners to use biodiesel by providing tax incentives and subsidies.
3. Set up collection centers for used cooking oil and provide incentives to households and restaurants to dispose of their used cooking oil at these centers.
4. Promote the cultivation of jatropha and other oil-producing crops on marginal lands and provide subsidies for farmers to grow these crops.
5. Establish quality standards for biodiesel production and blending and enforce compliance through regular monitoring and testing.
6. Provide financial assistance to biodiesel producers to encourage investment in production technology and infrastructure.
7. Create awareness campaigns to educate the public about the benefits of biodiesel and promote its use as a cleaner and more sustainable fuel option.

[22] https://rb.gy/ndntv

8. Monitor and evaluate the effectiveness of the policy regularly and make necessary adjustments to ensure its success.

The ethanol and biodiesel blending can lead to potential fossil fuel energy savings of 1.72 Mtoe and 3.26 Mtoe in the moderate and ambitious scenarios respectively.

Table 13 Moderate and ambitious scenarios for Ethanol & Biodiesel blending

PARTICULARS	MODERATE SCENARIO	AMBITIOUS SCENARIO
Energy Saving Potential (Mtoe)	1.72	3.26

Implementing Agency: State Transport Department

Actionable Items:

A. Financial Category:

1. Financial Assistance on Biofuel production plants (Capital Subsidy for MSMEs)–

To ensure a steady supply of ethanol for blending with petrol, it is recommended to offer financial assistance for the installation of biofuel production plants. Micro, small, and medium-sized enterprises (MSMEs) interested in setting up these plants could receive capital subsidies. The aim is to establish a strong supply chain for feedstock to meet production targets and create a supportive environment for ethanol blending in fuel. By promoting the growth of biofuel industries, new technologies can be introduced, and the market can be strengthened.

Strategy #3 Promotion of Standard and Labelling program of Tyres for Fuel Efficiency in Vehicles

The Bureau of Energy Efficiency (BEE) in India has implemented a standard and labeling program for tyres to promote fuel efficiency in vehicles The promotion of a standard and labeling program for tyres about fuel efficiency in vehicles can be an effective way to encourage the adoption of more fuel-efficient tyres by consumers.

Actionable Items:

A. Awareness Category:

1. **Awareness campaigns:** The first step is to create awareness among consumers about the importance of fuel-efficient tyres and the benefits of using them. This can be done through advertising campaigns, social media, and other public outreach efforts. The government can provide education to consumers on how to maintain their tyres for optimal fuel efficiency. This can include tips on proper inflation, regular rotation, and alignment.

2. **Capacity Building of Tyre Manufacturer and Vehicle OEMs-** Capacity building workshops shall be organized in the Uttar Pradesh to enhance the knowledge of Tyre Manufacturers and Vehicle OEMs about Star Rating of Tyre and its benefits and compliance methodology to encourage them to produce or use star rated tyres.

By promoting a standard and labeling program for tyres about fuel efficiency, consumers can make informed decisions about which tyres to purchase, and manufacturers can be encouraged to develop more fuel-efficient tyre technology. This can result in significant reductions in fuel consumption and greenhouse gas emissions, contributing to a more sustainable future.

6.3. Energy Saving Targets & Monitoring Mechanism

On the basis of the two strategies proposed for the transport sector, the total energy saving estimated is 5.47 Mtoe in the moderate scenario and 9.33 Mtoe in ambitious scenarios. The potential savings under moderate and ambitious scenarios is the overall estimated savings from individual strategies under the respective scenarios, and can be considered as the energy saving targets for FY 2031 for the Transport Sector.

Action Plan	Energy Savings in 2031 under moderate scenario (Mtoe)	Energy Savings in 2031 under ambitious scenario (Mtoe)
Energy Savings from EV Transition	3.74	6.07
Energy Savings from Ethanol and Biodiesel Blending in Petrol & Diesel respectively	1.72	3.26
Total Savings	**5.47**	**9.33**

Monitoring Mechanism:

The monitoring framework for achieving the target of the transport sector can be easily set up by defining annual reduction targets of the sector. Monitoring of points mention below through the dashboard will support in monitoring of energy efficiency initiatives in the State.

- Development of dashboard to monitor the sale of electric vehicles sold in a year categorized under 2-wheelers, 3-wheelers, 4-wheelers, buses, and heavy vehicles.
- The dashboard can also include city-wise mapping of EV charging infrastructure across the state.
- The dashboard may be scalable to include alternative fuel vehicles such as Hydrogen Fuel Cell Vehicles.

Mechanism for data collection and reporting from various clusters and various energy efficiency initiatives may be done through Setting up a Sector Specific Energy Efficiency Cell (SSEEC) and Cluster Level Energy Efficiency Cell (CLEEC).

Setting up a Sector Specific Energy Efficiency Cell (SSEEC)

- The working of this cell will be different from the operations of SDA, the SSEEC will be responsible to collect data from all the cluster energy efficiency cells in the Uttar Pradesh and share the same with the SDA for tracking the achievement of the targeted goal.

Cluster Level Energy Efficiency Cell (CLEEC)

- The CLEEC will be responsible for gathering information and will report the same to the SSEEC at the end of each quarter.

To enhance monitoring and ensure transparency in the transport sector, the specific performance metrics should include the number of 2-wheelers, 4-wheelers, and 3-wheelers Electric Vehicles, the number of State Electric Buses, the number of heavy electric vehicles (trucks and lorries), the percentage of ethanol blending, and the number of Awareness Programs focused on the Standard and Labelling program. As the relevant departments finalize the monitoring plan, additional metrics may be identified. These metrics will be essential in tracking progress toward reducing emissions and promoting sustainable transport solutions. Regular analysis will help detect any deviations from the targets early, enabling timely corrective actions and adjustments. The review frequency for each metric will be determined based on the monitoring plan developed by the relevant departments.

The table below outlines the identified performance metrics for the transport sector strategies, along with their review frequency.

S No	Sector	Specific Performance Metrics	Review Frequency
1.	Transport	Nos. of 2-wheelers Electric Vehicles	Quarterly
2.		Nos. of 4-wheelers Electric Vehicles	
3.		Nos. of State Electric Buses	
4.		Nos. of 3-wheelers Electric Vehicles	
5.		Nos. of heavy (trucks and lorries) Electric Vehicles	
6.		% Ethanol blending	Yearly
7.		Nos. of Awareness program on Standard and Labelling program	Quarterly

AGRICULTURE SECTOR

7. Focus Sector 4 – Agriculture

7.1. Current Scenario

Uttar Pradesh has a total geographical area of 24,093 sq.km out of which 16,417 sq.km is under cultivation (about 68%) compared with the national average of 40%. Uttar Pradesh agriculture is highly diversified. It produces numerous crops due to the comparative advantage of wide range of agro-climatic variability. Around 76% of the total population live in rural areas.

Uttar Pradesh is a well irrigated state with the majority of the cropped area under irrigation. The main sources of electricity consumption in this sector are agricultural machinery/equipment and pump sets in the state.

Different forms of energy are used for different purposes. Farmers mainly use energy from fossil resources – either directly or indirectly. Direct energy consumption includes the use of diesel, electricity, natural gas, and renewable fuels for activities on the farm. Indirect energy consumption includes the use of fuel and feedstock (especially natural gas) in the manufacturing of agricultural chemicals such as fertilizers and pesticides.

7.2. Energy Efficiency Strategies in the Agriculture Sector

This section discusses the strategies identified in the agriculture sector that can bring about substantial reduction in energy consumption and aid in emission mitigation. The strategies proposed would help in eliminating primary energy consumption, diesel in this case, and bring about significant secondary energy savings.

Strategy #1 Replacement of old pumps (10 years old) or less efficient pumps (non-star rated) with 5 Star rated Pumps along with smart control panel

Implementation period: Long-term (Till FY2031)

Initiatives have been taken at both the Central and State levels for switching from diesel pumps to electric pumps. In addition to these initiatives, conversion of diesel pumps to renewable/solar energy powered pumps is one strategy that can be assessed.

The first scenario is the moderate scenario, which aims to replace 50% of the inefficient electric powered pumps with BEE 5 Star rated pumps by FY2031. However, Uttar Pradesh has already replaced 8125 pumps with 5 star rated agricultural pumps with the smart meter on a pilot basis and results show about 30% electricity saving potential. This scenario aims to achieve significant energy savings and improve the efficiency of pumps used in irrigation.

BEE Star rated pumps are designed to consume less energy and operate efficiently, resulting in cost savings for farmers in terms of lower electricity bills and reduced maintenance costs. A provision should be established to use BEE Star rated pumps for borewells.

The second scenario is the ambitious scenario, which aims to replace 70% of the inefficient electric-powered pumps with BEE Star rated pumps by FY2031. This scenario is the ideal goal and aims to achieve maximum energy savings in the agriculture sector by replacing the majority of inefficient pumps with energy-efficient ones.

A provision may be established to replace 10-year-old diesel pump sets with 5 Star-rated electric pump/submersible pump with 70 percent government subsidy at the cost price of the electric submersible pump sets up to 10 HP.

Overall, this strategy will lead to a total saving of 0.03 Mtoe in moderate scenario and 0.05 Mtoe in ambitious scenario.

Particulars	Moderate Scenario	Ambitious Scenario
Energy Saving Potential (Mtoe)	0.03	0.05

Cost Benefit Analysis

For the better understanding of the strategy, we have considered a case in which we have calculated the savings from the transition of one diesel pump of 3HP, 5HP, 7.5HP and 10HP with total diesel consumption of 73 Liters per year, which resulted in a total energy savings of 19,045.92 kWh in a year.

Total Diesel Pumps	3 HP	5 HP	7.5 HP	10 HP
4	1	1	1	1
Operational Pumps	1	1	1	1
Diesel Consumption (Liters/Year/HP)	73.00	73	73	73
Diesel Consumption (Liters/Year)	219	365	548	730
Total Diesel Consumption (L)				1,862
Density (kg/L)				0.85
Total Diesel Consumption (Kg)				1,582.28
Total Diesel Consumption (Tonnes)				1.58
GCV (TOE/Ton)				1.035
Total Energy Offset (TOE)				1.64
Total Energy Offset/Savings (Mtoe)				0.0000016
Total Energy Offset/Savings (kWh)				19,045.92

Strategy #2: Transition of Electric Pumps to Solar Powered Pumps

A large portion of the pumps used in the agriculture sector are electric powered. As per the Statistical Abstract report, there are 13,00,000 electric pumps installed in the State of Uttar Pradesh. For energy savings in the agriculture sector, it is recommended to use BEE star labelled pumps or IE3, and IE4 pumps. These pumps consume less electricity as compared to conventional pumps and hence result in energy savings and equivalent emission reduction.

Transition of Electric Pumps to Solar Powered Pumps is proposed as a strategy for energy savings. In this regard, it is proposed to replace 75% electric pumps to solar powered pumps in the moderate scenario and replace 100% electric pumps with solar pumps in the ambitious scenario. Additionally, as part of component-B of the PM Kusum Yojana, there is a provision for the installation of solar pump sets, with 60 percent of the funding coming from the government and 40 percent from the farmers. To reduce the

farmer's contribution, the government may increase its share to 90 percent, leaving the farmer with only a 10 percent share. This will enable the maximum number of farmers to irrigate their agriculture land using solar energy. The successful implementation of the above-mentioned strategies would lead to energy savings of 0.85 Mtoe in the moderate scenario and 1.14 Mtoe in the ambitious scenario by FY2031.

Table 14: Moderate & ambitious scenarios for transition of diesel & electric to solar pumps

Particulars	Moderate Scenario	Ambitious Scenario
Energy Saving Potential (Mtoe)	0.85	1.14

Implementing Agency: State Agriculture & Irrigation Department, UPNEDA

Strategy #3: Issuance of notification or government directive that all the new pumps installed in the state should be either energy efficient 5 star rated pumps or solar pumps

To achieve the goal of solarization of the irrigation system, priority for the new pumps should be given to the solar powered pumps. This is because solar pumps are an eco-friendly option and they can help in reducing the dependency on grid electricity for pumping water, which can save on energy bills of farmers and subsequently reduce the total energy demand of the agriculture sector. However, in case of high-water demand and potential challenges with solar powered pumps, priority shall be given to high energy efficient pumps.

The Uttar Pradesh government shall issue directives or notification for the installation of Solar Pumps or BEE 5-star rated pumps for all new pumps required for irrigation purposes.

To encourage farmers to adopt these energy-efficient or solar pumps, the government can offer incentives such as subsidies, financial assistance, and rebate on energy bills on the installation of these pumps. A provision may be established to offer a 70 percent government subsidy for the installation of 5-star rated electric pumps or submersible pumps (applicable to pump sets with up to 10 HP) and a 90 percent government subsidy

for solar pumps (for pump sets up to 7.5 HP), with farmers contributing only 10 percent of the cost, based on the cost price of solar pump sets.

Additionally, the government can offer technical support and guidance to farmers to ensure that they can effectively use and maintain these pumps. This can help in increasing the adoption rate of these pumps and achieving the desired energy savings.

Cost Benefit Analysis:

Replacing inefficient (non-star rated) pumps with BEE 5 Star Rated Pumps, combined with a smart control panel, offers significant benefits. These pumps are highly energy-efficient, resulting in reduced electricity consumption and cost savings. The integration of a smart control panel allows for automated control, real-time monitoring, and intelligent features, optimizing the pumping System's performance.

This transition promotes environmental sustainability by reducing energy wastage and carbon emissions. Additionally, using BEE 5 Star Rated Pumps demonstrates compliance with energy efficiency standards. Overall, this upgrade improves efficiency, reduces operational costs, and supports sustainable practices in pumping systems.

Total Electrical Pumps to be transit	3 HP	5 HP	7.5 HP	10 HP
4	1	1	1	1
Inefficient Operational Pumps	1	1	1	1
Capacity (kW)	2.25	3.75	5.625	7.5
Running Hours/Day	6	6	6	6
Running Days	150	150	150	150
Electricity Consumption (kWh)	2,025	3,375	5,063	6,750
Replacement with BEE 5 Star Rated Pumps				18%
Total Energy Offset/Savings (kWh)				3098.25

Strategy #4: Sustainable agriculture through Micro Irrigation

Micro-irrigation systems have emerged as game-changers in modern agriculture and landscape management due to their remarkable energy-saving capabilities. Unlike conventional irrigation techniques that involve flooding fields or using high-pressure overhead sprinklers, micro-irrigation delivers water in a targeted and low-pressure

manner, directly to the plant roots. This precise application of water translates into several key energy-saving benefits:

1. **Reduced Water Pumping**: Micro-irrigation systems operate at lower pressures, minimizing the energy required to pump water from the source (e.g., wells, reservoirs, or pumps). With reduced pumping demands, farmers and landscape managers can significantly lower their energy consumption, leading to cost savings and environmental
2. **Lower Distribution Losses:** Traditional irrigation methods often suffer from significant water distribution losses due to evaporation, wind drift, and runoff. In contrast, micro-irrigation systems deliver water efficiently, mitigating losses and ensuring a higher percentage of water reaches the intended plants. As a result, less water needs to be pumped and treated, further contributing to energy conservation.
3. **Decreased Operational Costs:** The energy efficiency of micro-irrigation systems reduces the operational costs associated with irrigation. By using less power for water delivery, farmers can allocate their resources more effectively and invest in other agricultural practices, ultimately boosting productivity and sustainability.
4. **Enhanced Crop Watering Precision**: The precise application of water in micro-irrigation systems optimizes the hydration of crops or plants, ensuring they receive the appropriate amount of water needed for healthy growth. This targeted approach prevents both overwatering and underwatering, which not only saves energy but also enhances crop yield and quality.

In conclusion, micro-irrigation systems offer significant energy savings by reducing water pumping requirements, minimizing distribution losses, and enhancing overall irrigation precision. Embracing these water-efficient techniques presents a compelling opportunity for agricultural and landscaping sectors to conserve resources, reduce energy consumption, and promote sustainable practices for a greener future.

Strategy #5: Solarization of Agriculture Feeders

The solarization of agriculture feeders is a strategy to install solar power plants at the distribution substation level to supply power to agricultural consumers. It is a promising initiative that can help to reduce the energy demand of the agriculture sector in Uttar Pradesh.

To implement this strategy, the government should identify suitable feeders for solarization. This can be done based on factors such as the number of agricultural consumers, the load on the feeder, and the availability of land for solar power plants. The government may also provide incentives to farmers to install solar panels on their own land.

The Distribution Company (DISCOM)/Power Department in each region will serve as the primary implementing agency for feeder-level solarization. However, where necessary, expert agencies may be appointed by the state government to assist DISCOMs with tendering and installation activities.

In parallel, the DISCOM is undertaking the separation of agricultural feeders from rural feeders under the ADB and RDSS schemes. The work of separating agricultural feeders at substations is in progress. Currently, solar plants with a total capacity of 34.8 MW are being developed for the solarization of agricultural feeders originating from 22 substations. Power Purchase Agreements (PPAs) for purchasing energy from these solar plants have been signed by UPPCL (Uttar Pradesh Power Corporation Limited).

MVVNL has also planned to solarize pumps that carry more than 30% agricultural load. Out of a total of 234 feeders, 166 have been chosen for segregation. This segregation process is guided by the daytime load requirements for agricultural purposes, as outlined in the PM Kusum scheme. This initiative aims to enhance the efficiency and sustainability of agricultural power usage by transitioning to solar energy, thereby reducing dependency on conventional power sources and promoting renewable energy adoption in the agricultural sector.

Strategy #6: Capacity Building Program for Pump Technicians

This strategy has been proposed by the Agriculture Department, it includes a Capacity Building Program specifically for pump technicians, with an emphasis on solar pumps. This initiative is designed to enhance the technical skills and knowledge of technicians, ensuring they are well-equipped for the efficient installation, maintenance, and troubleshooting of solar pump systems. By providing specialized training, the program aims to support the sustainable implementation of solar energy solutions, thereby contributing to energy conservation and boosting agricultural productivity. This program underscores the commitment to fostering a skilled workforce capable of driving the adoption of renewable energy technologies in the agricultural sector.

Key Components of the Program:

1. **Technical Training**:
    - Installation Procedures: Step-by-step guidance on installing solar pumps, ensuring technicians can set up systems efficiently and correctly.
    - Maintenance Practices: In-depth training on routine maintenance tasks to ensure the longevity and optimal performance of solar pump systems.
    - Troubleshooting Techniques: Hands-on experience in diagnosing and fixing common issues that may arise in solar pump operations.
2. **Theoretical Knowledge**:
    - Understanding Solar Technology: Comprehensive education on the principles of solar energy and how it can be harnessed for agricultural use.
    - System Components: Detailed study of the components that make up solar pump systems, including solar panels, inverters, and pumps.
    - Energy Efficiency: Training on how to maximize energy efficiency in the use of solar pumps, contributing to overall sustainability.
3. **Practical Workshops**:

- Real-world Scenarios: Simulated environments where technicians can practice installation and maintenance in conditions similar to those they will encounter in the field.
- Field Visits: Opportunities to visit existing solar pump installations to observe and learn from operational systems.

4. **Certification and Accreditation**:
   - Certification: Upon completion of the program, technicians will receive certification, validating their skills and knowledge in solar pump technology.
   - Continuous Education: The program will include provisions for ongoing education and recertification to keep technicians up-to-date with the latest advancements in solar technology.
5. **Support and Resources**:
   - Access to Tools and Equipment: Technicians will be provided with access to the necessary tools and equipment required for effective training.
   - Resource Materials: Comprehensive manuals and guides that technicians can refer to during and after the program.
   - **Government Support:** The Capacity Building Program for pump technicians should be developed as part of a skill development program under the National Skill Development Mission. The Government of India should make provisions for funding this program under the Skill Development Mission to ensure sustainability and wide-reaching implementation.

Goals and Benefits:

- Enhanced Skill Set: Equip technicians with the expertise needed to support the growing demand for solar pumps.
- Job Creation: Provide new job opportunities in the renewable energy sector, contributing to economic growth.

- Sustainable Agriculture: Promote the use of sustainable energy sources in agriculture, reducing reliance on fossil fuels and lowering carbon emissions.
- Improved Productivity: Ensure that solar pump systems are installed and maintained correctly, leading to improved water management and agricultural productivity.

Strategy #7: Promotion of smart agriculture practices and energy efficient farm machineries

This strategy aims to enhance agricultural productivity and sustainability in Uttar Pradesh by promoting the adoption of smart agriculture practices and integrating energy-efficient farm machinery. The initiative focuses on reducing energy consumption, improving resource management, and addressing environmental challenges through the application of advanced technologies and modern farm equipment. By fostering the use of smart farming techniques and energy-efficient machinery, the strategy seeks to optimize agricultural outputs, reduce operational costs, and promote sustainable agricultural practices across the state.

Key Components of the Strategy:

1. **Smart Agriculture Practices:**
    - **Precision Farming Techniques:** Utilize IoT devices, GPS, and sensors to monitor soil, water, and crop conditions, enabling targeted and efficient use of resources like water, fertilizers, and pesticides. This method minimizes waste, conserves resources, and boosts crop productivity.

2. **Energy-Efficient Farm Machineries:**
    - **Electric-Powered Equipment:** Promote the use of electric-powered farm machinery, including tractors, and sprayers. These machines are eco-friendly, cost-effective, and require less maintenance compared to traditional fuel-powered equipment, while also reducing carbon emissions.

- **Fuel-Efficient Machines:** Encourage the adoption of advanced fuel-efficient harvesters and threshers that minimize fuel consumption and emissions. These machines enhance productivity by performing multiple tasks in one pass, reducing operational costs.
- **Renewable Energy Integration:** Promote the integration of renewable energy sources like solar power in farming operations, including solar-powered irrigation systems and charging stations for electric machinery, helping reduce dependence on fossil fuels and lowering energy costs.

Action Items:

a) Awareness Campaigns:

- Organize training programs, field demonstrations, and exhibitions to showcase the benefits of smart agriculture practices and energy-efficient machinery.
- Develop digital platforms, such as mobile apps and online portals, to educate farmers on smart farming technologies and equipment usage.

b) Financial Support and Incentives:

- Provide subsidies, tax incentives, and low-interest loans for farmers to encourage the purchase of energy-efficient machinery and the adoption of smart farming technologies.

c) Partnerships and Collaborations:

- Collaborate with technology providers, agricultural universities, and research institutions to develop cost-effective and region-specific smart farming solutions.

d) Policy Support:

- Formulate state-level policies to encourage the adoption of energy-efficient and smart agriculture practices, supported by both government funding and private sector investment.

Goals and Benefits:

- **Resource Efficiency**: Optimize the use of water, energy, and agricultural inputs, leading to reduced costs and enhanced farm productivity.
- **Environmental Sustainability**: Lower energy consumption, reduce emissions, and minimize the environmental impact of farming practices.
- **Cost Savings and Profitability:** Help farmers reduce operational costs using energy-efficient machinery and smart farming practices, leading to increased profitability.
- **Improved Farm Resilience**: Enable farmers to better adapt to climate change and market fluctuations through data-driven decisions and sustainable farming techniques.

7.3. Energy Saving Targets & Monitoring Mechanism

On the basis of the above strategy proposed for the agriculture sector, the total energy saving estimated is 0.89 Mtoe in the moderate scenario and 1.18 Mtoe in ambitious scenarios can be considered as the energy saving targets for FY 2031 for the Agriculture Sector.

Table 15 Energy Savings from Agriculture Sector

Final Energy Savings for FY 2031 (Mtoe)		
Strategy	**Moderate Scenario**	**Ambitious Scenario**
Transition of conventional diesel pumps to Solar powered pumps by FY 2024	0.85	1.14
Replacement of inefficient (non-star rated) pumps with BEE 5 Star Rated Pumps along with smart control panel	0.03	0.05
Total Savings (Mtoe)	**0.89**	**1.18**

Monitoring Mechanism:

The monitoring framework for achieving the target of the agriculture sector can be easily set up by defining annual reduction targets of the sector.

Setting up a Sector Specific Energy Efficiency Cell (SSEEC)

- The working of this cell will be different from the operations of SDA, the SSEEC will be responsible to collect data from all the cluster energy efficiency cells in the state and share the same with the SDA for tracking the achievement of the targeted goal.

Cluster Level Energy Efficiency Cell (CLEEC)

- The CLEEC will be responsible for gathering information about the old & inefficient pumps and replacement of inefficient pumps with BEE 5 Star Rated Pumps along with smart control panels. The CLEEC will report the data to the SSEEC at the end of each quarter, including the number of pumps replaced, energy consumption data, and any other relevant information.

Regular Review and Monitoring

- The SSEEC will review the progress of the program on a regular basis, ensuring that the targeted goals are being met. The SSEEC will also provide regular feedback to the CLEECs and the SDA to ensure that the program is running smoothly and that any issues are addressed in a timely manner.

To enhance monitoring and ensure transparency in the agriculture sector, the specific performance metrics should include the number of pumps replaced with BEE 5 Star rated pumps, the number of pumps solarized, the number of demonstration projects under sustainable agriculture through micro irrigation, the number of agriculture feeders solarized, the number of capacity-building programs for pump technicians, and the number of awareness programs conducted on smart agriculture practices and energy-efficient farm machinery. As the relevant departments finalize the monitoring plan, additional metrics may be identified. These metrics will be crucial in tracking the sector's progress toward achieving sustainability and energy efficiency goals. Regular monitoring and analysis will help detect any deviations from the targets early, enabling timely corrective actions and necessary adjustments. The review frequency for each

metric will be determined based on the monitoring plan developed by the relevant departments.

The table below outlines the identified performance metrics for the agriculture sector strategies, along with their respective review frequency.

S No	Sector	Specific Performance Metric	Review Frequency
1.	Agriculture	No of pumps replaced to BEE 5 Star	Half-Yearly
2.		No of pumps solarized	
3.		Nos. of demonstration projects under Sustainable agriculture through micro irrigation	
4.		Nos. of agriculture feeders solarized	
5.		Nos. of the capacity building program for pump technicians	
6.		Nos. of the awareness program conducted on smart agriculture practices and energy efficient farm machineries	

8. Market Potential in Focus Sectors

The energy saved as a result of the proposed strategies in all sectors will lead to avoided generation of equivalent amount. In order to implement the suggested strategies, there will be need for investments in energy efficiency projects, development of new policies, and modification of existing policies. In order to estimate the investment potential generated from the suggested strategies in the focus sectors, the equivalent cost of the saved energy in terms of metric tonnes of oil equivalent has been calculated. The Ministry of Power, Government of India, in consultation with the Bureau of Energy Efficiency (BEE) has notified the price of per metric tonne of oil equivalent as INR 18,402 only for the year 2018-19. The same amount has been applied to energy savings under ambitious scenario for the estimation of maximum investment potential. Total energy saving potential by implementing various strategies in Uttar Pradesh is shown in the graph below:

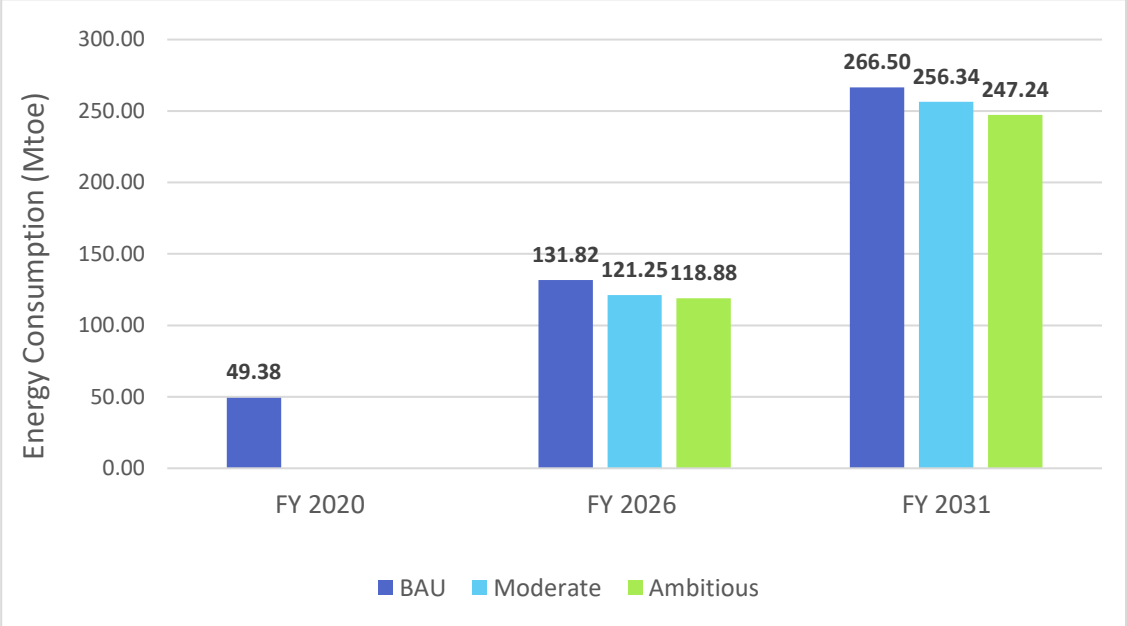


Figure 23 Total Energy Saving Potential

It is estimated that with the implementation of various proposed strategies of Building, Transport, Agriculture and Industry Sectors, energy saving of 10.16 Mtoe in moderate scenario and 19.26 Mtoe in ambitious scenario can be achieved.

Table 16 Energy Saving Summary

Sectors	Energy Saving Potential (Mtoe)		Energy Saving Potential (GWh or MU)		Emission Saving Potential ($MtCO_2$)		Market Potential (INR Crore)
	Moderate	Ambitious	Moderate	Ambitious	Moderate	Ambitious	
Industry	3.36	8.16	39,020.9	94,872.8	10.50	25.53	15,012
Buildings	0.45	0.59	5,276.5	6,911.1	1.42	1.86	1,094
Transport	5.47	9.33	63,588.0	1,08,473.5	17.11	29.19	17,164
Agriculture	0.89	1.18	10,300.8	13,759.6	2.77	3.70	2,177
Total	10.16	19.26	1,18,186.3	2,24,017.1	31.81	60.29	35,446

9. The Way Forward

The state energy efficiency action plan, through the research and interaction with various stakeholders, identifies the need, opportunity, and the potential of energy efficiency in the State of Uttar Pradesh. While addressing the key focus sectors – Industry, Buildings, Transport and Agriculture, the action plan envisages to analyze consumption pattern, growth rates in alignment with GDP growth rate of the state and potential strategies for achieving savings.

The action plan lays out a plan for the state to implement the strategies, while at the same time being able to monitor implementation. It is imperative that implementation is carried out in the state through various stakeholders.

To ensure effective execution, it is recommended to establish an independent State Designated Agency (SDA) for energy policy implementation at the state level. This agency will be responsible for coordinating, overseeing, and facilitating energy efficiency projects, ensuring that the policies are executed efficiently and in alignment with both state and central government guidelines. Their role will be crucial in monitoring progress, providing technical support, and ensuring that energy efficiency goals are met.

A market-based mechanism is anticipated to be developed through the implementation of the action plan which drives energy efficiency through better availability of energy efficiency products, financial instruments for improving the product reach and a wider adoption of energy efficiency schemes and policies curated by both state and central governments.

A collaborative approach, on the part of the government, industry and academia is the ideal way forward to implement the vision and targets of this action plan and continue to put the country on a high pedestal of energy efficiency achievements at the global platform.

To ensure effective implementation of the proposed strategies, the State Energy Efficiency Action Plan provides a structured and detailed roadmap, encompassing clearly defined action items, implementation timelines, and the allocation of responsibilities to relevant departments. This approach ensures transparency, accountability, and the alignment of efforts across sectors. The following table highlights the sector-wise action plan, outlining the corresponding timelines and responsible departments for each initiative:

Focus Sector	Action Item	Implementation Timeline	Responsible Department
Industry	Deepening and Widening of PAT Scheme	Long Term (Till FY 2031)	BEE/ UPNEDA
	Promoting Energy Efficiency Interventions in Brick Clusters	Long Term (Till FY 2031)	Infrastructure and Industrial Development Department, Uttar Pradesh; UPNEDA
	Promoting Energy Efficiency Interventions in Glass Clusters	Short Term (Till FY 2026) for lower coverage; Long Term (Till FY 2031) for higher coverage	Infrastructure and Industrial Development Department, Uttar Pradesh; UPNEDA
	Energy Efficiency Interventions in Paper Clusters	Short Term (Till FY 2026) for lower coverage; Long Term (Till FY 2031) for higher coverage.	Infrastructure and Industrial Development Department, Uttar Pradesh; UPNEDA
	Energy Efficiency Interventions in Foundry Clusters	Short Term (Till FY 2026) for lower coverage; Long Term (Till FY 2031) for higher coverage	Infrastructure and Industrial Development Department, Uttar Pradesh; UPNEDA
	Clean Energy Transition in Thermal Power Plant	Short Term (Till FY 2026) for lower coverage; Long Term (Till	UPRVUNL, BEPL, LAPPL, RPSCL etc

Focus Sector	Action Item	Implementation Timeline	Responsible Department
		FY 2031) for higher coverage.	
Building	Effective Implementation of ECSBC (previously known as ECBC & ENS)	Short Term (Till FY 2026)	Uttar Pradesh Housing and Urban Development Authority as the nodal agency for ECSBC, Municipal Corporations, Industrial Development Authority (NOIDA, BIDA)
	Replacement program for inefficient appliances	Long Term (Till FY 2031)	Bureau of Energy Efficiency (BEE)
	Promotion of BEE Star Rating and Shunya Rating of Buildings	Long Term (Till FY 2031)	Bureau of Energy Efficiency; UPNEDA; Department of Housing & Urban Development
Transport	Infrastructure Development for EV charging stations and Incentives to Consumers for quick transition to EVs	Short Term (Till FY 2026)	UPREV/UPPCL
	Ethanol and Biodiesel Blending Program	Long Term (Till FY 2031)	State Transport Department
	Promotion of Standard and Labelling program of Tyres for Fuel Efficiency in Vehicles	Short Term (Till FY 2026)	BEE /UPNEDA
Agriculture	Replacement of old pumps (10 years old) or less efficient pumps (non-star rated) with 5 Star rated Pumps along with smart control panel	Long-term (Till FY2031)	UPNEDA/ DISCOMs

Focus Sector	Action Item	Implementation Timeline	Responsible Department
	Transition of Electric Pumps to Solar Powered Pumps	Long Term (Till FY 2031	State Agriculture & Irrigation Department, UPNEDA
	Issuance of notification or government directive that all the new pumps installed in the state should be either energy efficient 5 star rated pumps or solar pumps	Short Term (Till FY 2026)	UPNEDA/DISCOMs
	Sustainable agriculture through Micro Irrigation	Long Term (Till FY 2031	Minor Irrigation and Groundwater Department
	Solarization of Agriculture Feeders	Long Term (Till FY 2031)	UPNEDA/DISCOMs
	Capacity Building Program for Pump Technicians	Short Term (Till FY 2026)	UPNEDA

10. Financial Mechanisms

This section provides an overview of the market and fiscal instruments[23] available in India for mainstreaming energy efficiency in various sectors, as mentioned below

S No	Type of Fiscal Instruments	Brief Description
1.	Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE) Suitable Sectors: Building and Industry	**About:** It's a finical instrument, notified by MoP in May 2016, where the financial institutions (FIs) such as banks and Non-Banking Financial Company (NBFC) are provided with partial risk coverage associated with extending loan for the energy efficiency related projects. It has been estimated that this fund will mobilize investment of more than Rs 800 crores in the nation. Thus, would acts as a catalyst in mainstreaming energy efficiency in various energy intensive sectors in India. **Fund guaranteed:** It guarantees 50% of loan amount or Rs.10 crores per project, whichever is less.
2.	Partial Risk Sharing Facility (PRSF) Suitable Sectors: Building and Industry	**About:** As the name suggest, this financial instrument, supported by BEE and established by Clean Technology Fund and Global Environment Fund, provides partial credit guarantee to Participating Financial Institutions (PFIs) to cover their risk associated with extending loans for energy efficiency related projects. The energy efficiency projects should have been implemented via Energy Service Companies (ESCOs) post entering an Energy Saving Performance Contract (ESPC). **Fund guaranteed:** It guarantees 75% of the loan amount or Rs 15 crore, whichever is minimum.

[23] BEE, Ministry of Power, "Unlocking National Energy Efficiency Potential (UNNATEE)", 2019, https://beeindia.gov.in/sites/default/files/UNNATEE%20Final%20Report.pdf.
BEE, Ministry of Power, "Roadmap of Sustainable and Holistic Approach to National Energy Efficiency",2019,
https://beeindia.gov.in/sites/default/files/Roshanee_print%20version%282%29.pdf
Organization for Economic Co-operation and Development, "Clean Energy Finance and Investment Roadmap of India", 2022, https://www.oecd.org/environment/cc/policy-highlights-clean-energy-finance-and-investment-roadmap-of-india.pdf

S No	Type of Fiscal Instruments	Brief Description
3.	Venture Capital Fund for Energy Efficiency (VCFEE) Suitable Sectors: Building	**About:** As the name suggests, this financial instrument was established by the BEE, provides access to funds in the form of equity for the last mile financial support for the projects related to energy efficiency. This has been established under the Framework for Energy Efficient Economic Development of NMEEE. As of now, this has been leveraged only by government buildings, private buildings (commercial or multistory residential buildings) and municipalities. **Fund guaranteed:** It provides a maximum of 15% of total equity required, through Special Purpose Vehicles or Rs. 2 crores, whichever is less.
4.	Energy Efficiency Financing Facility (EEFF) Suitable Sectors: Industry	This financing initiative has been established by BEE specifically for the financing requirement of large-scale industries, project aggregation approach covering ESCO projects, MSME clusters, etc. This facility will be anchored by a Public Financial Institution. The facility will also follow a project aggregation approach across industries or clusters or technologies, for ensuring the inclusion of the small sized projects.
5.	Framework for Energy Efficiency Financing Suitable Sectors: Building, Industry, Agriculture, and Transport	This unique platform offers interaction between FIs and project developers to foster the implementation of energy efficiency projects.
6.	Energy-saving certificates (ESCerts) Suitable Sectors: Building and Industry	On over achievement of set energy savings target, the designated consumers receive ESCerts. These ESCerts can be then traded and sold to the designated consumers who have under-performed i.e., who were not able to achieve their energy saving targets.
7.	On-bill financing (OBF) Suitable Sectors: Building	As the name suggest, in this type of financing mechanism, being done in partnership with a utility company, the consumer pays back based on the monthly utility bill generated.
8.	Capital subsidy (CS) Suitable Sectors: Building, Industry	As the name suggest, in this financial instrument capital subsidy is granted by the state government towards the energy efficiency related projects/investments, to cover capital expenses

S No	Type of Fiscal Instruments	Brief Description
	Sector, Agriculture and Transport	incurred for during incorporating the energy efficiency improvement mechanisms.
9.	Revolving loan fund (RLF) Suitable Sectors: Building, and Industry	This financial instrument aids in increasing the availability of funds in the market which in turn would fast-track mainstreaming of energy efficiency in the select sectors. The borrower can take loan in line with standard prudent lending practices which allows the money to be returned to the RLF for make additional loans, on the loan repayment being done by the borrower.
10.	Accelerated Depreciation based incentivization (ADI) Suitable Sectors: Industry	In this instrument, the project developers get the opportunity to take the advantage of the higher depreciation during the initial years, which acts as a catalyst for incentivizing industries to implement energy efficiency schemes.
11.	Loan loss recovery/partial risk guarantee fund (PRGF) Suitable Sectors: Industry	As the name suggest, this financial instrument provides a partial guarantee over the associated risk, a pre-specified percentage of loan loss is covered.
12.	Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) Suitable Sectors: Industry	This market instrument established by MoMSME, SIDBI, provides collateral-free credit guarantee of up to 85% on loans up to INR 200 lakh, to micro and small enterprises.
13.	Promoting market transformation for energy efficiency in MSMEs Suitable Sectors: Industry	This initiative, established by GEF, EESL, UNIDO, BEE, MoMSME, SIDBI act as a catalyst in increasing the availability of funds for MSMEs by setting up revolving fund mechanism, which would also ensure replicability of the project.
14.	SIDBI Venture Capital Limited (SVCL) Suitable Sectors: Agriculture and Industry	Under this funding mechanism, an investment management company under SIDBI extends equity capital to early-stage SMEs and start-ups for select sectors namely in manufacturing, agricultural and service.

S No	Type of Fiscal Instruments	Brief Description
15.	Additional Financial Schemes and support for MSMEs from UP Government	To bring the stability of MSME, UP Govt has started ventured in accordance with environment – 1. Green Production Incentives: MSMEs can receive up to 50% funding for pollution control facilities like CETPs and ZLDs, promoting waste reduction. 2. Environmental Audit: The state offers up to 75% reimbursement for energy and water audits and 50% support for green certifications. 3. Pollution Control Assistance: MSMEs adopting shared energy-efficient boilers can receive 50% of the project cost. 4. ZED Certification and ERP Assistance: Financial support for ZED certification and ERP systems encourages sustainable and high-quality production. 5. Eco-Friendly MSME Parks: Development of MSME parks promotes environmentally friendly and sustainable industrial zones. Additionally, under the Micro and Small Enterprises Technology Upgradation Policy, the Uttar Pradesh government provides 50% capital contribution, up to ₹25 lakhs, for small and medium enterprises adopting technological advancements to improve product quality, environmental practices, labor safety, energy efficiency, and computerized quality control. This contribution applies exclusively to the purchase of plant machinery and equipment, excluding financial or non-manufacturing costs. Moreover, MSMEs can avail 50% interest subsidy on loans taken for approved equipment purchases (up to ₹1 lakh per year for five years). This helps reduce the financial burden of technology upgradation, although it is limited to the unit.

S No	Type of Fiscal Instruments	Brief Description
16.	ADITEE (Accelerated Development and Innovation in Energy Efficiency) Suitable Sector: Industry	ADITEE is a financial initiative aimed at fostering innovation and accelerating the development of energy-efficient technologies and solutions in India. It provides funding support to start-ups and businesses involved in energy efficiency projects that promote sustainable energy use. The scheme supports the scaling of innovative products, services, and technologies that can contribute to reducing energy consumption and mitigating climate change. Fund varies based on project scope, typically offering equity funding, grants, or soft loans.
17.	PM Surya Ghar: Muft Bijli Yojana Suitable Sectors: Residential Sector	PM Surya Ghar Yojana is a government initiative under the Ministry of New and Renewable Energy (MNRE) aimed at providing solar energy solutions to households, enabling them to harness solar power for domestic use. The scheme is designed to make solar energy accessible and affordable to households, reducing their dependency on conventional power sources and lowering electricity bills. It includes subsidies for the installation of rooftop solar systems, making solar power a viable option for more families across India. **Central Financial Assistance (CFA)[24]:** 60% subsidy for 2 kW systems and 40% for 2-3 kW systems, capped at 3 kW. Subsidy amounts: Rs. 30,000 for 1 kW, Rs. 60,000 for 2 kW, and Rs. 78,000 for 3 kW or higher systems. **Loans**: Households will be able to access collateral-free low-interest loan products of around 7% at present for installation of residential RTS systems up to 3 kW.

[24] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2010130

S No	Type of Fiscal Instruments	Brief Description
18.	DELP- LED distribution under DELP scheme[25] Suitable Sector: Residential Buildings	The Government of Uttar Pradesh (GoUP) with Government of India (GoI)in association with Energy Efficiency Services (EESL) has launched Domestic Efficient Lighting Program across the state of Uttar Pradesh. Domestic Efficient Lighting Program (DELP) scheme focuses on promoting efficient use of energy and mitigates climate change by increasing the use of energy efficient LED lighting at the residential level. It seeks to enhance the awareness of consumers about the efficacy of using efficient appliances. Aggregating demand, reducing the high initial costs and thus facilitating higher uptake of LED lights by residential users is a key take away of this project. Either a connected load of less than or equal to two kilowatts will be provided with up to five 7-watt high-quality LED bulbs. Or a connected load of more than two kilowatts will be provided with up to ten 7-watt high-quality LED bulbs.
19.	Uttar Pradesh Micro, Small & Medium Enterprises Promotion Policy 2022[26] Suitable Sector: Industry	The Uttar Pradesh Micro, Small, and Medium Enterprises (MSME) Promotion Policy 2022 is designed to accelerate the growth of the MSME sector across the state. It emphasizes regional development, particularly in Bundelkhand and Purvanchal, by offering financial assistance, infrastructural support, and incentives to entrepreneurs. The overall goal is to boost industrial innovation, support local economies, and position Uttar Pradesh as a hub for sustainable industrial development. **Subsidy:** 50% of Interest subsidy, subject to ceiling of Rs 25 Lakh/ unit. Capital subsidy, capped at Rs 4 Crore/ unit based on the region of MSME. Approved MSME industrial parks/ estates/ flatted factory complex will be eligible for annual infrastructure interest subsidy of up to 50%, subject to ceiling of Rs 2 Crore, annually.

[25] https://upneda.org.in/ecp-schemes.aspx
[26] https://invest.up.gov.in/uttar-pradesh-micro-small-medium-enterprises-promotion-policy-2022/

In addition to the mentioned list of financing mechanisms for mainstreaming energy efficiency, a few globally used financing Mechanisms could also be adopted in India namely Carbon finance (CF), Energy-savings insurance (ESI), Energy improvement mortgage (EIM), Securitization of loans for energy-efficient appliances (SLEE), Revenue decoupling models for DSM (RD), Energy conservation bonds (ECB), Interest rate buys down fund (IRBDF), Property assessed clean energy (PACE), Cross-border technology transfer and energy-efficiency financing facility (CBTT), Green receivables fund (GRF), Peer-to-peer lending (PPL), Operation lease/vendor financing (OL), Stranded project financing facility (SPFF), etc.

11. Bibliography

1. India Economic Survey 2019-20, Department of Economic Affairs, Ministry of Finance, Government of India, January 2020.
2. National Accounts Data, Ministry of Statistics and Programme Implementation (MoSPI), Government of India.
3. World Energy Outlook 2021, International Energy Agency (IEA), December 2021.
4. Roadmap of Sustainable and Holistic Approach to National Energy Efficiency (ROSHANEE), Bureau of Energy Efficiency, Ministry of Power, April 2019.
5. Population Projection for India and States, 2011-2036, National Commission on Population, Ministry of Health & Family Welfare, Government of India, July 2020.
6. Uttar Pradesh At A Glance 2020, Economics and Statistics Division, State Planning Institute, Planning Department, Uttar Pradesh, December 2020.
7. Energy Statistics India 2021, National Statistical Office, Ministry of Statistics and Programme Implementation (MoSPI), Government of India, March 2020.
8. NITI Aayog – India Energy Dashboards, NITI Aayog, Government of India
9. Coal Directory of India 2019-20, Coal Statistics, Coal Controller's Organization, Ministry of Coal, Government of India, April 2021.
10. Indian Petroleum & Natural Gas Statistics 2019-20, Ministry of Petroleum & Natural Gas (MoPNG), Government of India, January 2021.
11. Annual Report 2020-21, Ministry of New & Renewable Energy (MNRE), Government of India, March 2021.
12. Uttar Pradesh Solar Energy Policy 2022, Uttar Pradesh New & Renewable Energy Development Agency (UPNEDA), 2022.
13. Mini Grid Policy Uttar Pradesh 2016, Uttar Pradesh New & Renewable Energy Development Agency (UPNEDA), 2016.
14. Bio Energy Program, UPNEDA, upneda.org
15. Bio Energy Enterprises Promotion Programme, U.P. State Bioenergy Development Board.

16. Invest UP, invest.up.gov.in.
17. Annual Report 2020-21, Ministry of Micro, Small and Medium Enterprises, Government of India.
18. Perform, Achieve and Trade (PAT), Bureau of Energy Efficiency (BEE)
19. Impact of Energy Efficiency Measures for The Year 2018-19, Bureau of Energy Efficiency (BEE), March 2021.
20. Technology and Quality Upgradation, msme.gov.
21. MSME Sustainable (ZED) Certification, msme.gov.
22. Revised Policy for Biomass Utilization for Power Generation through Co-firing in Coal-based Power Plants, Ministry of Power, Government of India.
23. Waste to Energy Programme, Ministry of New and Renewable Energy (MNRE), Government of India.
24. Biomass Programme, Ministry of New and Renewable Energy (MNRE), Government of India.
25. National Hydrogen Mission, Ministry of New and Renewable Energy (MNRE), Government of India, March 2021.
26. Small and Medium Enterprises: Energy Efficiency Knowledge Sharing (SAMEEKSHA) – A Platform for Promoting Energy Efficiency in SMEs, sameeksha.org.
27. ECBC, Energy Conservation Programme, upsavesenergy.com
28. S&L – Bureau of Energy Efficiency (BEE)
29. Government Incentives to IGBC-rated Green Building Projects, Indian Green Building Council (IGBC).
30. Energy Efficiency Services Limited (EESL)
31. Impact Assessment of BEE's Standards & Labelling Program in India, Collaborative Labeling and Appliance Standards Program, Market Xcel Data Matrix Pvt. Ltd., January 2015.
32. Road Transport Yearbook 2017-18 & 2018-19, Ministry of Road Transport & Highways, Government of India.
33. Vahan Dashboard, vahan.parivahan.gov.in

34. National Electric Mobility Mission Plan (NEMMP 2020), Ministry of Heavy Industries, Government of India.
35. Green Urban Transport Scheme (GUTS), Ministry of Housing and Urban Affairs, Government of India.
36. Uttar Pradesh Electric Vehicle Manufacturing and Mobility Policy – 2019, Department of Infrastructure and Industrial Development, Government of Uttar Pradesh.
37. Noida Electric Charging Infrastructure Policy, NOIDA Authority.
38. Uttar Pradesh Warehousing and Logistics Policy, Department of Infrastructure and Industrial Development, Government of Uttar Pradesh.
39. National Policy on Biofuels 2018, Ministry of Petroleum & Natural Gas, Government of India.
40. Standards & Labelling (S&L) Programme for Tyres, Bureau of Energy Efficiency (BEE).
41. Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan Yojana (PM KUSUM), Ministry of New & Renewable Energy (MNRE), Government of India.
42. Agriculture Demand Side Management (AgDSM) Programme, Bureau of Energy Efficiency (BEE).
43. Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), Department of Agriculture, Cooperation & Farmers' Welfare, under Ministry of Agriculture & Farmers' Welfare.
44. 24X7 Power for All Uttar Pradesh