Bureau of Energy Efficiency
Government of India, Ministry of Power

STATE ENERGY EFFICIENCY ACTION PLAN

KERALA

Prepared by
Confederation of Indian Industry

Confederation of Indian Industry

Supported by
Energy Management Centre Kerala

ENERGY MANAGEMENT CENTRE KERALA

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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)

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PREFACE

The Bureau of Energy Efficiency (BEE) has been involved in numerous of efforts aimed at developing and implementing energy efficiency programmes. As part of this initiative, BEE has proposed the above assignment, which aims to provide technical assistance for the identification of focus sectors for the "State Energy Efficiency Action Plan" in various states/UTs, to ensure that resources are allocated in accordance with state/UT requirements, and to estimate the potential of energy conservation in sectors that are prevalent in the region. The "State Energy Efficiency Action Plan" is sought in two parts: a 5-year short-term strategy and a long-term plan aimed at high-impact energy efficiency by FY 2030.

All states/UTs are grouped into six zones for this assignment: North-East, East, North-1, North-2, West, and South. In this context, the Bureau of Energy Efficiency (BEE), with the assistance of the Confederation of Indian Industry (CII), was involved in identifying major energy guzzling sectors in the West and South Zones, as well as reviewing all existing policies related to energy conservation, which will be presented in the form of this report "State Energy Efficiency Action Plan."

Policymakers, planners, domain consultants, and other important stakeholders would benefit from the State Energy Efficiency Action Plan. The report will also allow knowledge exchange among stakeholders and, in the long run, will help to scale up energy efficiency programmes in their respective states.

ACKNOWLEDGEMENT

Confederation of Indian Industry (CII) would like to express its sincere thanks to the Bureau of Energy Efficiency (BEE), Ministry of Power, Govt. of India for their role in guiding and steering this prominent assignment "State Energy Efficiency Action Plan" for Kerala. CII is grateful to Shri Srikant Nagulapalli, Director General, BEE, and Shri Milind Deore, Secretary, BEE, for their overall guidance and encouragement for successful completion of this project.

We are also thankful to Shri Abhishek Sharma, Joint Director and Shri Vikash Kumar Jha, Project Engineer with whom the team regularly consulted during the project for assistance, feedback, and valuable inputs.

CII is grateful to the proactive management by Energy Management Centre (EMC) Kerala for its role in guiding and steering this first task of this prestigious assignment and their support in coordination throughout the study. We would like to specifically mention the guidance and cooperation received from Dr. R. Harikumar, Director, EMC, Shri. Johnson Daniel, Head, NMEEE & DSM Division, Shri. Sarath Krishnan, Energy Technologist, who helped to complete the study in a timely manner.

CII would like to express sincere gratitude to the 'High Level Apex Level Committee' for Energy Conservation in Kerala chaired by Dr. V. P Joy IAS, Chief secretary to Government of Kerala for their guidance, support, and cooperation. CII team is also grateful to all the stakeholders, for showing keen interest and providing their wholehearted cooperation throughout the project.

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Table of Contents

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List of Figures

`

List of Tables

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List of Abbreviations

ANERT	Agency For New and Renewable Energy Research and Technology
ATF	Aviation Turbine Fuel
BEE	Bureau Of Energy Efficiency
CAGR	Compounded Annual Growth Rate
CBG	Compressed Biogas Fuel
CEA	Central Electricity Authority
CII	Confederation Of Indian Industry
CNG	Compressed Natural Gas
CPWS	Comprehensive Protected Water Supply
CSIND	Coastal Shipping and Inland Navigation Department
DAP	Di-Ammonium Phosphate
DISCOMS	Distribution Company
DSM	Demand Side Management
ECBC	Energy Conservation Building Code
EE	Energy Efficient
EMC	Energy Management Centre
EMS	Energy Management Systems
epi	Energy Performance Index
EV	Electric Vehicle
FY	Fiscal Year
GCV	Gross Calorific Value
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GSVA	Gross State Value Addition
HVAC	Heating, Ventilation, And Air Conditioning
IAPH	International Association Of Ports And Harbors
ICE	Internal Combustion Engine
INR	Indian Rupees
KIIFB	Kerala Infrastructure Investment Fund Board
KSINC	Kerala Shipping and Inland Navigation Corporation Ltd
KSPCB	Kerala State Pollution Control Board
KSRTC	Kerala State Road Transport Corporation
KWIL	Kerala Waterways and Infrastructures Ltd
LDO	Light Diesel Oil
LED	Light Emitting Diode
LPG	Liquefied Petroleum Gas
MoPNG	Ministry of Petroleum and Natural Gas
MSME	Micro, Small and Medium Enterprises
MT	Million Tonne
MTOE	Million Tonnes of Oil Equivalent

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MU	Million Units
MW	Mega Watt
NHPC	National Hydro Power Corporation
NMEE	National Mission for Enhanced Energy Efficiency
NPK	Nitrogen, Phosphorus, Potassium
NTPC	National Thermal Power Corporation
OEM	Original equipment manufacturer
PAT	Perform, Achieve and Trade
PPP	Public Private Ownership
PRT	Personal Rapid Transit
PWS/MPWS	Piped Water Supply/Miscellaneous Public Water System
RE	Renewable Energy
RSPCB	Rajasthan State Pollution Control Board
SDA	State Designated Agency
SEC	Specific Energy Consumption
SEEI	State Energy Efficiency Index
SKO	Superior Kerosene Oil
SWTD	State Water Transport Department
TFEC	Total Final Energy Consumption

Executive Summary

India's rapid economic expansion and urbanization have spurred a significant surge in energy demand. This burgeoning need for energy to fuel industries, transportation, and households presents a multifaceted challenge. The challenge is to provide affordable, reliable energy access to all while simultaneously addressing concerns of environmental sustainability and energy security. In response to these imperatives, India unveiled its strategic framework for climate action during the 26th session of the Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2021. Represented by the "Panchamrit" (five nectar) elements, this framework underscores India's steadfast commitment to achieving net-zero emissions by 2070 and sourcing 50% of its energy from renewable sources by 2030.

Central to this transition is the recognition of the pivotal role played by Indian States and Union Territories (UTs). In this context, the Bureau of Energy Efficiency, operating under the aegis of the Ministry of Power, Government of India, initiated the development of State Energy Efficiency Action Plan (SEEAP). These plans are meticulously designed to align with each state's unique requirements, ensuring that resource allocation is in harmony with the state's sustainable development goals. The SEEAP project is positioned to make a substantial contribution towards India's national energy efficiency targets, serving as a comprehensive roadmap for elevating energy efficiency standards both at the state and national levels.

For the state of Kerala, the SEEAP has been drafted in adherence to the guidelines set forth by the Bureau of Energy Efficiency, Ministry of Power, Government of India, collaboration with the State Designated Agency, the Energy Management Centre Kerala (EMC), as well as the knowledge partner, the Confederation of Indian Industry (CII). The plan has also benefited from valuable insights and recommendations from various government departments and sector experts. The primary objective of the State Energy Efficiency Action Plan for Kerala is to formulate sector-specific strategies for enhancing energy efficiency in the state.

Energy Landscape and Projections:

Kerala consumed 10.78 Mtoe of energy in FY 2020, primarily through oil (64%), electricity (19%), and imported coal (16%). With projected economic growth and considering energy intensity, total energy consumption is estimated to reach nearly 17.98 Mtoe by FY 2030.

Strategic Focus:

Based on factors like GSVA, energy consumption and feedback from stakeholders, four key sectors – Transport, Buildings, Industry, Agriculture & Fisheries were identified for targeted interventions. Dedicated strategies for each sector will optimize resource allocation and maximize impact.

Actionable Strategies:

1) Transport:
   - Promote widespread electric vehicle adoption to decrease dependence on fossil fuels.
   - Expand the ethanol blending program to create a cleaner fuel mix and reduce emissions.
   - Explore implementing Personal Rapid Transit (PRT) systems in Tier-2 and Tier-3 cities for improved urban mobility.
   - Develop inland waterways for efficient goods and passenger transportation, reducing reliance on road networks.
2) Industry:
   - Implement "Identify, Implement & Verify" (IIV) scheme to establish state-level energy reduction targets for industries.
   - Focus on energy efficiency interventions within energy intensive MSME clusters.
3) Buildings:
   - Implementation of the "Eco Niwas Samhita" program for promoting energy-efficient building practices.
   - Strengthen the existing Standard & Labelling Programme to incentivize the use of energy-efficient appliances and equipment.
   - Encourage widespread adoption of BEE Star Ratings and green building practices for new and existing constructions.
4) Agriculture & Fisheries:

   Facilitate transition from diesel pumps to solar-powered pumps, leveraging renewable energy and reducing dependence on fossil fuels.
   - Promote the replacement of old or inefficient irrigation pumps with 5-star rated models equipped with smart control panels to enhance water management and operational cost savings.
   - Integrate energy efficiency measures across the entire fisheries value chain.

Expected Outcomes:

This action plan, depending on the implementation scenario, is projected to achieve:

Energy Savings: Reduction of 1.9 Mtoe (moderate) and 2.8 Mtoe (ambitious) by FY 2030.

Market Potential: Creation of nearly ₹5,000 crore market for energy-efficient solutions and technologies.

Emission Reduction: Decrease in CO_2 emissions by 5.9 $MtCO_2$ (moderate) and 8.9 $MtCO_2$ (ambitious) by FY 2030.

By focusing on strategic sectors and implementing targeted interventions, this plan seeks to drive significant energy savings, unlock market potential, and contribute to a cleaner environment for Kerala.

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1 INTRODUCTION

1.1 Background

India is a diverse country with diverse energy consumption patterns in different states/UTs. Broadly, the energy consumption is divided in major sectors i.e., buildings, transportation, municipalities, discoms, agriculture and industries among others. A need for a focussed sector-based energy efficiency approach by states/UTs has been felt. For instance, there may be states with lesser urbanised areas and therefore lesser number of high energy consumption buildings. Such a state may need more focus on energy efficiency in sectors such as Transportation, Agriculture, or others.

Similarly, Industry sector has 53% of total primary energy demand in India, and more than 30% in most states. However, the level of energy efficiency initiatives and programmes is not commensurate with the energy consumption in this sector. Most states are yet to set energy saving targets for industry, apart from targets set for the PAT programme. Most states focus primarily on energy conservation for PAT Designated Consumers (DC) and monitor DCs for energy audits and compliance with specific energy consumption (SEC) targets. Only a few states have mandated energy audits for specific categories of industry other than PAT DCs and provision to provide financial incentives for implementing energy efficiency in industrial units.

In the transport sector, there is a need to include and promote energy efficient public transport besides policy level intervention for efficient or clean fuel vehicles. Several states have come forward with a state level incentivisation for electric vehicles. Policy and framework for electric vehicles at the state level needs further focus. Though energy efficiency is a multi-dimensional subject, defining key focus areas to bridge gaps is the need of the hour. While some states may have the potential to improve efficiency in a particular sector, there may be gaps in terms of identification of these sectors.

If, for instance, a state with many MSME industrial units, may focus on energy efficiency in the industrial sector alone, a large potential of achieving energy efficiency may be unearthed. This may involve activities and resource mobilization to create awareness in industry, replacement of appliances and machinery with the help of ESCOs, setting up and utilization of Revolving Investment Fund, besides others.

1.2 About State Energy Efficiency Action Plan

This assignment aims to provide technical assistance for the identification of focus sectors for the **State Energy Efficiency Action Plan for Kerala** to ensure that the allocation of resources is as per the requirement of state and estimate the potential of energy conservation in sectors which are predominant in the region. The State Energy Efficiency Action Plan is sought 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 year FY 2031.

The above said objective will be achieved by completion of four tasks as given below.

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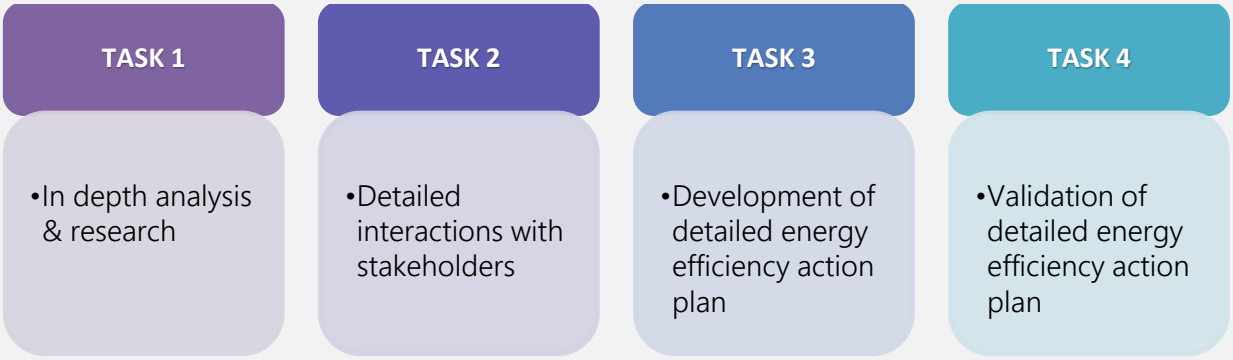
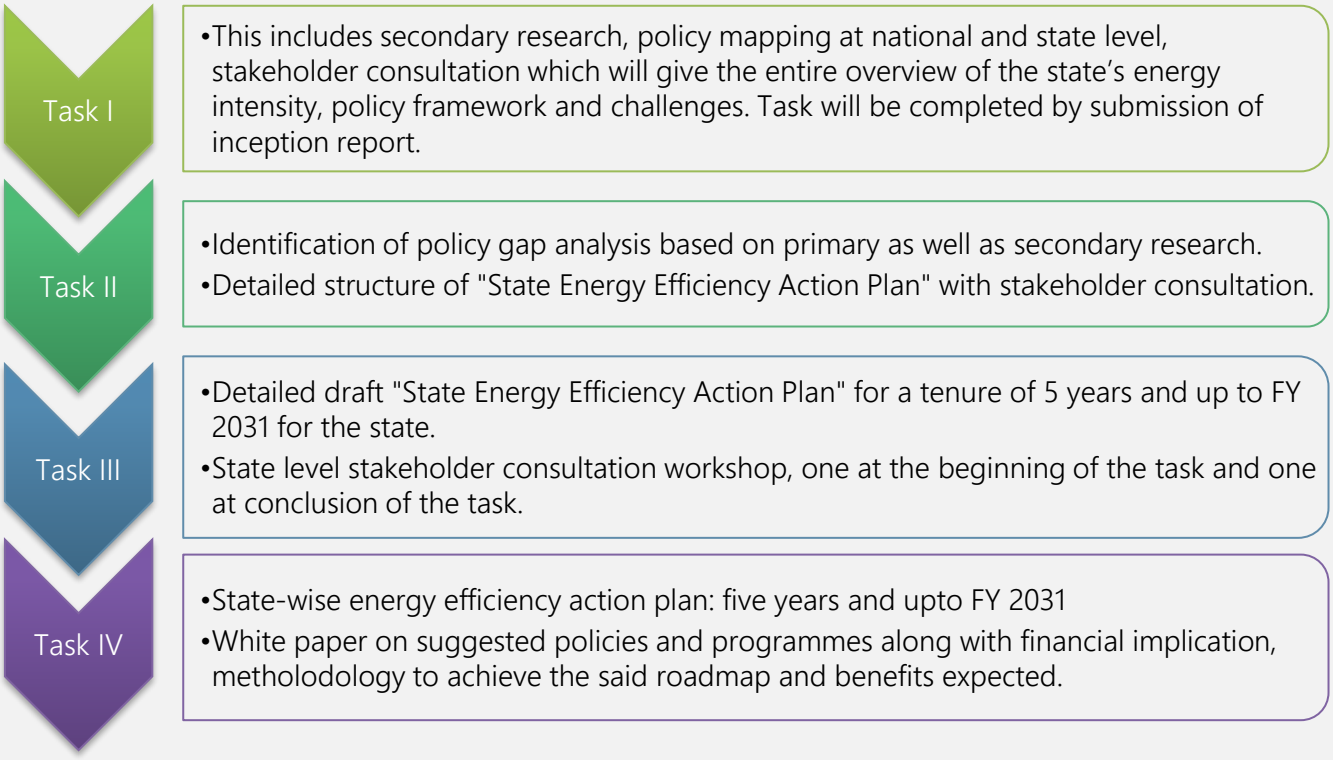
Figure 1 Key tasks in state energy action plan



Outcome

Task wise outcome of the study is as detailed in Figure 2.

Figure 2 Task wise expected outcome of the study



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1.2.1 Energy efficiency drivers for state

Kerala has scored 53 points in SEEI 2020 and is one of the best performing states in energy conservation, which is a clear indication of the state's determination and the actions taken to improve the energy efficiency. The key drivers of energy efficiency in the State are shown below.

Limited Self Generation of Power:

Kerala relies heavily on hydropower for electricity generation, and its capacity expansion is constrained by technical and ecological factors. This limitation drives the need for increased energy efficiency to reduce dependency on other states for additional power supply and move towards self-sufficiency in power generation.

High Domestic Electricity Costs:

Kerala's domestic consumers face a telescopic tariff rate structure for electricity, with significantly higher rates in upper consumption slabs. This pricing structure incentivizes residents to limit their electricity consumption, making them more interested in adopting energy-efficient appliances and practices to reduce costs.

State's Interest in Emission Reduction:

The government of Kerala is committed to reducing carbon emissions within the state. Energy efficiency plays a vital role in achieving this goal. The government has initiated efforts to make Kerala carbon-neutral, recognizing the importance of energy efficiency in reducing environmental impacts.

Increasing Awareness on Energy Efficiency:

Various awareness programs conducted by government agencies and organizations have contributed to raising public awareness about the importance of energy efficiency. These programs have influenced the mindset of residents and businesses, driving greater interest in energy-efficient practices and technologies.

These energy efficiency drivers align with Kerala's unique energy landscape and its commitment to environmental sustainability, cost savings, and self-sufficiency in power generation.

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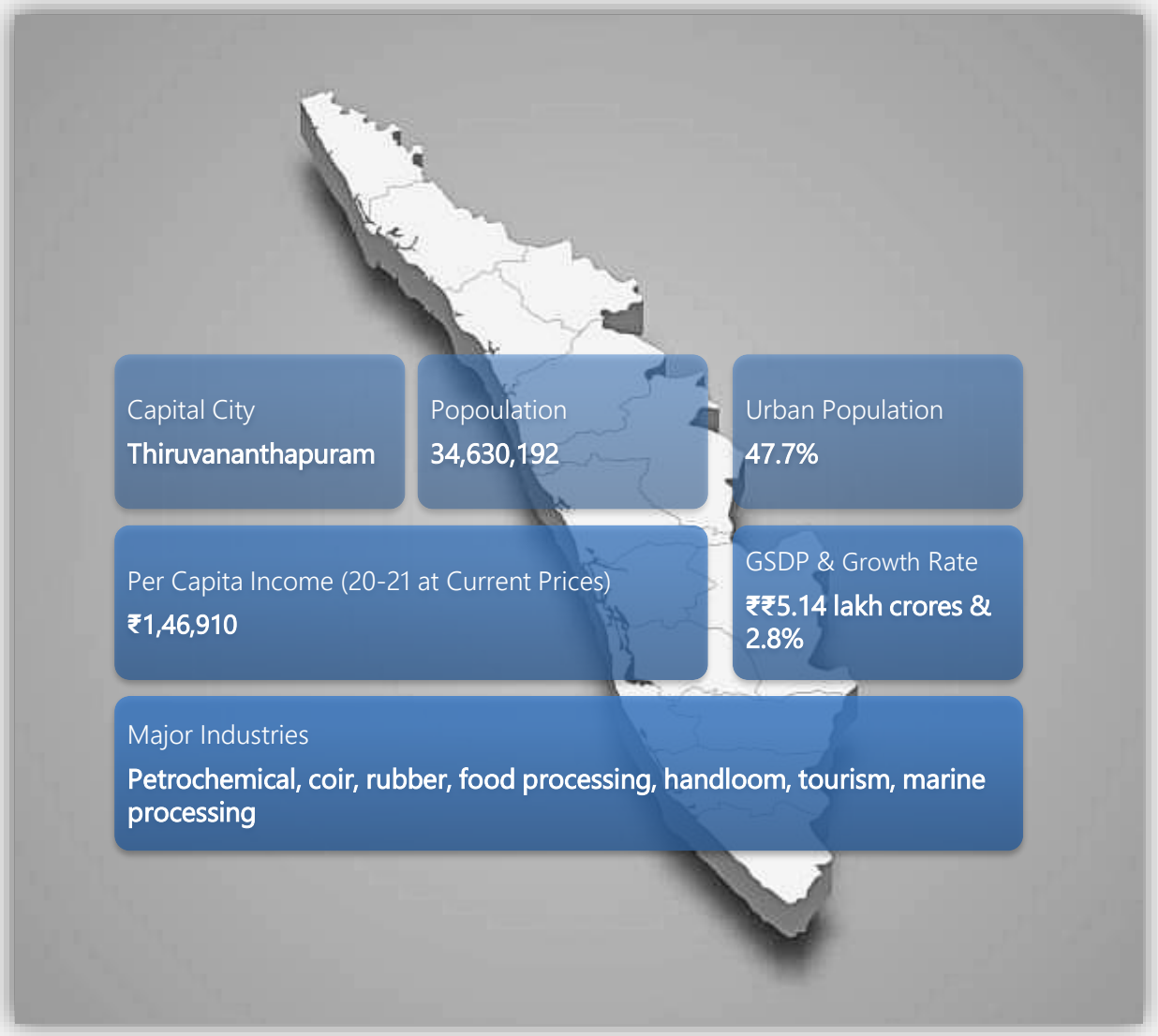
1.3 Kerala State Profile



Kerala lies in the southwestern coastal region of India and stretches for about 580 km along the Malabar Coast, varying in width from 30 to 120 km approximately. It is a small state in terms of the total area and constitutes about 1 per cent of the total area of the country. Kerala is bordered in the North by the State of Karnataka, in the East by Tamil Nadu, in the South and West by the Arabian Sea. In the northwestern coast it also surrounds Mahe, a segment of the state of Puducherry. The state has 14 districts, 6 municipal corporations, 87 municipalities and 941 Panchayats.

1.4 Total Final Energy Consumption (TFEC)

Total Final Energy Consumption (TFEC) refers to the total amount of energy consumed by end-users and sectors in an economy used for various purposes, such as transportation, industrial processes, agriculture, residential and commercial activities.

TFEC takes into account all forms of energy, including electricity, natural gas, petroleum products, coal, and renewable energy sources. It is a crucial indicator for assessing a state's energy consumption patterns, understanding energy efficiency, and evaluating the sustainability of energy use. Monitoring TFEC helps governments and policymakers make informed decisions regarding energy policies, energy security, and efforts to reduce energy-related emissions and environmental impacts.

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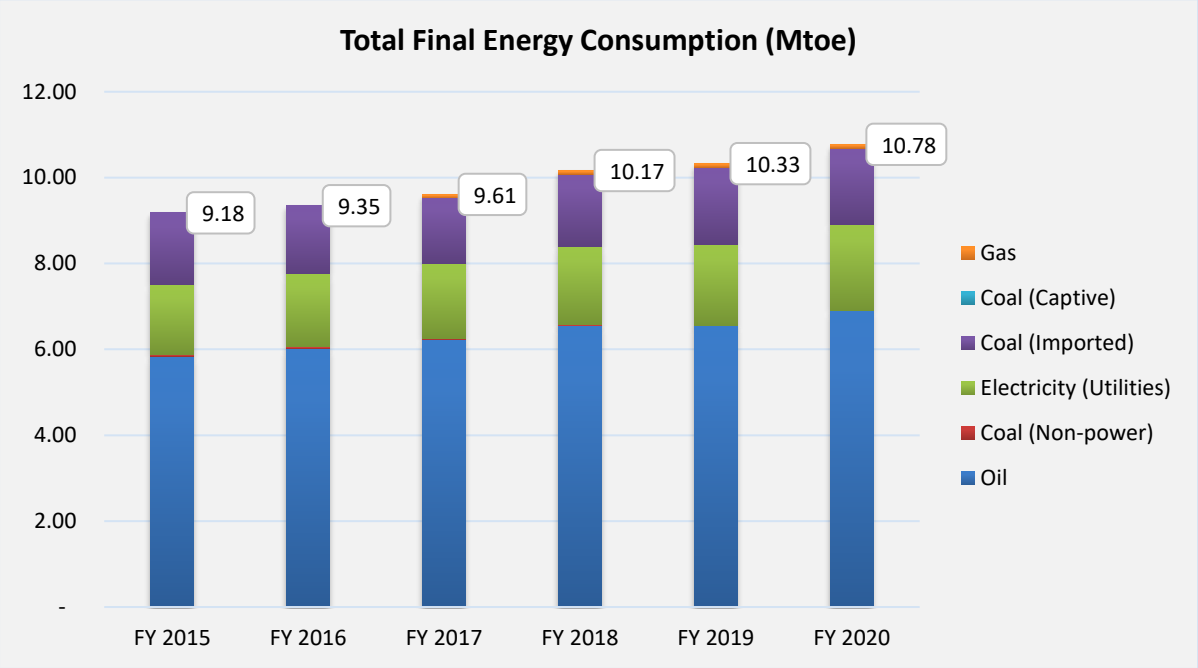
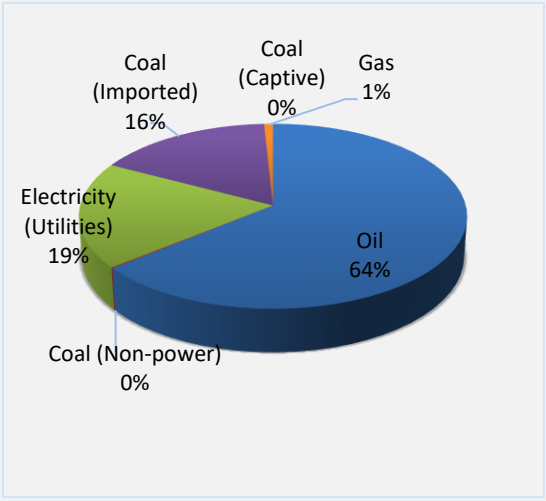
In the following section, we will examine the TFEC of Kerala sector wise and analyse the trend from FY2015-16 to FY2019-20 which will help us understand and identify energy saving potential. The baseline year is 2019-20 for all the subsequent sections.

Figure 3 TFEC for Kerala state from FY2015 to FY2020



The Total Final Energy Consumption (TFEC) of Kerala for the FY2019-20 is 10.78 MTOE (Million Tonnes of Oil Equivalent). It accounts for the total energy consumed from electricity and fuel like coal, major petroleum products like LPG, diesel, ATF, furnace oil etc.

Figure 4 Contribution of energy sources in FY2020



Kerala's energy landscape is characterized by a reliance on hydropower due to its abundant rivers and dams, which contribute significantly to electricity generation. Additionally, the state has been making strides in promoting renewable energy, particularly solar and wind power, with an increasing number of rooftop solar installations and solar parks. However, oil remains a dominant energy source, constituting 64% of the state's energy consumption, followed by electricity, coal and gas, as shown in the figure.

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Electricity Demand

Almost 99 % of the electricity needs in the state are met by KSEBL, the integrated state public sector electricity utility company. As on 31 March 2021, the total installed capacity of generation units of KSEBL was 2,174.27 MW. The transmission asset of the company includes 421 numbers of substations, and the distribution network carries 3.62 Lakh km line and more than 83,339 Distribution Transformers. Even though the internal resources are limited, capable of meeting only 30% of the energy requirement, KSEBL manages to meet the power requirement of the entire state without imposing any power restrictions by procuring power from other agencies and power exchange. After enabling the State to become 100% electrified in 2017, KSEBL continues to provide Power on Demand.

In Kerala, the total power inflow in FY 2021 was 25,132.93 MU (was 26,226 MU in FY 2020), out of which the internal generation was 7109.09 MU (5781.23 MU in FY 2020) and power imported was 18,262.34 MU (19,833.53 MU in FY 2020). The electricity through open-access was 407.41 MU (611.32 MU in FY 2020). Electricity consumption (includes open access consumption) in 2020-21 decreased at a rate of 2.54%, to 22,540.32 MU from 23,058.91 MU in 2019-20. In 2020-21, AT&C loss decreased to 7.76 per cent from 13.15 per cent and transmission and distribution (T&D) loss came down to 10.32 per cent from 12.08 per cent. The increase in AT&C loss in 2019-20 and decrease in 2020-21 was due to the corresponding decrease or increase in collection efficiency in respective period. The Peak demand of the State in 2020-21 was 4,284 MW, indicating a slight fall from 4,316 MW in 2019-20. The fall in peak demand in 2020-2021 is due to lower economic activities in the wake of Covid-19[1].

The electricity consumption[2] in MU by the major sectors of Kerala for FY 2020 is given below.

Figure 5 Sector wise electricity consumption of Kerala

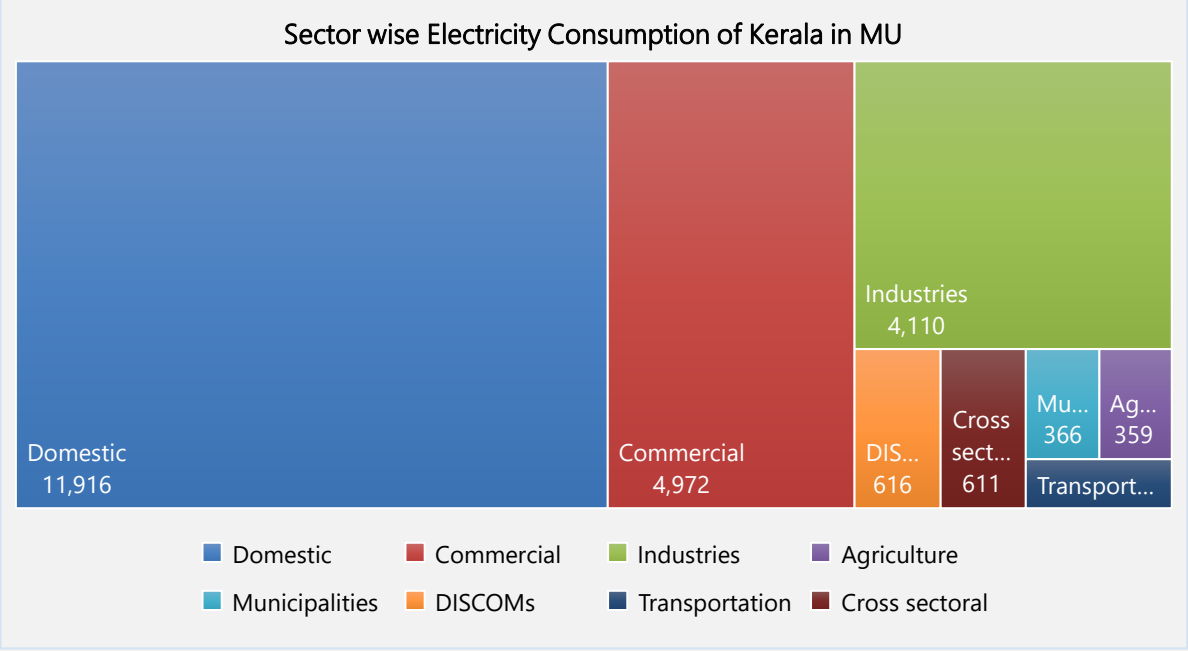

Figure 6: Sector wise Electricity Consumption of Kerala

[1] Economic Review of Kerala 2021
[2] ARR – ERC Petition of Kerala 2022-27

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The domestic sector is the most significant consumer of electricity and consumes about 51% of total electricity. The commercial sector comes second in electricity consumption and accounts for 18% of the total electricity consumption.

The industrial sector contributes to 18% of the total electricity consumption. In Industries, there are 6 Designated Consumers in Kerala. Kerala has the 12th largest number of MSMEs in India – around 23.79 lakh units, of which 23.58 are micro-enterprises.

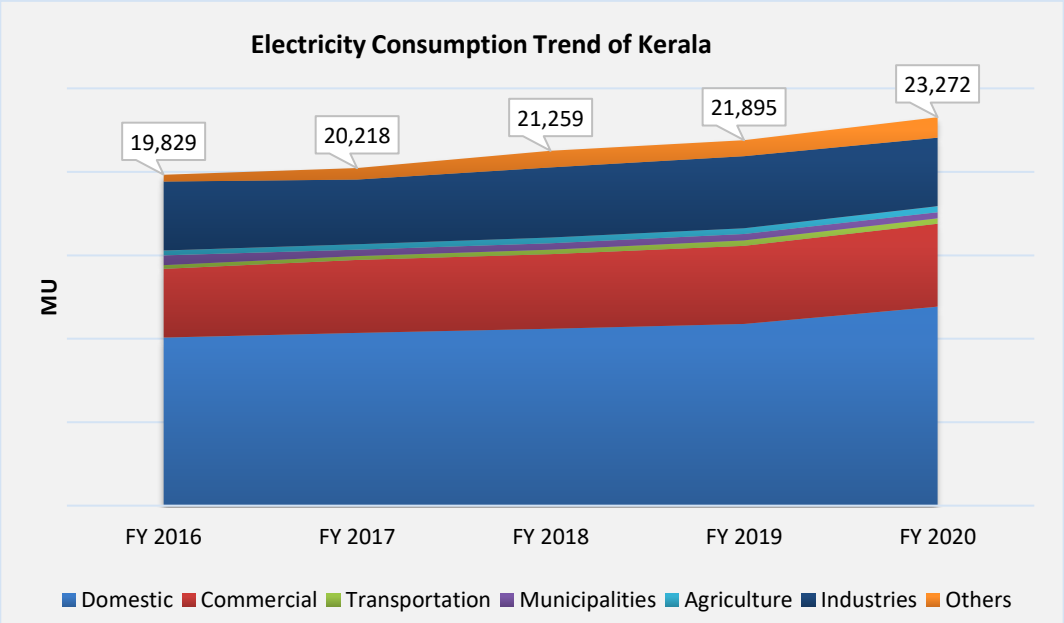
DISCOMs account for 3% of total electricity consumption. KSEBL distributes power across the state, from where some companies/ institutions purchase power in bulk and distribute it further. Currently there are 10 such bulk suppliers/licensees within the state.

Electricity consumption from open-access is accounted as cross-sectoral consumption, as the procured electricity will be used by various consumers and bifurcation is not available. It constitutes 3% of the total electricity consumption.

The municipality sector consumes 2% of electricity, while the transport and agricultural sectors consume 1% each. Transport sector consumption includes that by railway traction and metro services, and in municipality, the accounted consumption is from the use of streetlights. As mentioned before, the municipal pumping electricity consumption was not available as it was included in the industrial LT category and hence not included in Municipality sector. Pumps are the major electricity consumer in the agricultural sector.

Electricity consumption trend[3] of Kerala in MU for the period FY 2016 and FY 2020 is shown below.

Figure 7 Electricity Consumption Trend of Kerala



The electricity consumption of Kerala has increased from 19,829 MU at a CAGR of 4.1% between FY 2016 and 2020. The largest contributor to electricity consumption, the domestic sector, has a CAGR of 4.3% while the commercial sector has a CAGR of 4.82%.

The transportation sector, which includes the consumption of traction is grown at a CAGR of 10%. The agricultural sector's electricity consumption grew by 5.62%, primarily due to an increase in electrical pumps instead of diesel pumps. The data for electricity consumption in

[3] https://cea.nic.in/dashboard/?lang=en

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municipal pump works is unavailable and has been excluded from the analysis, potentially explaining the negative CAGR of -11% in the municipal sector.

1.5 Overview of Institutional framework and stakeholder mapping Energy

The Department of Power under the Government of Kerala is the apex authority in Kerala under which various agencies are working in tandem.

The Kerala State Electricity Regulatory Commission was constituted under the provisions of Subsection (1) of Section 17 of the Electricity Regulatory Commissions Act, 1998. With effect from 10th June 2003, the Commission has come under the purview of the Electricity Act, 2003, as the Electricity Regulatory Commissions Act, 1998 has since been repealed. It regulates and controls all the electricity related activities within the state like determining the tariff for generation, supply, transmission and wheeling of electricity, regulating electricity purchase and procurement process of distribution licensees, enforcing standards with respect to quality, continuity and reliability of service by licensees etc.

The Department of Electrical Inspectorate was formed by the Government vide G.O. (Ms) No.28 / 68 / PW. Dated 20-10-1968. The main function of the department is to ensure safety of all electrical installations as per the provisions of section 53 of Electricity Act 2003. The Licensing Board constituted vide Kerala State Electricity Licensing Board Rules is functioning under this Department. The main function of the Board is to issue Licences and permits to competent persons for the installation and maintenance of Electrical Installations.

The Kerala State Electricity Board Limited (formerly, Kerala State Electricity Board) which was constituted by the Government of Kerala as per order no. EL1-6475/56/PW dated 7-3-1957 of the Kerala State Government under the Electricity (Supply) Act, 1948 is the entity responsible for carrying out the business of Generation, Transmission and Distribution of electricity in the state of Kerala. It has been incorporated under the Companies Act, 1956 on 14th January 2011 and started operations as an independent company with effect from 1st November 2013 with the aim of providing quality electricity at an affordable cost to all classes of consumers in the state of Kerala.

Kerala Government is the first State Government in India to establish an Energy Management Centre (EMC) at State level, aiming primarily to remould and instrumentalise energy sector as a catalyst in promoting a development process that is economically and ecologically sustainable. It was established in Thiruvananthapuram (Trivandrum), Kerala, India in February 1996 as an autonomous organization under the Department of Power, Government of Kerala. It is the Designated Government agency or State Designated Agency (SDA) in Kerala to co-ordinate, regulate and enforce the provisions of the Energy Conservation Act 2001 (Central Act 52 of 2001).

Agency for New and Renewable Energy Research and Technology (ANERT) is an agency under the Power Department of Kerala which gathers and disseminates useful knowledge in the areas of non-conventional energy, energy conservation and rural technology; conducts studies, demonstrates, implements and supports the implementation of schemes and projects in these fields; updates the technologies used in rural areas; and introduces appropriate new technologies to reduce drudgery, increase productivity and improve the quality of life.

The institutional framework for energy efficiency in Kerala is shown in Figure 8.

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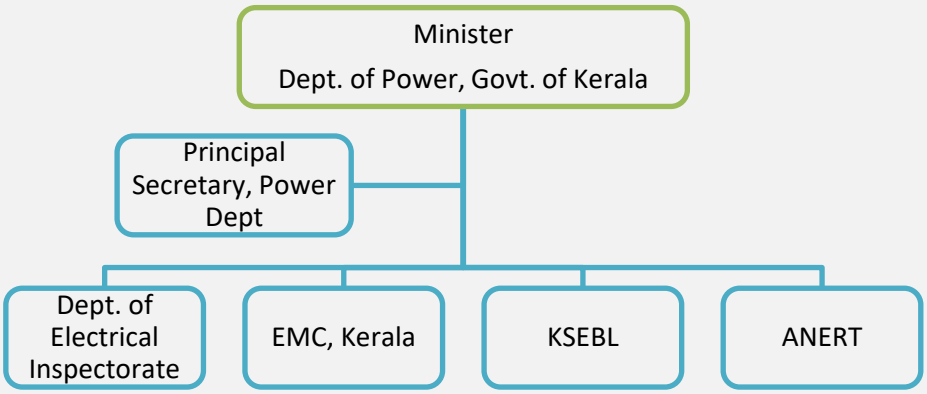

Figure 8: Institutional framework of Kerala – Energy Efficiency

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2 PROJECTIONS AND FORECASTING

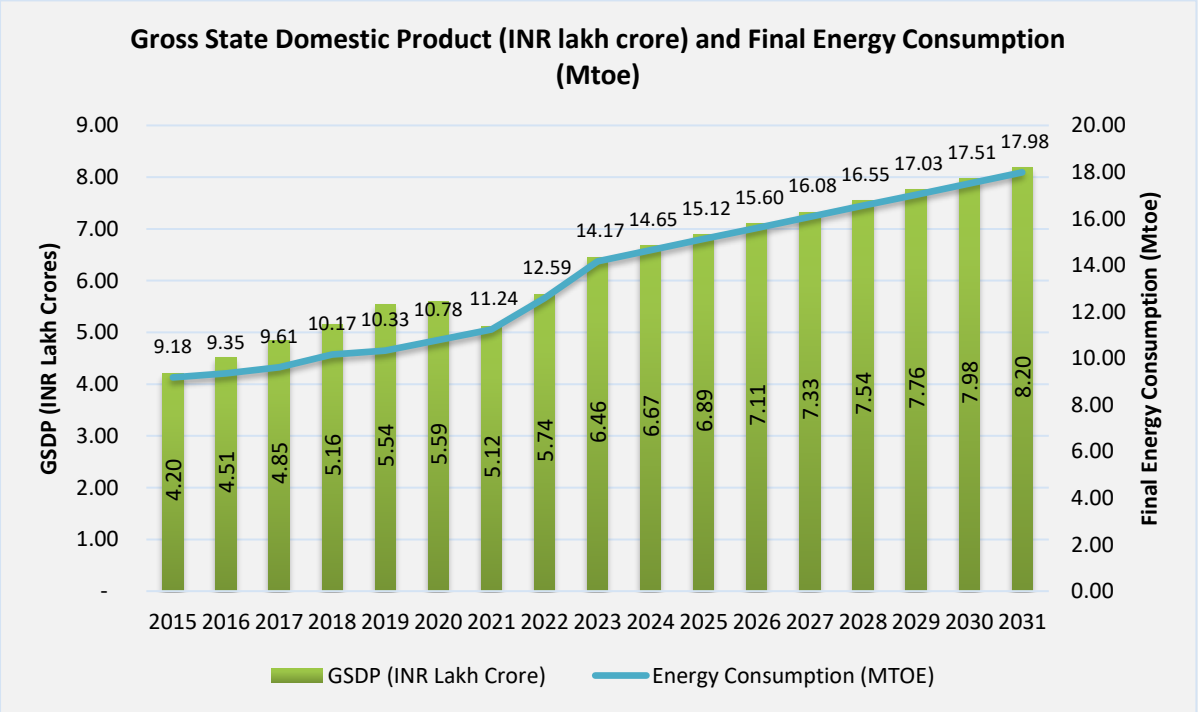
The methodology employed for estimating the TFEC projection for Kerala involved analyzing trends in final energy consumption and energy intensity, calculating the average intensity, using time-series modelling to make projections, and estimating the TFEC projection for 2031.

Base year determination: FY 2019-20 was selected as the base year for this study, since FY 2021 and FY 2022, marked by the impact of the pandemic. FY 2015 had a TFEC of 9.81 MTOE.

Average intensity calculation: The average energy intensity is the ratio of the TFEC value and GSDP for the years 2015-2020 and taking the average of the obtained values. This was done to identify the energy intensity trend and estimate the energy consumption for the year 2031.

Time-series modelling: Time-series modelling was used to analyze the trends in energy consumption and energy intensity to project the TFEC for the year 2031.

Figure 9 Gross State Domestic vs Final Energy Consumption



By examining energy consumption and intensity trends, it is possible to identify factors that influence energy demand, such as changes in economic conditions, shifts in technology, and policy interventions. Additionally, analyzing energy intensity trends can provide insights into the efficiency of energy usage and the effectiveness of energy-saving measures.

Projection estimation: Using the trends identified through the above steps, a projection was made for the TFEC for 2031. Based on the time-series modelling and average intensity calculation, the estimated TFEC projection for Kerala for the fiscal year 2031 will be 17.98 MTOE.

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2.1 Energy Scenarios

Projected total final energy consumption (TFEC) for FY 2025-26 and FY 2030-31 are assessed under three scenarios: Business as Usual (BAU), Moderate (MOD), and Ambitious (AMB). These scenarios provide strategic insights into potential energy savings within the identified focus sectors: transport, industries, buildings, agriculture, and fisheries.

Business as Usual (BAU) Scenario	•The BAU scenario represents a baseline projection of energy consumption for the state, assuming no specific interventions or changes in the existing trends. •It serves as a reference point against which the impact of energy-saving strategies can be measured.
Moderate (MOD) Scenario	•The Moderate scenario takes into account moderate levels of technological interventions and policy and program initiatives. •It reflects a realistic but not overly aggressive approach to energy efficiency measures, considering advancements in technology and moderate policy changes.
Ambitious (AMB) Scenario	•The Ambitious scenario considers high levels of technological advancements and ambitious policy and program interventions. •It represents an optimistic outlook, showcasing the potential energy savings if the state adopts cutting-edge technologies and implements ambitious policies to enhance energy efficiency.

Figure 10 Description of key energy scenarios

Factors Influencing Scenarios:

Technological Interventions: The level of advancement in technologies related to energy consumption plays a significant role in shaping the Moderate and Ambitious scenarios. This includes improvements in energy-efficient appliances, industrial processes, and renewable energy technologies.

Policy Interventions: The extent of governmental policies and programs aimed at promoting energy efficiency greatly influences the outcomes of the Moderate and Ambitious scenarios. This involves initiatives such as energy conservation policies, incentives for renewable energy adoption, and regulatory frameworks.

Figure 11 Factors Influencing Scenarios

Factors Influencing Scenarios	*Technological Interventions*	*Policy Interventions*
Transport	Electric vehicles, intelligent transportation systems.	Incentives for electric vehicles, emission standards.
Industries	Energy-efficient manufacturing, Industry 4.0 technologies.	Energy efficiency standards, financial incentives.

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Buildings	Smart technologies, energy-efficient HVAC systems.	Stringent building codes, green building incentives.
Agriculture	Precision farming, sustainable practices.	Sustainable farming policies, incentives for efficiency.
Fisheries	Advanced technologies in aquaculture and fishing practices.	Policies promoting sustainable fisheries and energy-efficient equipment.

These energy scenarios provide a framework for understanding the potential energy savings that can be achieved through strategic interventions in the designated sectors. It enables policymakers to make informed decisions based on a range of possibilities, from a conservative business-as-usual approach to ambitious and transformative energy efficiency measures.

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3 IDENTIFICATION OF FOCUS SECTORS

3.1 Methodology for identifying focus sectors

Methodology for Identifying Focus Sectors for Kerala:

- Energy Consumption Analysis: The first step in identifying the focus sectors involved analysing the state's energy consumption patterns. This analysis considered the overall energy consumption in Kerala, including both primary and secondary energy sources. Understanding the sectors responsible for significant energy consumption provided insights into areas where potential improvements could yield substantial benefits.
- Emissions: Simultaneously, an assessment of emissions generated by different sectors was studied. This analysis helped in identifying sectors with higher carbon footprints and those contributing significantly to air pollution and greenhouse gas emissions.
- Gross State Value Addition (GSVA): The GSVA study provided an understanding of the economic contribution of different sectors to Kerala's economy. Sectors with high GSVA were given priority as improving energy efficiency and reducing emissions in these sectors could have a more significant impact on the state's overall economic growth.
- Gap Analysis in Respective Sectors: A thorough gap analysis was performed for each sector to identify existing challenges in these sectors. This step allowed identifying specific areas where targeted interventions and policies could yield the best results.
- Stakeholder Inputs: The inputs and feedback from various stakeholders and government agencies, were considered. This helped in understanding the priorities and concerns of key stakeholders in the state's energy and environmental landscape.
- State Designated Agency (SDA) and Government Vision: The focus sectors aligned with the state's long-term development agenda and the vision of the state government were given preference. This ensured that the selected sectors were in line with the overall strategic direction of the state.

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3.2 Identified focus sectors

Energy consumption indicators and situation assessment are used to define target focus sectors and specific industries.

The following sectors should be focused for the development of "State Energy Efficiency Action Plan" for Kerala.

Energy efficiency measures are thus becoming increasingly significant in these sectors, based not just on overall energy use but also on the potential for cost-effective improvements. For setting priorities, account has to be taken of the measures applicable in a given sector (including cost implications) and on the means of promoting energy efficiency action.

In the transport sector, road transport can be given more focus as the major contribution is from the consumption of fuels in road transport. Aviation sector also has a significant contribution but the scope for improvement is limited due to the sector specialties.

The domestic sector dominates in electricity consumption, followed by the commercial sector. Implementing demand side management in both groups of consumers has greater scope in reducing the energy consumption of the state.

In Kerala, MSME penetration is higher and the use of energy efficient technologies in the MSME sector, especially in MSME clusters reveals larger opportunity for energy reduction.

TRANSPORT SECTOR

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4 FOCUS SECTOR 1: TRANSPORT

4.1 Overview

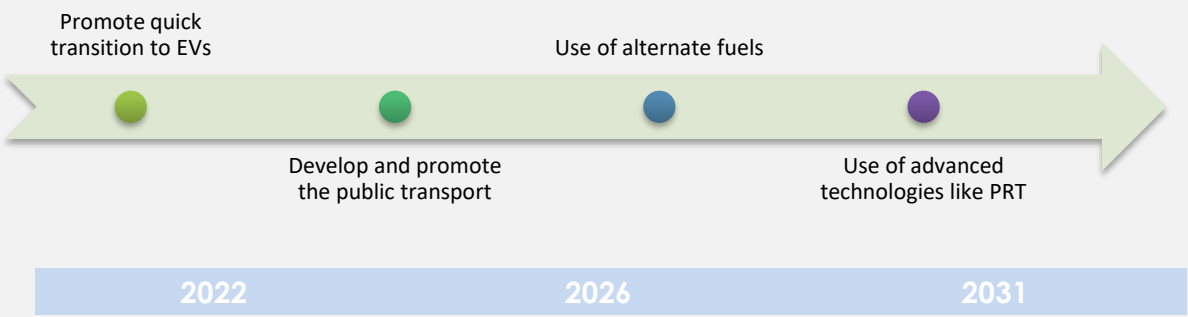
Kerala has a well-developed transport sector that comprises various modes of transportation such as roadways, railways, waterways, and airways. Kerala has a well-connected road network with a total length of around 145,704 km, out of which 4,341 km are national highways. The state has an extensive network of state highways, district roads, and village roads, which are maintained by the Kerala Public Works Department. The state-run Kerala State Road Transport Corporation (KSRTC) operates a fleet of buses that provide intercity and intracity transport services to the people. Apart from this, private operators also provide bus services in the state. The state of Kerala has an extensive network of backwaters and canals, which are used for transportation purposes. The Inland Waterways Authority of India has developed waterways in the state for cargo and passenger transportation. The major ports in Kerala are the Kochi Port and the Vizhinjam Port.

4.2 Energy efficiency strategies in the transport sector

The most commonly used vehicles in Kerala are motorcycles, scooters, and auto-rickshaws. Cars and buses are also commonly used for transportation, especially for long-distance travel. Kerala has a high density of vehicles, with over 14 million registered vehicles as of 2021. This has resulted in traffic congestion and pollution in some of the major cities in the state.

In recent years, the state government has been promoting the use of electric vehicles as a means of reducing pollution and dependence on fossil fuels. There are a few electric vehicle charging stations in the state, and the government has announced plans to set up more of them in the coming years. Kerala also has a well-developed public transportation system, with state-run buses and private buses operating on various routes. The state government also operates a metro rail system in Kochi, which is the only metro rail system in the state currently. Water transport is also available in some parts of the state, with ferries and boats operating on various routes.

The strategic areas that can be focused on in short-term and long-term for reducing the energy consumption of transportation sector is shown below.



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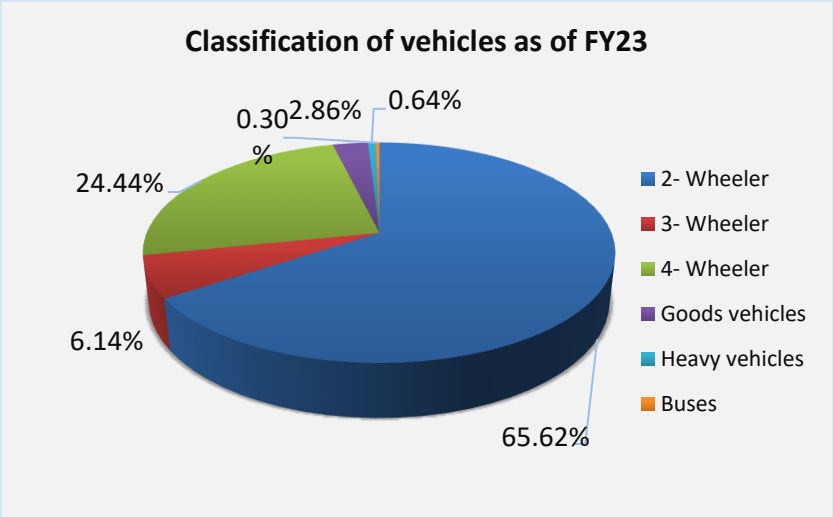
The policy interventions required for reducing the energy consumption of transportation sector is discussed in the subsequent section.

4.2.1 Strategy #1: Facilitating Electrification of Road Transport

Electric vehicles are significantly more efficient than their petrol or diesel counterparts. While electric vehicles can convert around 60% of the electrical energy from the grid to power the wheels, petrol or diesel cars can only convert 17%-21% of the energy stored in the fuel to the wheels, resulting in a wastage of around 80%. Thus, electrification of road transport is a good way to reduce energy consumption and emissions, particularly as the grid becomes greener with increased use of renewables.[4]

According to the data from Vahan dashboard[5], the state has nearly 66% of two wheelers out of the total share of vehicles followed by four wheelers and three wheelers respectively.

Figure 12 Classification of vehicles as on FY2022



There are nearly 1.4 crore petrol vehicles and 25 lakhs diesel vehicles. The adoption of electric vehicles is increasing steadily in Kerala, with more and more people opting for electric two-wheelers and cars. There are more than 85,000 electric vehicles in Kerala. However, this only constitutes to 0.5% share of fuel source as opposed to petrol and diesel which stands at 84% and 16% respectively.

[4]https://e-amrit.niti.gov.in/benefits-of-electric-vehicles

[5] Online dashboard for national visibility of vehicle registration and related services.

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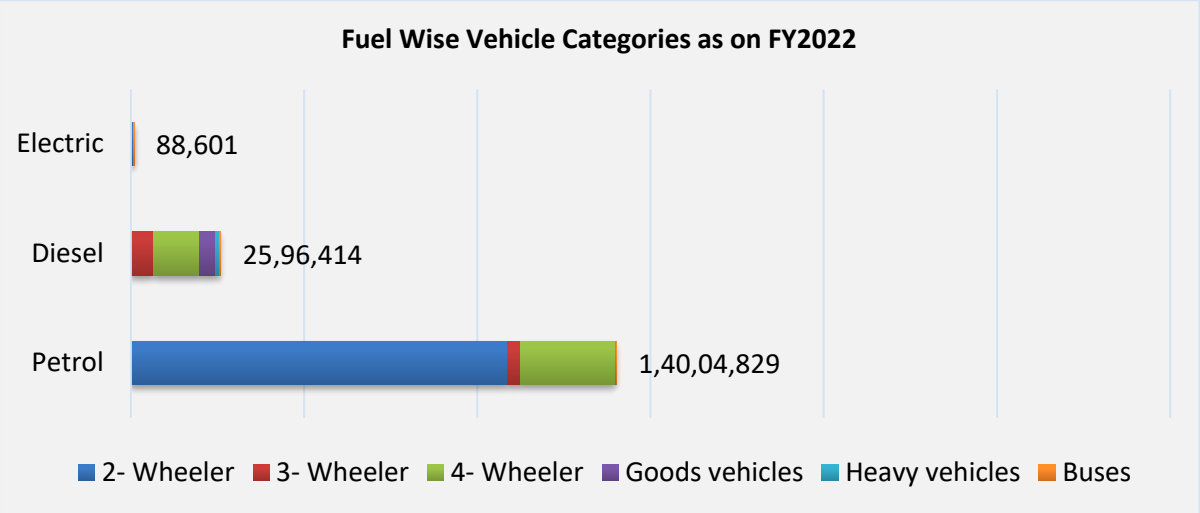
Figure 13 Fuel Wise Vehicle Categories as on FY 2022



To accelerate the transition towards cleaner and more sustainable transportation, a comprehensive strategy is recommended. The strategy for electrification of vehicles and its implementation is explained below.

Scope Boundary

- It will be applicable to all categories of road transport, including two-wheelers, three-wheelers, four-wheelers, buses, and commercial vehicles.

Implementing Agency

- Kerala Transport Department
- Kerala State Road Transport Corporation
- Kerala State Electricity Board Limited
- Agency for New and Renewable Energy Research and Technology (ANERT)
- Energy Management Centre (EMC)
- Deptartment of Industries
- Kerala State Pollution Control Board (KSPCB)
- Municipal Corporations and Urban Development Authorities

Current Policy/Policies In Place

- Kerala Government through its Electric Vehicle Policy 2019 had targeted to roll out one million EVs in the state by 2022 and transition of entire fleet of KSRTCs 6000+ buses into electric vehicles by 2025.

Implementation Period

- Short-term (2022-2024): Focus on building charging infrastructure in urban centers and along major highways, creating awareness campaigns, and introducing initial incentives for EV buyers.
- Medium-term (2025-2026): Expand charging infrastructure to semi-urban and rural areas,
- Long-term (2027 to 2031): Achieve significant electrification of road transport, establish a comprehensive charging network, encourage local EV manufacturing and battery production, and closely monitor the environmental impact.

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Energy Saving Potential

Below figure shows the actual number of electric vehicles in the state as of FY2021 categorized into vehicle types. If these numbers are projected under "business as usual" scenario based on the historic economic and energy growth rate (6%) of this sector, there is only a slight rise in EV numbers. However, after the implementation of the policy of converting existing petrol and diesel fleet, considering the conversion percentage of ICE vehicles for the moderate scenario and ambitious scenario, it can result into significant energy saving of nearly 1 MTOE under the ambitious scenario.

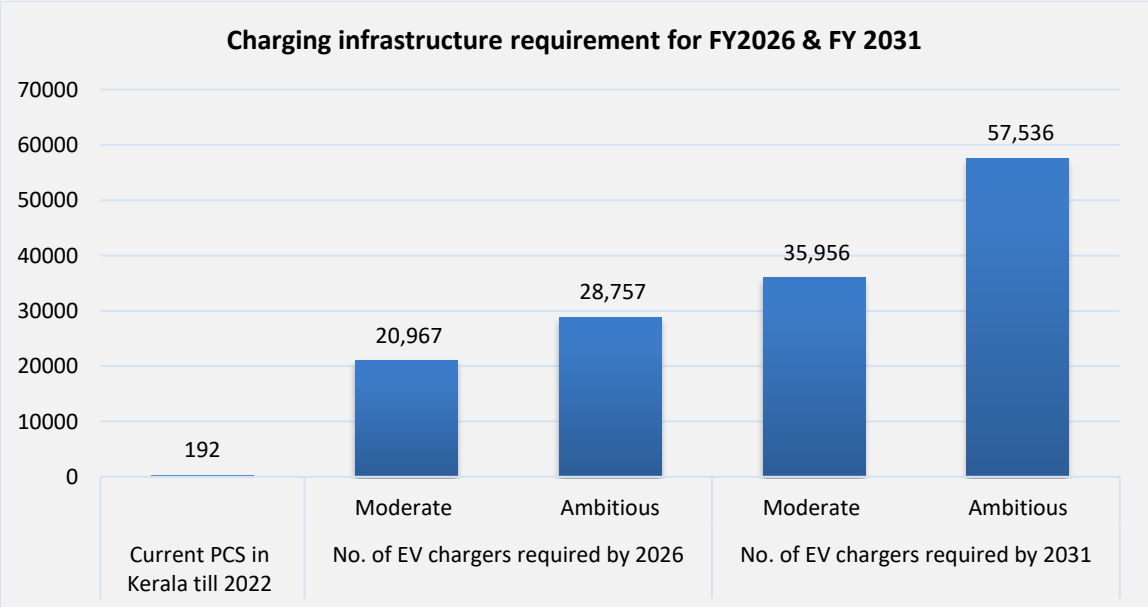
From 0.5% of EVs of total numbers of vehicles in FY21, the state can aim to achieve 2.5% of EVs by 2030 under moderate scenario and 4% under ambitious scenario as per the estimation below.

Figure 14 Actual EVs till FY 2021 vs projected EVs of till FY 2031

	% conversion of existing fleet onto EVs		No of Vehicle Converted to EV in 2026		No of Vehicle Converted to EV in 2031	
Category	Moderate %	Ambitious %	Moderate	Ambitious	Moderate	Ambitious
2- Wheeler	-5%	-8%	4,24,925	5,82,755	7,28,714	11,65,943
3- Wheeler	-5%	-8%	39,823	54,614	68,293	1,09,268
4- Wheeler	-5%	-8%	1,58,883	2,17,897	2,72,472	4,35,955
Goods vehicles	-1%	-2%	3,722	6,380	6,382	12,764
Heavy vehicles	-1%	-2%	831	1,424	1,424	2,849
Buses	-25%	-35%	9,827	11,793	16,853	23,594
		Total	6,38,010	8,74,862	10,94,138	17,50,373

In order to accommodate the addition of these electric vehicles following number of charging stations will be required.

Figure 15 Charging infrastructure requirement for FY 2026 & FY 2031



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By increasing the share of EVs in the vehicle stock of Kerala with nearly 10 lakh EVs in moderate scenario and 17 Lakh EVs in ambitious scenario by 2031, additionally 35,000 charging stations and battery swapping infrastructure by 2026 and 56,000 charging stations and battery swapping infrastructure by 2031, with Level-1, Level-2 and Level-3 (DC) chargers across all cities will result into energy saving of 0.84 MTOE under ambitious scenario by FY 2031.

Table 1: Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.33	0.42	0.56	0.84
GHG Emission Reduction Potential ($MtCO_2$)	1.0	1.3	1.7	2.6

Action Plans

This section describes several action plans that can be implemented across the transport sector for this strategy.

1. Developing Charging Infrastructure for Induction Charging on Greenfield Highway Projects:
    a) Feasibility Study: Conduct a comprehensive feasibility study to identify optimal locations for induction charging stations along greenfield highway projects.
    b) Public-Private Partnerships (PPP): Partner with private companies specializing in EV infrastructure development to plan, construct, and maintain the charging stations.
    c) Regulatory Framework: Establish clear regulations and standards for induction charging technology to ensure safety and compatibility.
2. Adoption of E-Buses to Other Cities:
    a) City Assessment: Conduct a city-wise assessment to determine the feasibility of introducing e-buses, considering factors such as route optimization, charging infrastructure, and passenger demand.
    b) Public Awareness: Launch public awareness campaigns to educate citizens about the benefits of e-buses and encourage their use.
    c) Fleet Expansion: Procure additional e-buses for cities based on their specific requirements and operational needs.
3. Adoption of Battery Swapping for 2 & 3 Wheelers:
    a) Pilot Projects: Identify ten model cities for launching pilot battery swapping projects. Collaborate with EV manufacturers and service providers.
    b) Infrastructure Investment: Allocate funds for the setup of battery swapping stations and ensure they meet safety and technical standards.
    c) Consumer Incentives: Offer incentives such as reduced swapping fees or subscription-based packages to encourage adoption.

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4. Awareness on Energy Efficiency Program for High Energy Lithium-Ion Traction Battery Packs and Systems:
   a) Multi-Channel Campaign: Implement a multi-channel awareness campaign involving digital media, workshops, seminars, and collaboration with automotive associations.
   b) Manufacturer Engagement: Collaborate with EV manufacturers to educate them about the benefits of high-efficiency batteries and incentivize their adoption.
   c) Consumer Workshops: Organize workshops for consumers to showcase the advantages of EVs equipped with high efficiency batteries.
5. Pantographs for EV Charging in Proposed Seashore Highway:
   a) Infrastructure Integration: Include pantograph charging infrastructure in the design and development plans of the proposed seashore highway.
   b) Tourism Promotion: Highlight the convenience of EV travel along the scenic coastline in tourism promotions.
   c) Public-Private Partnerships: Collaborate with private charging infrastructure providers for seamless implementation.
6. Integrated Fuel Station with Water Metro:
   a) Feasibility Study: Conduct a feasibility study to assess the integration of fuel stations with water metro hubs.
   b) Incentives: Provide financial incentives for fuel station owners willing to integrate with water metro facilities.
   c) Promotion: Promote the combined water and road transportation system through marketing campaigns.
7. Supporting MSMEs for EV Development:
   a) MSME Grants: Establish a grant program specifically for MSMEs involved in EV development, offering financial support for R&D and prototyping.
   b) Skill Development: Provide training and skill development programs for MSME employees in EV technology.
   c) Incubation Centres: Set up incubation centres to nurture innovation and collaboration among MSMEs in the EV sector.

   .
8. Green Hydrogen Programme:

   Kerala aims to achieve 30% green hydrogen blending in the total hydrogen usage in the State by 2027, as per draft drawn up for a Kerala green hydrogen policy. To realize this goal, the state should:

   a) Establish a Green Hydrogen Fund to provide low-interest loans and grants for domestic hydrogen fuel cell technology manufacturing.
   b) Offer priority sector lending with favourable interest rates to companies engaged in hydrogen fuel cell production.
   c) Reduce electricity tariffs for green hydrogen producers to encourage production.
   d) Eliminate or reduce import duties and excise duties on equipment and materials for green hydrogen production.

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e) Foster Public-Private Partnerships (PPPs) to develop green hydrogen production facilities and infrastructure.

f) Implement cost-sharing agreements for infrastructure development related to green hydrogen production and distribution.

g) Develop a comprehensive plan for establishing a network of hydrogen fuelling stations, prioritizing strategic locations along transportation.

4.2.2 Strategy #2: Minimum renewable energy integration (60%) for EV charging stations

The adoption of electric vehicles (EVs) is growing rapidly in Kerala, and this trend is expected to continue. As more EVs hit the road, the demand for electricity will increase, which could strain the existing power grid. However, if EV charging stations are powered by solar energy, the additional demand can be met without putting additional pressure on the grid. According to the Ministry of New and Renewable Energy, India had a total installed solar capacity of 41.09 GW as of 31 December 2021. Kerala's electricity generation is heavily dependent on fossil fuels. According to the Central Electricity Authority (CEA), fossil fuels account for 78% of the state's installed capacity as of March 2021. However, solar energy can be a clean and renewable source of power that can help reduce Kerala's dependence on fossil fuels for electricity. As of March 2021, Kerala had an installed solar capacity of 128 MW, which is only a small fraction of its total installed capacity.

According to the Kerala State Electricity Board, the state's peak demand for electricity in 2020-21 was 4,423 MW, while the average power consumption was around 78,000 MU. If we assume that EVs will account for 10% of the total vehicles in Kerala by 2031 and that each EV requires an average of 20 kWh to charge, the total energy demand for EVs will be around 5,040 MU per year. If 60% of this demand is met through solar energy, it would require an additional 3,024 MU of solar energy per year.

In conclusion, implementing a policy mandating solar energy integration of at least 60% for EV charging stations can help Kerala meet the increasing demand for electricity from EVs, reduce its dependency on fossil fuels, and promote clean energy.

The strategy and its implementation are explained below.

Scope Boundary
This policy applies to all existing and future EV charging stations within the state of Kerala, including public, private, and government-owned facilities. It also encompasses EV charging infrastructure deployed in residential, commercial, and industrial areas.
Implementing Agency
• Kerala Transport Department • Kerala State Road Transport Corporation • Kerala State Electricity Board Limited • Agency for New and Renewable Energy Research and Technology (ANERT) • Energy Management Centre (EMC) • Department of Industries • Kerala State Pollution Control Board (KSPCB)

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- Municipal Corporations and Urban Development Authorities

Current Policy/Policies in Place

Kerala's current policy (EV Policy 2019) is limited to planning of e-mobility zones and tariff structures. The state can propose specific mandates for the integration of clean energy sources like solar power.

Implementation Period

Phase 1 (2022-2024): Awareness campaigns and educational programs to inform the public and private stakeholders about the benefits of solar integration with EV charging stations.

Phase 2 (2025-2029): Scaling up the installation of solar energy systems in existing and new public charging stations. Monitoring and reporting mechanisms to track progress towards the 60% solar energy target. Strengthening grid integration capabilities

Phase 3 (2030-2031): Strict enforcement of the policy, including inspections, certification, and penalties for non-compliance. Existing charging stations will be encouraged to retrofit with solar systems.

Energy Saving Potential

Based on assumptions from Table 23, following kW panel requirement was estimated.

Figure 16 kW Panel Required for 60% RE integration till FY2025 & FY 2030

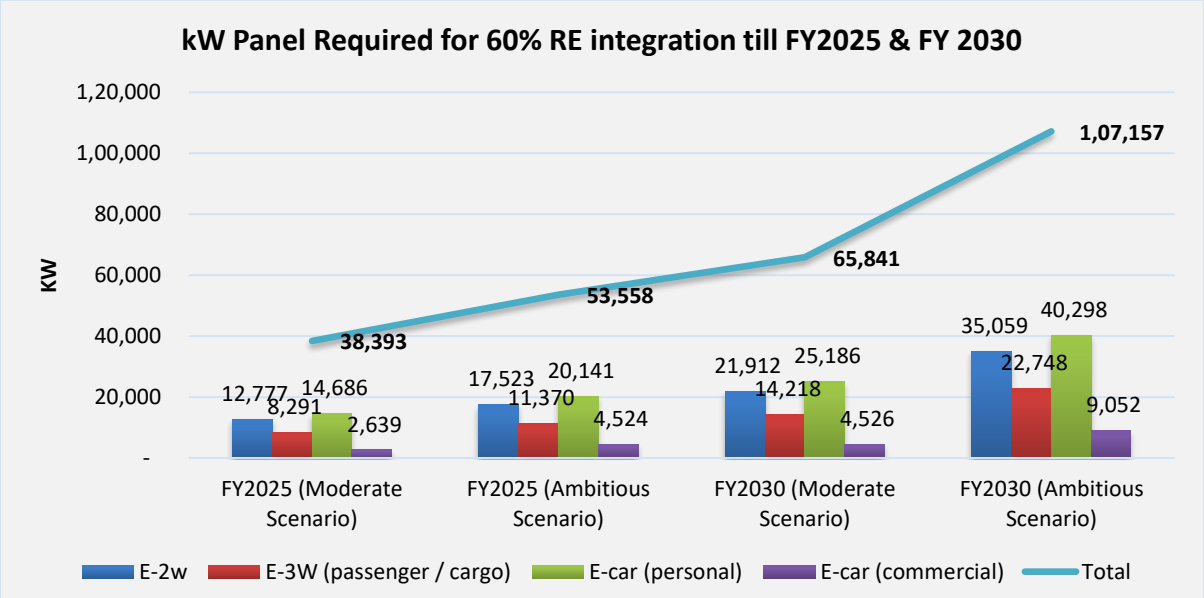

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Table 2: Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.02	0.03	0.04	0.07
GHG Emission Reduction Potential ($MtCO_2$)	0.07	0.10	0.13	0.20

Action Plans

1. **Integration of EV Batteries for Renewable Energy Storage and Grid Balancing**

   Kerala has been actively transitioning towards renewable energy sources, particularly solar power. However, one of the challenges in renewable energy integration is managing the intermittent nature of solar generation. To address this issue and optimize the use of renewable energy, Kerala can encourage the adoption of EVs as energy storage assets.

   a) Implement time-of-the-day (ToD) tariff structures that incentivize EV owners to charge their vehicles during periods of excess RE generation and low electricity demand.

   b) Install grid-connected EV charging infrastructure at strategic locations, such as residential areas, commercial zones, and public spaces. These chargers should be capable of two-way power flow.

   c) Develop a smart charging system that enables bidirectional communication between the grid, charging infrastructure, and EVs. This system should allow for grid operators to signal when to charge or discharge EV batteries based on grid conditions and renewable energy availability.

   d) Education and Outreach: Conduct awareness campaigns and educational programs to inform the public about the benefits of using their EVs as energy storage devices. Highlight the environmental advantages and potential cost savings.

1. **Integration of EV Batteries for Renewable Energy Storage and Grid Balancing:**

   a) Tariff Structure: Work with the state electricity regulatory authority to design ToD tariff structures that offer lower electricity rates during periods of excess renewable energy (RE) generation and high rates during peak demand hours.

   b) Consumer Incentives: Provide financial incentives or discounts on electricity bills for EV owners who opt for ToD tariffs and actively participate in grid-balancing programs.

2. **Grid-Connected EV Charging Infrastructure:**

   a) Strategic Locations: Identify strategic locations for installing grid-connected EV charging infrastructure, including residential areas, commercial zones, public spaces, and near renewable energy generation sites.

   b) Government Support: Allocate budgetary support or subsidies to encourage private and public entities to invest in charging infrastructure deployment.

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c) Public-Private Partnerships (PPPs): Establish PPPs to accelerate the rollout of charging infrastructure, with the government providing land or other incentives to private operators.

3. Smart Charging System:

a) Bidirectional Communication: Develop a sophisticated smart charging system capable of bidirectional communication between EVs, charging infrastructure, and the grid.

b) Dynamic Charging Control: Implement dynamic charging control algorithms that enable grid operators to manage charging and discharging of EV batteries based on real-time grid conditions and renewable energy availability.

c) Data Analytics: Use advanced data analytics to predict renewable energy generation patterns and EV charging behaviours, allowing for proactive grid balancing.

4. Education and Outreach:

a) Awareness Campaigns: Conduct extensive awareness campaigns through various media channels, workshops, and community engagement programs.

b) Public Seminars: Organize seminars and webinars to educate EV owners and the general public about the environmental and cost-saving benefits of using EVs for energy storage.

c) Incentives: Offer incentives such as tax breaks, rebates, or reduced registration fees for EV buyers who commit to participating in grid-balancing programs.

d) Demonstration Projects: Launch pilot projects to showcase the effectiveness of EV battery integration for renewable energy storage and grid balancing.

4.2.3 Strategy #3: Ethanol Blending Programme

The ethanol blending policy of fuels can have a significant impact on the economy and environment of Kerala. By blending ethanol with petrol, the state can reduce its dependence on imported crude oil and promote the use of cleaner fuels. According to the Ministry of Petroleum and Natural Gas, India's ethanol blending program has resulted in a reduction of 7.9 million tonnes of CO2 emissions in 2020-21. The central government has set a target of achieving 20% ethanol blending in petrol and 5% in diesel by 2025, which will create an additional demand of 1,000 crore litres of ethanol.[6] The state can leverage its agricultural resources to promote the production of ethanol and create new job opportunities.

The strategy and its implementation are explained below.

Scope Boundary
Production, distribution, and utilization of ethanol-blended petrol in the transportation sector.
Implementing Agency
• Ministry of Petroleum & Natural Gas • Kerala Transport Department

[6]https://www.niti.gov.in/sites/default/files/2021-06/EthanolBlendingInIndia_compressed.pdf

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- Dept. of Industries

Current Policy/Policies in Place

a) Ministry of Petroleum and Natural Gas published its "National Policy on Biofuels" in 2018. The policy's objective is to reduce the import of petroleum products by fostering domestic biofuel production.

b) Government has introduced blending of ethanol in petrol under the Ethanol Blended Petrol (EBP) Programme with multiple objectives including reducing import dependence, savings in foreign exchange, providing boost to domestic agriculture sector and for associated environmental benefits.

c) The "Roadmap for Ethanol Blending in India 2020-25" lays out an annual plan to increase domestic ethanol production in line with target of the amended National Policy on Biofuels (2018) as well as with its Ethanol Blended Petrol (EBP) Programme to reach a blending of 20% of ethanol in petrol (E20) by 2025/26

Modification Required

Kerala BioFuel policy (KBF) policy for achieving targets.

Implementation Period

Phase 1 (2022-2023): Awareness campaigns and stakeholder consultations to introduce the policy's objectives and targets.

Phase 2 (2024-2026): Develop infrastructure for the storage, transportation, and distribution of ethanol, encourage investment in ethanol production facilities, and progressively increase the ethanol blending ratio.

Phase 3 (2027-2029): Encourage investments in ethanol production with incentives and support for fuel producers and distributors.

Phase 4 (2030-2031): Incentivize the development of advanced ethanol technologies, such as cellulosic ethanol and production of Ethanol from Tapioca.

Energy Saving Potential

The energy-saving potential of the strategy for promoting ethanol-blended petrol is determined by estimating the energy that can be conserved through gradual increases in ethanol blending. In the moderate scenario, by 2026, the state can aim to achieve a 15% ethanol blend in the fuel, and by 2031, this target increases to 20%.

In the ambitious scenario, the state sets higher targets of 20% ethanol blending by 2026 and 25% by 2031.

	FY 2026		FY 2031	
Blending of fuel	Moderate	Ambitious	Moderate	Ambitious
Fuel Blending %age	15%	20%	20%	25%
Already Blending in Fuel%	10%	10%	10%	10%
Incremental Fuel Blending	5%	10%	10%	15%
Energy consumption by petrol vehicles	2.17	2.17	2.61	2.61

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Energy Saved (MTOE)	0.11	0.22	0.26	0.39
Emission Factor for Oil ($kgCO_2$/MTOE)	3.13	3.13	3.13	3.13
Emission Avoided (Mn TCO2)	0.34	0.68	0.82	1.23

Table 3: Ethanol Blending Programme- Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.11	0.22	0.26	0.39
GHG Emission Reduction Potential ($MtCO_2$)	0.34	0.68	0.82	1.23

Action Plans

This section describes several action plans that can be implemented across the transport sector for this strategy.

1. **Easing Storage, Movement, and Permit Norms for Industrial Fuel-Grade Ethanol:**
   a) Establish a dedicated committee to review and simplify regulations related to the storage, transportation, and permits for industrial fuel-grade ethanol.
   b) Conduct awareness programs and training sessions for industries and transporters to educate them about the revised norms and safety protocols.
   c) Collaborate with industry associations to disseminate information and best practices.

2. **Interest Subsidy on Term Loans for Ethanol Production:**
   a) Establish a state-level interest subsidy scheme offering a 7% interest subsidy on term loans for ethanol production.
   b) Cap the subsidy amount to ensure it remains financially attractive for businesses while aligning with any assistance received from the central government.
   c) Create a dedicated online portal for loan application and subsidy disbursement.

3. **Monitoring and Compliance:**
   a) Implement a robust monitoring system to ensure that subsidized loans are used for ethanol production as intended.
   b) Regularly audit and verify compliance with the subsidy scheme's terms and conditions.

4. **Use of Biodiesel and CBG in State Transport Buses:**

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Utilizing biodiesel and Compressed BioGas (CBG) in state transport buses aligns with Kerala's commitment to cleaner energy sources. Promoting bio diesel for internal combustion engines (ICE) can serve as an interim solution. This scheme aids in reducing emissions while phasing out ICE engines.

5. Awareness and Transition Plan:

a) Launch an awareness campaign to inform the public about the shift to cleaner fuels in state transport buses.

b) Develop a phased transition plan to gradually replace conventional fuels with biodiesel and CBG in the state's bus fleet.

6. Methanol for Marine Engine Application:

a) Initiate a pilot program in collaboration with maritime authorities to test the use of methanol in marine engines.

b) Select specific vessels or routes for the pilot to assess the feasibility and emissions reduction potential.

c) Invest in methanol storage and refueling infrastructure in key coastal areas.

d) Collaborate with ports and shipping companies to establish methanol refueling facilities.

4.2.4 Strategy #4: Personal Rapid Transit (PRT) in Tier-2 & Tier-3 Cities

Implementing a policy on Personal Rapid Transit (PRT) in Tier-2 & Tier-3 Cities can significantly contribute to energy efficiency in Kerala. PRT systems consist of small, driverless electric vehicles that run on dedicated tracks, which eliminates the need for large-scale infrastructure and minimizes energy consumption. According to a study by the International Energy Agency, PRT systems can reduce energy consumption by up to 90% compared to traditional modes of transportation.

Kerala has a high population density and is heavily reliant on fossil fuels for transportation, which contributes to air pollution and greenhouse gas emissions. By adopting PRT systems in Tier-2 & Tier-3 Cities, Kerala can reduce its energy consumption and carbon footprint while providing a convenient and sustainable mode of transportation to its residents. Additionally, PRT systems have the potential to increase access to public transportation and reduce traffic congestion, which can lead to further energy savings and environmental benefits.

According to the Ministry of New and Renewable Energy, Kerala has a target of achieving 15% renewable energy generation by 2022. Adopting PRT systems in Tier-2 & Tier-3 Cities can contribute to achieving this target by reducing the demand for fossil fuel-based transportation.

This is particularly important for cities like Kozhikode and Trivandrum, which have high population densities and suffer from traffic congestion and poor air quality.

The strategy and its implementation are explained below.

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Scope Boundary
This policy applies to the cities of Kozhikode and Trivandrum and covers all aspects of planning, construction, operation, and maintenance of the PRT system. It is applicable to government bodies, transit authorities, private sector entities, and others.
Implementing Agency
• Kerala Transport Department • Urban Affairs Department • Department of Town & Country Planning • Private Sector Partners • Dept. of Industries • Energy Management Centre (EMC)
Current Policy/Policies in Place
Kerala does not have specific policies or infrastructure related to Personal Rapid Transit.
Implementation Period
Phase 1 (2022-2023): Public awareness campaigns to inform residents about the new transit options. Phase 2 (2024-2026): Feasibility studies and site selection for PRT systems in Kozhikode and Trivandrum. Exploring funding sources and potential public-private partnerships. Phase 3 (2027-2029): Regulatory framework for the establishment of PRT infrastructure, including the construction of dedicated PRT lanes, stations, and maintenance facilities within Kozhikode and Trivandrum, safety standards. Phase 4 (2030-2031): Commencement of PRT infrastructure construction and installation in both cities. Planning of integration of the PRT system with existing transportation networks.

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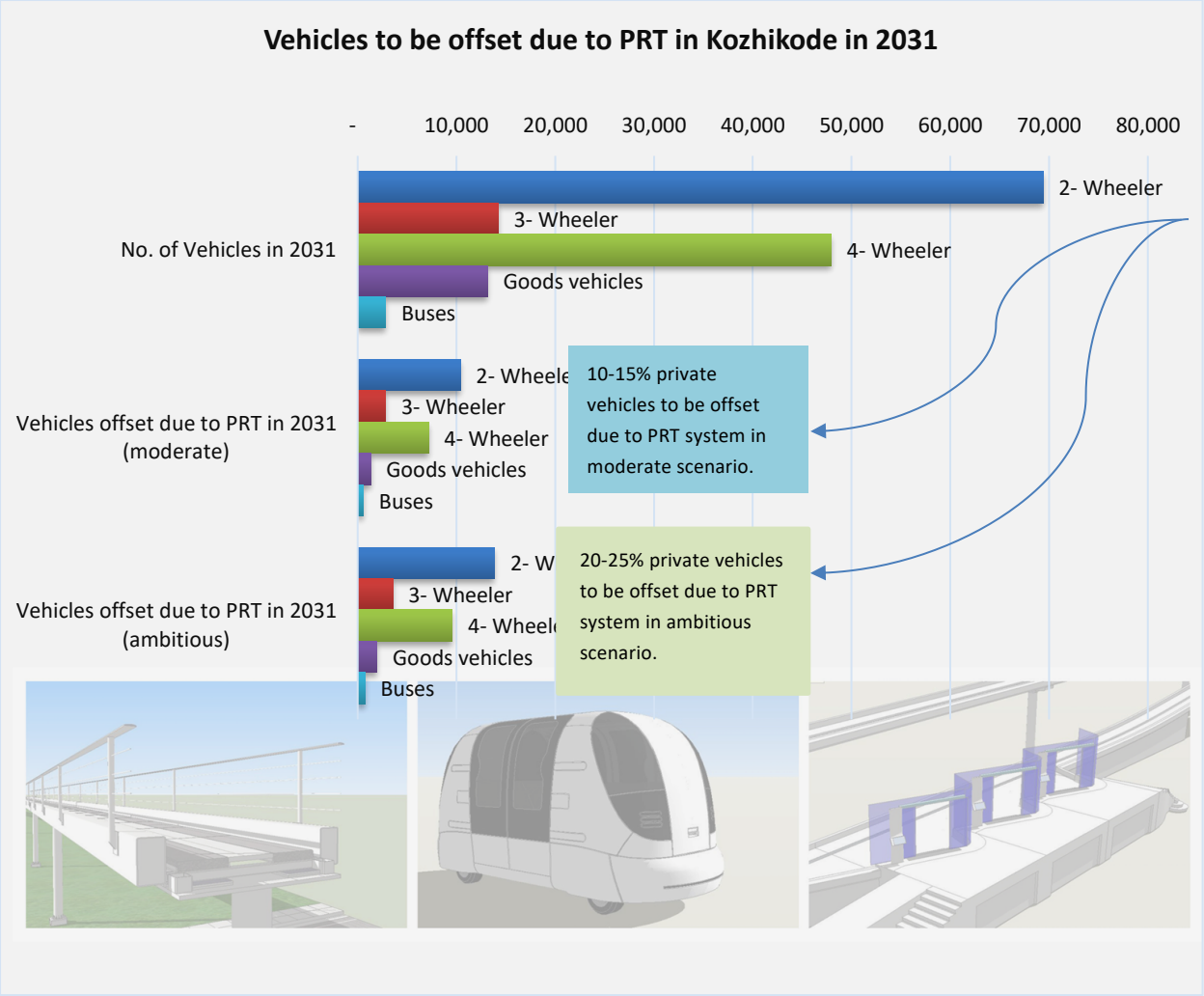
Energy Saving Potential

The calculation for estimating the "energy saving potential" of the Personal Rapid Transit (PRT) Policy for Tier-2 & Tier-3 Cities in Kerala (Kozhikode and Trivandrum) is based on the projected number of vehicles in these cities for the years FY 2026 and FY 2031.

Figure 17 Vehicles to be offset due to PRT in Kozhikode in 2031



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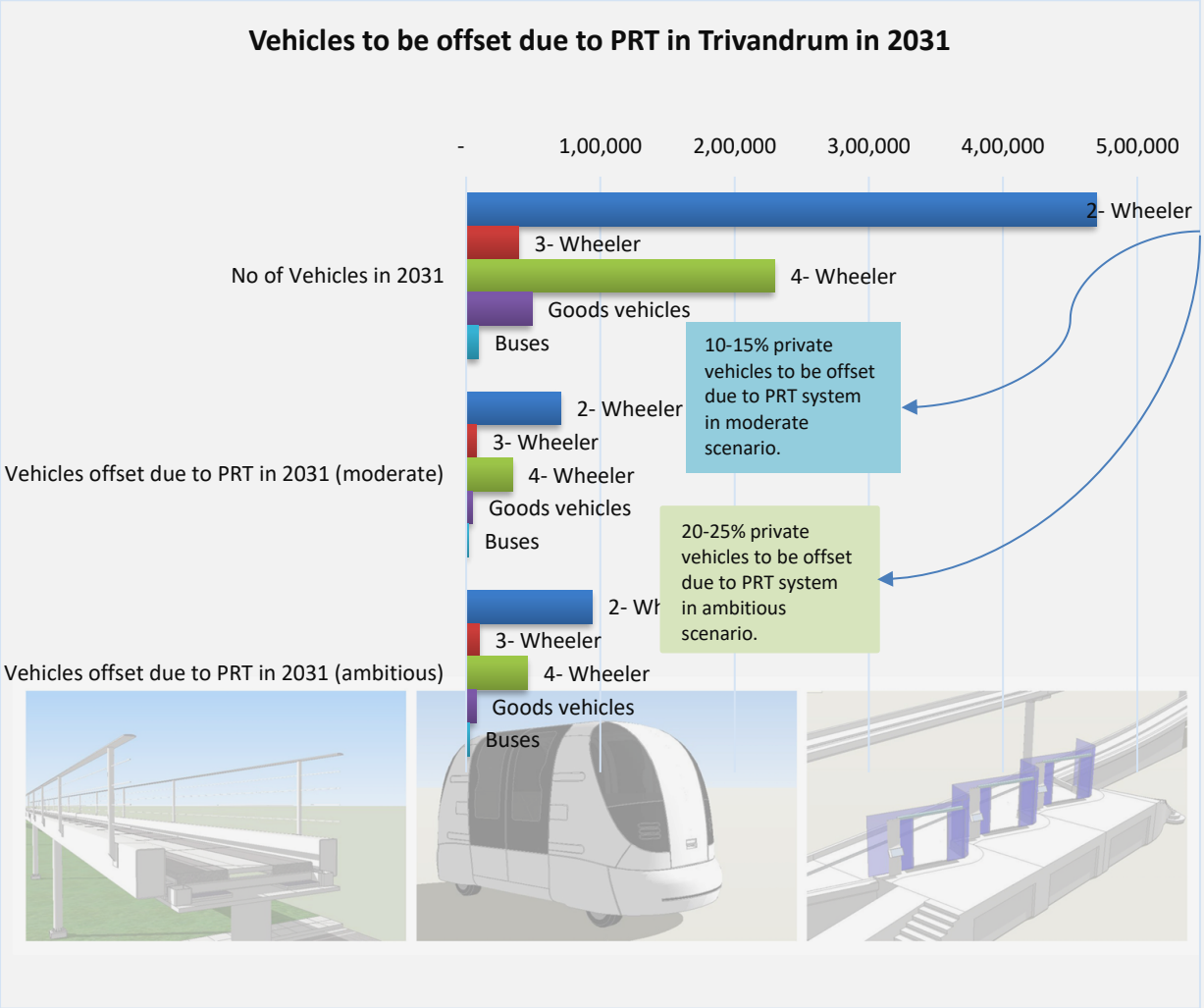
Similarly, total number of vehicles in Trivandrum for FY 2026 and FY 2031 is projected below.

Figure 18 Vehicles to be offset due to PRT in Trivandrum in 2031



Following table consists of percentage of these projected category wise vehicles that will be offset or replaced by the PRT system. This percentage represents the expected mode shift from private vehicles to the PRT system due to its convenience, efficiency, and environmental benefits.

Category of Vehicle	Moderate	Ambitious
2- Wheeler	15%	20%
3- Wheeler	20%	25%
4- Wheeler	15%	20%
Goods vehicles	10%	15%
Buses	20%	25%

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Cumulatively, if Kozhikode and Trivandrum vehicle consumers based on above percentages switch to PRT mode of transport, 0.16 MTOE energy can be conserved under ambitious scenario by FY 2031.

Table 4: Personal Rapid Transit (PRT)- Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.09	0.11	0.12	0.15
GHG Emission Reduction Potential ($MtCO_2$)	0.27	0.35	0.38	0.49

4.2.5 Strategy #5: Inland waterways development for goods and passenger transport

Inland waterways transportation is a highly energy-efficient mode of transport as it requires less fuel than road transport. According to a study conducted by the National Waterway (NW) 3 and 4, the energy consumption per ton-km of inland water transport is about one-tenth that of road transport. This will help in reducing the fuel consumption of the transport sector in Kerala, resulting in significant energy savings.

Inland waterways transportation emits fewer greenhouse gases per tonne-kilometer than road transport. According to a study by the Inland Waterways Authority of India the CO_2 emissions per tonne-kilometer for inland waterways transport are about 50% lower than for road transport. This reduction in emissions can help Kerala meet its climate change goals and contribute to global efforts to reduce greenhouse gas emissions.

Kerala is grappling with narrow and congested roads, especially in urban areas. By shifting goods and passengers to inland waterways, the state can reduce road traffic congestion, leading to shorter travel times, improved road safety, and lower fuel consumption. This can also help in reducing the maintenance costs of roads, as they will experience less wear and tear. The development of inland waterways in Kerala is primarily driven by the State Water Transport Department (SWTD), Coastal Shipping and Inland Navigation Department (CSIND), and Kerala Shipping and Inland Navigation Corporation (KSINC). These agencies play significant roles in advancing the infrastructure and operations of inland water transportation systems in the region.

The Inland Waterways Development policy for Kerala aims to harness the state's unique geography to provide an eco-friendly, efficient, and sustainable transportation system. Leveraging its abundant water resources, this policy seeks to promote waterborne transport as a viable alternative to road and rail transport, reducing congestion, cutting carbon emissions, and boosting economic activity.

The strategy and its implementation are explained below.

Scope Boundary
This policy covers all aspects of inland waterway development, including infrastructure, safety, environmental standards among others.
Implementing Agency

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- Coastal Shipping and Inland Navigation Department (CSIND)
- Kerala Shipping and Inland Navigation Corporation Ltd. (KSINC)
- Kerala Waterways and Infrastructures Ltd. (KWIL)

Current Policy/Policies in Place

The existing policies may primarily focus on road and rail transport. The state needs a comprehensive in addressing inland waterway development for goods and passenger transport.

Implementation Period[7]

Phase 1 (2022-2024):

- Constitute State Maritime Board: The State Maritime Board will be established, and its initial functions, responsibilities, and leadership will be defined during this phase.
- Identify potential funding sources for major projects under the Kerala Infrastructure Investment Fund Board (KIIFB). Begin discussions with potential public-private partnership (PPP) investors.
- Commence feasibility studies and site assessments for inland waterway development, ensuring that these studies align with environmental and safety standards.
- Initiate programs to incentivize cargo and passenger movement through water transport modes, including discussions on tax benefits and reduced tariffs.

Phase 2 (2025-2028):

- Integration of Coastal Shipping with IWT systems to improve connectivity.
- Infrastructure Development and expansion of water channels, terminals, jetties, and other necessary facilities.
- Establish comprehensive regulatory frameworks and safety standards to ensure compliance and safety in waterway operations.
- Explore VGF schemes for PPP projects to ensure their financial viability and successful operation.

Phase 3 (2029-2031):

- Operationalization of key inland waterway routes for both goods and passenger transport.
- Implement and enforce mandatory waterway use for specified cargo, particularly hazardous and bulk cargo.

Saving Potential

The "energy saving potential" of the Inland Waterways Development Policy is calculated based on the projected number of goods vehicles and heavy vehicles for the years 2026 and 2031 through road transport.

[7] Based on Kerala State Planning Board Fourteenth Five-Year Plan (2022-2027)

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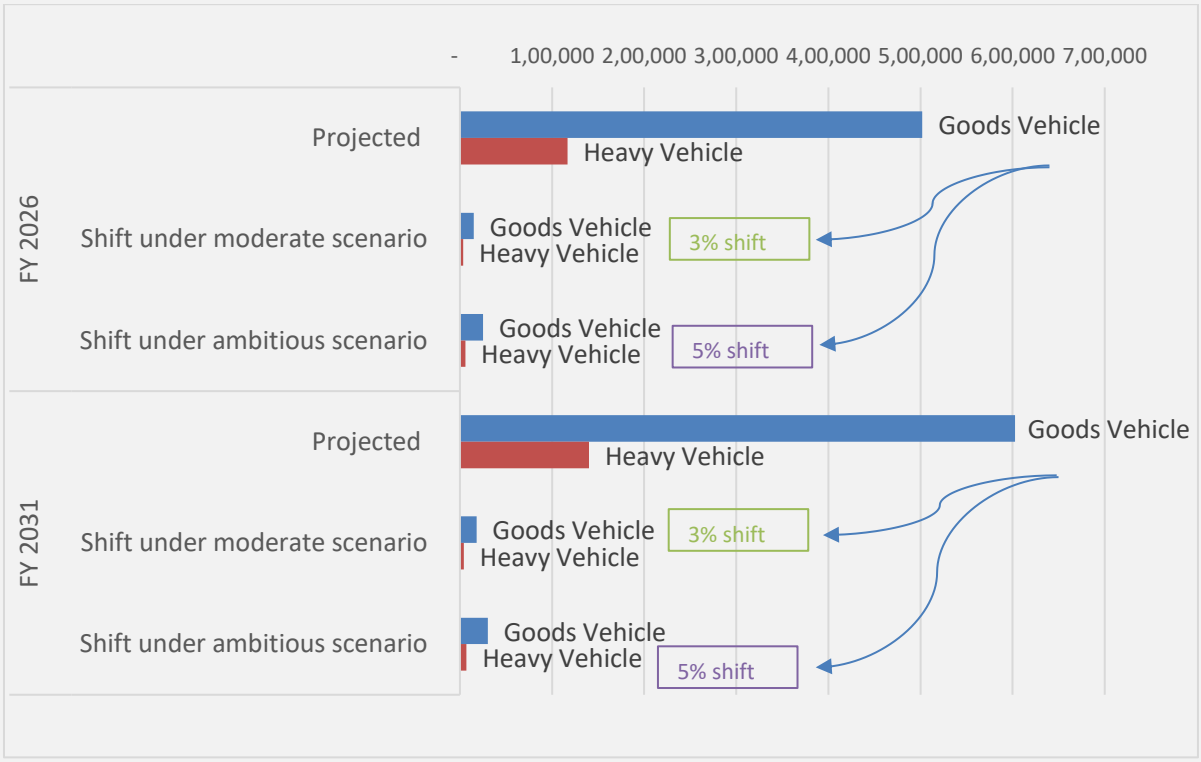
Figure 19 Diesel Goods and Heavy Transfer Vehicles Projection in FY 2026 & FY 2031



Considering that 3% in the moderate scenario and 5% in the ambitious scenario goods will be shifted from road transportation to water transportation due to the implementation of the Inland Waterways Development Policy, following savings can be achieved.

Table 5: Inland waterways development- Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.06	0.08	0.15	0.25
GHG Emission Reduction Potential ($MtCO_2$)	0.19	0.26	0.47	0.78

Action Plans

This section describes several action plans that can be implemented across the transport sector for this strategy.

1. **Financial Incentives for Inland Waterway Transport:**
   a) Offer tax breaks and exemptions on key areas such as vessel purchases, fuel consumption, and infrastructure development related to inland waterway transport.
   b) Provide subsidies or reduced taxes on fuels specifically used for inland waterway transport, such as marine diesel.

2. **Infrastructure Support:**

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a) Capital Grants: Establish a grant program to provide financial support to transport operators for the setup and maintenance of inland waterway infrastructure. This can include docks, jetties, and other necessary facilities.

b) Low-Interest Loans: Offer low-interest loans or credit facilities for transport operators looking to invest in or expand their inland waterway transport operations.

3. Performance-Based Incentives:

Incentive Programs: Create incentive programs that reward transport operators for achieving specific milestones related to safety, efficiency, and environmental sustainability.

4. Awareness and Training:

a) Training Programs: Develop training programs for transport operators and crew members to enhance their skills and knowledge in operating vessels for inland waterway transport.

b) Awareness Campaigns: Launch public awareness campaigns to educate businesses and consumers about the benefits of inland waterway transport, such as reduced congestion and emissions.

5. Regulations and Standards for Inland Waterway Transport:

a) Vessel Safety Standards: Establish safety regulations that govern vessel design, construction, and maintenance to ensure safe operations on inland waterways.

b) Crew Certification: Require mandatory certification and training for crew members operating vessels on inland waterways.

c) Emissions Reduction: Set emissions standards for vessels and engines used in inland waterway transport to minimize air pollution.

d) Water Quality Protection: Implement regulations to prevent pollution of inland waterways through strict discharge controls and waste management.

6. Operational Guidelines:

a) Traffic Management: Develop traffic management guidelines to avoid congestion and ensure efficient use of waterways.

b) Navigation Aids: Install navigation aids such as buoys and signage to enhance the safety of vessels navigating inland waterways.

7. Monitoring and Enforcement:

a) Regulatory Authorities: Establish a regulatory authority responsible for monitoring compliance with safety and environmental regulations.

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b) Penalties: Enforce penalties for non-compliance with regulations to deter violations and maintain a high standard of safety and environmental protection.

4.3 Energy saving potential of the sector & monitoring mechanism

Energy saving potential of the transport sector is 1.13 MTOE and 1.7 MTOE for moderate and ambitious scenarios FYFY 2030 respectively as seen from Table 10.

Table 6 Transport sector- Summary of energy saving potential

Strategies	*Energy Saving Potential in 2031 (MTOE)*	
	Moderate	Ambitious
1. *Electrification of vehicles*	0.56	0.84
2. *Minimum renewable energy integration (60%) for EV charging stations*	0.04	0.07
3. *Ethanol Blending*	0.26	0.39
4. *Personal Rapid Transit (PRT) in Tier-2 & Tier-3 Cities*	0.12	0.16
5. *Inland waterways development for goods and passenger transport*	0.15	0.25
Total	1.13	1.7
Emission Reduction Potential (mTCO2)	3.53	5.3

Following are the monitoring mechanisms that could be implemented to track the progress and effectiveness of the policies in the transport sector in Kerala state:

Particulars	Monitoring Mechanism
Data Collection	Regular data collection and analysis can help track progress towards these targets and indicators. The state government can collect data on the number of electric vehicles on the road, the amount of fuel consumed, and the usage of public transportation. This data can be

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	analysed to assess the effectiveness of policies and identify areas where improvements can be made.
Reporting	The state government can publicly report on progress towards climate change targets and indicators. This can be done through annual reports or other public documents. By making this information public, the government can increase accountability and transparency, and encourage public engagement and participation.
Stakeholder engagement	Engaging with stakeholders, including industry, civil society, and the public, can help ensure that policies are effective, and that progress is being made. The state government can establish stakeholder groups or committees to provide feedback on policies, identify potential challenges, and suggest improvements.
Technology Assessment	Regularly assessing emerging transport technologies and their potential impact on greenhouse gas emissions can help inform policy decisions and ensure that policies remain up to date with the latest developments.

INDUSTRY SECTOR

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5 FOCUS SECTOR 2: INDUSTRY

5.1 Overview

As per the DIC dashboard of Kerala, 238 large scale industries (investment in plant and machinery or equipment is more than ₹50 crore and annual turnover is more than ₹250 crore) registered within the state; out of which 162 are from the manufacturing sector and 72 are from the service sector. The Table 7 shows the district wise number of large-scale industries in Kerala[8].

Table 7: District wise number of Large-scale industries in Kerala

Sr. No.	District	Manufacture	Service	Total
1	Thiruvananthapuram	4	12	16
2	Kollam	7	12	19
3	Pathanamthitta	26	19	45
4	Alappuzha	6	2	8
5	Kottayam	9	2	11
6	Idukki	4	2	6
7	Ernakulam	69	11	80
8	Trissur	9	12	21
9	Palakkad	11	2	13
10	Malappuram	12	7	19
11	Kozhikode	3	7	10
12	Wayanad	2	3	5
13	Kannur	2	1	3
14	Kasaragod	1	1	2
	Total	166	72	238

[8] https://schemes.industry.kerala.gov.in/public/index.php/public_dashboard

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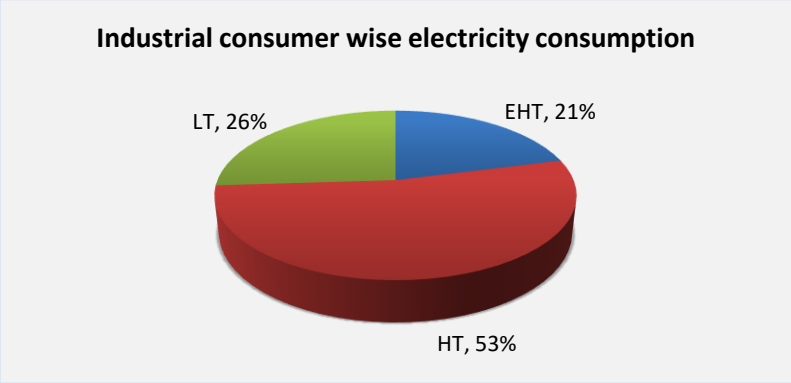
In 2019-20, the electricity consumption of large-scale industries under the EHT category is found to decrease by 18% when compared with 2018-19 data and the reason can be attributed to the impact of flood 2019 and Covid-19 in the last quarter of the year. The consumer wise electricity consumption of Industries in Kerala is given in below.

Figure 20 Industrial Consumer Electricity Consumption

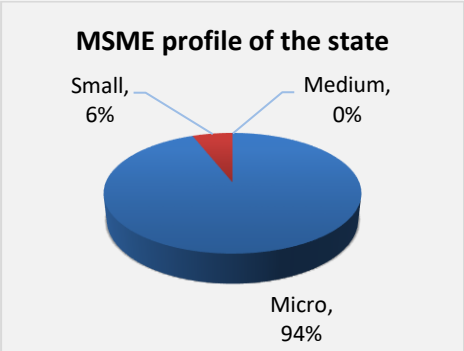


The industrial sector of Kerala was showing a decreased trend in energy consumption (-1.06 %) for the period FY 2016 and FY 2020. The average reduction in SEC of Designated Consumers in Kerala achieved through PAT cycle -1 and 2 was 2.65%. As Kerala made energy audits mandatory for all EHT/ HT consumers, it is recommended to introduce state level energy reduction targets and the estimated potential is 10%.

MSMEs

Micro, Small and Medium Enterprises (MSMEs) is the most important sector of the Indian economy, providing the largest number of employment opportunities after agriculture, with a relatively low level of capital per employee. The sector contributes about 45 per cent to India's manufacturing output and creates employment for about 11.1 crore people[9].

Kerala has a relatively high share of MSMEs in the country and the economic growth of the state is also related to the development of MSMEs. As per the DIC Dashboard, 150728 MSME units are registered in Kerala, out of which 142013 are in the micro sector, 8419 are in the small-scale sector and 296 are in the medium scale sector[10]. MSME Profile of Kerala is shown in the graph.



Micro Industries of Kerala has a massive contribution of 94% in terms of MSME numbers, while the medium scale industries contribution is less than 1%.

According to the Directorate of Industries and Commerce, 13,826 new MSME units were started in Kerala in 2018-19 with a total investment of ₹1,321.94 crores, and generated employment for

[9]https://msme.gov.in/sites/default/files/Accelerating%20Manufacturing%20in%20the%20MSME%20Sector_0.pdf

[10] https://schemes.industry.kerala.gov.in/public/index.php/public_dashboard

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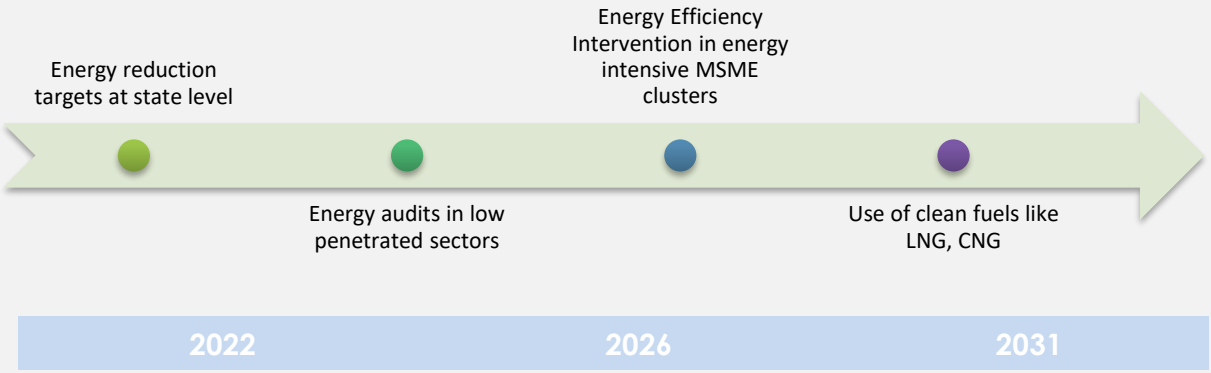
49,068 persons. In 2019-20, 13,695 new MSME units were started with an investment of ₹1,338.65 crores and generated employment for 46,081 persons.

Most of the SMEs in Kerala fall under the industrial LT category and the electricity consumption in 2019-20 of the above categories is 1085 MU. A small decrease in consumption is seen when compared to the 2018-19 level due to flood-19 in Kerala.

The EE penetration in the MSME sector is low and the energy efficiency interventions have a larger scope in that sector. The energy saving opportunities in MSME sector shows an average reduction potential of 13%.

5.2 Energy efficiency strategies in the industry sector

Some strategies that can be adopted to reduce the energy footprint of the industrial sector of Kerala are depicted below.



The policy aspects required at the state level for strategic actions in industrial sector is discussed in below chapters.

5.2.1 Strategy #1: State level Energy Reduction Targets – Identify, Implement & Verify scheme (IIV scheme)

In Kerala, the industrial sector is one of the major consumers of electricity, with high-tension (HT) and extra-high-tension (EHT) consumers accounting for a significant proportion of energy consumption. Therefore, policies targeting energy efficiency in this sector have the potential to have a significant impact on overall energy consumption in the state.

Kerala has mandated energy audits for all HT/ EHT consumers, which was a very good initiative to improve the energy efficiency of the sector. This scheme can be expanded further like a state level PAT scheme by introducing energy reduction targets for HT/ EHT consumers. An Identify, Implement and Verify (IIV) scheme can be introduced and penalties should be given to those who fails to comply.

The strategy and its implementation are explained below.

Scope Boundary
This policy is applicable to all High Tension (HT) and Extra High Tension (EHT) consumers in the state of Kerala, encompassing industrial and commercial establishments, except for industries covered under BEE's PAT scheme.

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Implementing Agency

- Department of Industries
- Kerala State Electricity Regulatory Commission (KSERC)
- Energy Management Centre, Kerala (EMC)

Current Policy/Policies in Place

Kerala has already mandated energy audits for HT and EHT consumers, which serves as a foundation for the proposed scheme. The current policy requires consumers to conduct energy audits periodically, contributing to improved energy efficiency. The state currently should include a comprehensive system of energy reduction targets, incentives, and penalties.

Implementation Period

Phase 1 (2022-2024):

- Identification of sector-specific benchmarks and energy reduction targets.
- Development of reporting and verification procedures.

Phase 2 (2025-2028):

- Implementation of energy reduction targets and initiation of energy-saving measures by HT and EHT consumers.
- Ongoing monitoring and verification of energy consumption data.

Phase 3 (2029-2031):

Full-scale implementation of the "IIV Scheme" with penalties for non-compliant consumers.

Energy Saving Potential

The methodology used to determine the potential energy savings in HT/EHT consumers is based on the electric consumption data from the entire industry sector in Kerala.

In a moderate scenario, it is estimated that there is a potential energy reduction of approximately 4% of the total energy consumption in the HT/EHT sector. In ambitious scenario, the potential energy reduction increases to approximately 7%[11] of the total energy consumption in the HT/EHT sector. This scenario considers a more proactive approach and assumes the implementation of additional energy-saving measures and technologies.

Table 8: Identify, Implement & Verify scheme (IIV scheme)- Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.08	0.09	0.16	0.20
GHG Emission Reduction Potential ($MtCO_2$)	0.24	0.29	0.50	0.63

[11] The percentages for energy saving potential have been derived from the extensive audit expertise of the Confederation of Indian Industry (CII)

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Action Plans

This section describes several action plans that can be implemented across the industry sector for this strategy. For each of the strategies, a short-, medium-, and long-term period has been taken into consideration for actionable instruments.

1. Identify, Implement and Verify (IIV) scheme:

Identify, Implement and Verify (IIV) scheme	
Timeframe: Long Term	

Introduction:
The "Identify, Implement, and Verify (IIV)" scheme can be designed to further enhance energy efficiency in industries across Kerala. Building upon the successful energy audit mandate for High Tension (HT) and Extra High Tension (EHT) consumers, this scheme aims to expand energy reduction targets and promote the implementation of energy efficiency technologies. Non-compliance with the scheme should in penalties to ensure active participation and adherence to energy efficiency practices.

Energy Reduction Targets:
1) Implementation Scope: The IIV scheme will apply to all HT and EHT consumers in the industrial sector in Kerala. These consumers will be categorized into appropriate sectors based on their energy consumption patterns and industry types. 2) Energy Reduction Targets: Each categorized sector will be assigned energy reduction targets based on their historical energy consumption levels. These targets will be set in consultation with relevant industry associations, experts, and government agencies.

Components:
Identify Phase: a. Energy Audit Compliance: All HT and EHT consumers will be required to conduct regular energy audits as mandated by existing regulations. Compliance with energy audits will be monitored and enforced strictly. b. Technology Assessment: Consumers failing to achieve specified energy reduction targets in previous cycles will be required to undergo a comprehensive technology assessment. This assessment will identify potential energy efficiency technologies and practices suitable for their industry. Implement Phase: a. Implementation Plans: Consumers failing to meet energy reduction targets will be required to develop and submit an implementation plan outlining the energy efficiency technologies and measures they intend to adopt. The plan should include a timeline, estimated energy savings, and cost-benefit analysis. b. Financial Assistance: The government will offer financial assistance programs, incentives, and grants to support the implementation of energy efficiency technologies. These programs

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will be designed to encourage and facilitate the adoption of cost-effective energy-saving measures.

Verify Phase:

a. Performance Monitoring: Consumers implementing energy efficiency technologies will undergo regular performance monitoring to assess the effectiveness of their measures in achieving the set energy reduction targets.

b. Verification Audits: Independent third-party audits will be conducted periodically to verify the reported energy savings and assess the overall compliance of consumers with the IIV scheme. The audits will ensure transparency, accuracy, and reliability of the reported energy savings.

Penalties for Non-Compliance:

a. Non-compliance penalties will be imposed on HT and EHT consumers failing to comply with the IIV scheme, including not conducting energy audits, not meeting energy reduction targets, or not implementing proposed energy efficiency technologies.

b. Penalty amounts will be proportionate to the extent of non-compliance and may include financial penalties, reduction in benefits, or other suitable penalties as determined by the regulatory authority.

c. Penalties collected will be utilized for further promoting energy efficiency initiatives and providing additional support to compliant consumers.

Awareness and Capacity Building:

a. The government will conduct awareness campaigns and capacity-building programs to educate HT and EHT consumers about the benefits of energy efficiency technologies, the IIV scheme, and the penalties associated with non-compliance.

b. Training programs and workshops will be organized to enhance the technical knowledge and skills of consumers in implementing energy efficiency measures.

2. Biomass Resources for Industrial Energy Efficiency:

   a) Installation Subsidies: Offer subsidies covering a percentage of the installation costs for industries that invest in biomass-based absorption chillers and evaporative cooling technologies.

   b) Capacity Building: Establish training programs and workshops for industries to educate them on the design, installation, and maintenance of biomass-based cooling systems.

   c) Technical Assistance: Set up dedicated technical support centers or helplines where industries can seek guidance and assistance in implementing and troubleshooting biomass-based cooling systems.

   d) Feasibility Studies: Conduct comprehensive feasibility studies to assess the suitability of different biomass resources, including agricultural residues, forest biomass, and organic waste, for cooling system applications in various industrial sectors.

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e) Success Stories: Share case studies and success stories from industries that have successfully adopted biomass-based cooling, highlighting the economic and environmental advantages.

3. Transition from Furnace Oil (FO) to LNG for Industrial Boilers:

Collaborate with industries to facilitate the transition from FO to cleaner and more efficient liquefied natural gas (LNG) for industrial boilers by offering technical assistance, financial incentives, and guidance on fuel switch planning.

4. Green Incentives for Better Performing Industries:

Establish a performance-based incentive program that rewards industries for achieving higher energy efficiency and environmental sustainability standards.

5.2.2 Strategy #2: Energy Efficiency Intervention in Energy Intensive MSME Clusters

The Micro, Small, and Medium Enterprises (MSME) sector in Kerala is a significant contributor to the state's economy. In the past five years from 2017-18 to 2021-2022, the majority of MSME units, more than 85%, have been concentrated in the top five subsectors. Among these, Agro and food-based units account for 28%, and Service Activities contribute 27%, making them the dominant segments within the MSME sector.

The major energy intensive MSME clusters in Kerala are engaged in various manufacturing activities such as textiles, chemical production, electronics manufacturing, metal fabrication, food processing, and packaging. For instance, the Kinfra Apparel Park in Trivandrum, Kalamassery Industrial Estate in Ernakulam, and the Cochin Special Economic Zone in Kochi are large clusters that house several MSMEs engaged in energy-intensive activities.

The adoption of energy audits within the MSME sector is relatively lower, indicating substantial room for improvement. Offering incentives to MSMEs for conducting energy audits could significantly enhance the uptake of energy-efficient technologies in this sector. Initially, priority can be given to MSME clusters where the potential for sampling and replication is more substantial. Notable MSME clusters in Kerala include the Dairy cluster, the Seafood cluster in Kochi, the Rice Mill cluster in Kalady, and the Plywood cluster in Perumbavoor.

The strategy and its implementation are explained below.

Scope Boundary
MSME clusters like dairy, seafood, rice mill cluster, plywood cluster & other Energy intensive MSMEs.
Implementing Agency
• Department of Industries • Kerala State Industrial Development Corporation (KSIDC) • Kerala Financial Corporation (KFC) • Energy Management Centre, Kerala (EMC)

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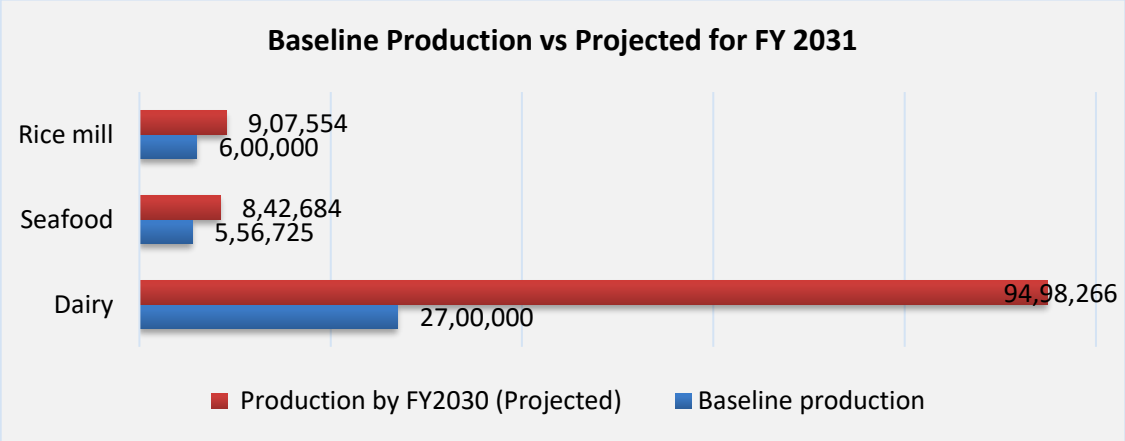
Current Policy/Policies In Place
The state already mandates energy audit for all HT/ EHT consumers. Modification Required: Inclusion of energy intensive MSMEs in the policy
Implementation Period
Phase 1 (2022-2024): • Conducting initial energy audits within designated clusters to assess baseline energy consumption and identify potential areas for improvement. Phase 2 (2025-2028): • Collaborating with stakeholders to develop and implement energy efficiency measures like technology upgrades, process optimization, and workforce training. • Providing financial support and incentives to MSMEs within the designated clusters to facilitate the adoption of energy-efficient practices. Phase 3 (2029-2031): • Evaluation of the policy's impact on energy consumption, cost reduction, and environmental improvement. • Adjusting and fine-tuning the policy based on results and emerging energy-efficient technologies and practices.

The graph below shows the production of rill mill, seafood and dairy cluster in the state of Kerala.

Figure 21 Baseline Production vs Projected for 2031[12]



Specific Energy Consumption (SEC) is the amount of energy consumed per unit of production The graph below shows the Specific Energy Consumption (SEC) of rill mill, seafood and dairy cluster in the state of Kerala, estimated based on the ratio of energy consumption of the sector and production mentioned above.

[12] 1. Dairy Production 2021 2. Seafood Production 2021 3. Rice Production 2021

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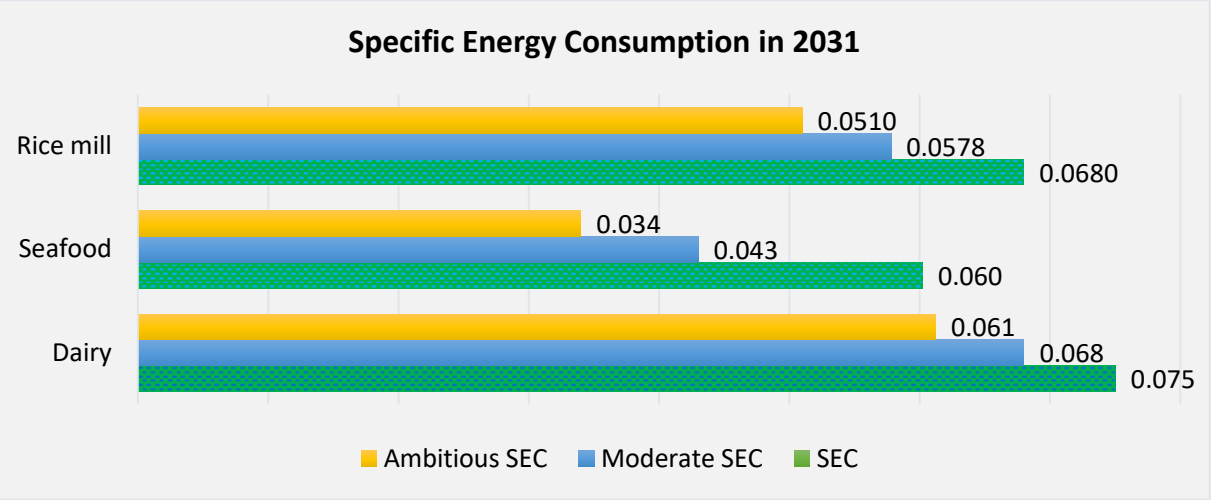
Figure 22 Specific Energy Consumption



Energy efficiency technologies that can be applied to these sectors:

Rill Mill	• Solar dryer • Energy-efficient milling machines • LED Lighting • Implementation of IOT
Sea food	• Blast chillers and freezers • Adoption of Thermal Storage Systems • Energy-efficient water pumping • Heat recovery systems
Dairy	• Energy Efficient Chiller with VFD • Efficient CIP (cleaning-in-place) systems • Anaerobic digestion • Implementation of IOT • Ester oil transformers

Energy Saving Potential

It is estimated that by 2031, under the moderate scenario, the implementation of various energy-efficient technologies and practices will lead to a 15% reduction in SEC. In the ambitious scenario, it is projected that the technological interventions will result in a more substantial reduction in SEC. By 2031, the expected savings in this scenario are estimated to be 25%. The following table shows the energy saving potential is estimated by comparing the baseline SEC to the projected SEC in both moderate and ambitious scenarios.

Table 9: Energy Efficiency Intervention in energy intensive MSME clusters- Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.03	0.04	0.06	0.15

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GHG Emission Reduction Potential ($MtCO_2$)	0.10	0.14	0.19	0.5

Action Plans

This section describes several action plans that can be implemented across the industry sector for this strategy:

1. **Energy Audit Subsidy Scheme (EASS)**

Energy Audit Subsidy Scheme (EASS)	
Timeframe: Long Term	

Introduction:

The Energy Audit Subsidy Scheme (EASS) can be an initiative designed to incentivize energy audits in Micro, Small, and Medium Enterprises (MSMEs) in Kerala. The scheme should aim to increase the penetration of energy audits and promote the adoption of energy-efficient technologies in MSMEs. The Energy Management Centre (EMC) Kerala will allocate funds in each budget specifically for this activity.

Subsidy for Energy Audits:

. MSMEs will be eligible for subsidies to conduct energy audits in their facilities. The subsidies will cover a percentage of the total cost of the energy audit, including consultancy fees, instrumentation, and data analysis.

b. The subsidy rates will be determined by the EMC Kerala and communicated to the eligible MSMEs.

Fund Allocation and Target Utilization:

a. The EMC Kerala will allocate funds in each budget specifically for the Energy Audit Subsidy Scheme (EASS).

b. A minimum target for fund utilization or the number of energy audits will be set to ensure the efficient utilization of the scheme and maximize the coverage of MSMEs.

c. Regular monitoring and evaluation will be conducted to track the utilization of funds and the progress of the scheme.

MSME Clusters:

a. Initially, priority will be given to MSME clusters where sampling is possible and replication potential is higher. Some major MSME clusters in Kerala include the Dairy cluster, Seafood cluster in Kochi, Rice mill cluster in Kalady, and Plywood cluster in Perumbavoor.

b. The scheme will target MSMEs within these clusters to encourage comprehensive energy audits and facilitate the implementation of energy efficiency measures.

Application Process:

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a. MSMEs interested in availing subsidies for energy audits under the EASS shall submit an application to the EMC Kerala.

b. The application shall include relevant information about the MSME, such as the nature of the business, energy consumption data, and the estimated cost of the energy audit.

Evaluation and Approval:

a. The EMC Kerala will evaluate the applications based on predefined criteria, such as the potential for energy savings, the existing energy efficiency measures, and the feasibility of conducting the energy audit.

b. Approved MSMEs will be notified and provided with the necessary instructions to proceed with the energy audit.

Subsidy Disbursement:

a. Upon completion of the energy audit, the MSMEs will submit the audit report and related documentation to the EMC Kerala.

b. The approved subsidy amount will be disbursed to the MSMEs based on the eligible expenses incurred during the energy audit.

Public Awareness and Capacity Building:

a. The EMC Kerala, in collaboration with industry associations and other stakeholders, can conduct awareness programs and capacity-building initiatives to educate MSMEs about the importance of energy audits and the benefits of energy efficiency.

b. Training sessions, workshops, and informational materials can be provided to assist MSMEs in understanding the energy audit process and implementing energy-saving measures.

2. Promotion of Green Rating of Industries:

A) Case of Rajasthan State Pollution Control Board (RSPCB)[13]

RSPCB launched the 'Green rating scheme for Industries in Rajasthan', on 7th July 2021. The program is aimed at enhancing and motivating the environmental performance of companies in Rajasthan, thereby enabling them to compete globally, in addition to achieving resource conservation and cost benefits. To ensure maximum participation of the industries in the scheme and to provide financial and other benefit to the green rated industries, the State Board has decided to provide the following incentives and recognition to the Green Rated industrial units:

Rating Category	Reduction in consent fee
Platinum	50%
Gold	25%

[13]https://environment.rajasthan.gov.in/content/environment/en/rajasthan-state-pollution-control-board/GreenRatingScheme.html

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Silver	10%
Bronze	5%
Certified	-

Implementing a green rating system that evaluates these parameters and promotes sustainable practices in the industrial sector can contribute to improving energy efficiency and sustainability in Kerala. By incentivizing and recognizing industries that adopt environmentally friendly practices, the state can foster a culture of sustainability and promote the adoption of greener technologies and practices.

3. **Workshops on Technology Interventions:**

   Organize workshops focused on technology interventions for energy conservation in food processing units and manufacturing sectors to educate MSMEs on the latest energy-efficient practices and technologies.

4. **Technical Assistance:**

   Provide technical assistance to help MSMEs transition from inefficient to efficient motors, upgrade their technology in boilers, and implement other Energy Conservation Measures (ECMs).

5. **Demonstration Projects:**

   Implement demonstration projects showcasing the latest Energy Efficiency Technologies within SME clusters to encourage MSMEs to adopt these innovations.

6. **Standardized Energy Audits:**

7. Conduct periodic standardized energy audits for MSMEs based on their load and reimburse the cost of these energy audits up to a maximum cap.

8. **Capacity Building:**

   Organize capacity building and technical training programs that offer BEE Energy Auditor Courses to train local experts within the state in energy efficiency practices.

9. **ISO 50001 Implementation:**

   Issue directives for the implementation of ISO 50001, Energy Management Systems, in organizations based on their load, promoting a standardized approach to energy efficiency.

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5.3 Energy saving potential of the sector & monitoring mechanism

Energy saving potential of the industry sector is 0.14 MTOE and 0.3 MTOE for moderate and ambitious scenarios FY 2031 respectively as seen from Table 10.

Table 10 Industry sector- Summary of energy saving potential

Strategies	*Energy Saving Potential in 2031 (MTOE)*	
	Moderate	Ambitious
1. *State level Energy Reduction Targets – Identify, Implement & Verify scheme (IIV scheme)*	0.16	0.20
2. *Energy Efficiency Intervention in energy intensive MSME clusters*	0.06	0.15
Total	0.23	0.36
Emission Reduction Potential (mTCO2)	0.71	1.11

Following are the possible monitoring mechanisms for strategies in industry sector.

Particulars	Monitoring Mechanism
Regulatory	The State Electricity Regulatory Commission is responsible for regulating the power sector in the state, including the implementation of energy policies for industries. They can monitor compliance with these policies through inspections, audits, and other enforcement measures.
Industry associations	Industry associations can play a key role in monitoring energy policies for their members.
SDA (State Designated Agency)	The SDA can monitor industry compliance with energy policies through data collection and analysis, as well as through partnerships with industry associations and other stakeholders.
Audits	Energy audits can be conducted by independent third-party providers to assess the energy consumption and efficiency of industrial facilities. These audits can help identify areas for improvement and track progress towards energy policy goals.
Reporting	Mandatory reporting requirements or through voluntary reporting programs that incentivize companies to disclose their energy use and emissions data.

BUILDING SECTOR

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6 FOCUS SECTOR 3: BUILDINGS

6.1 Overview

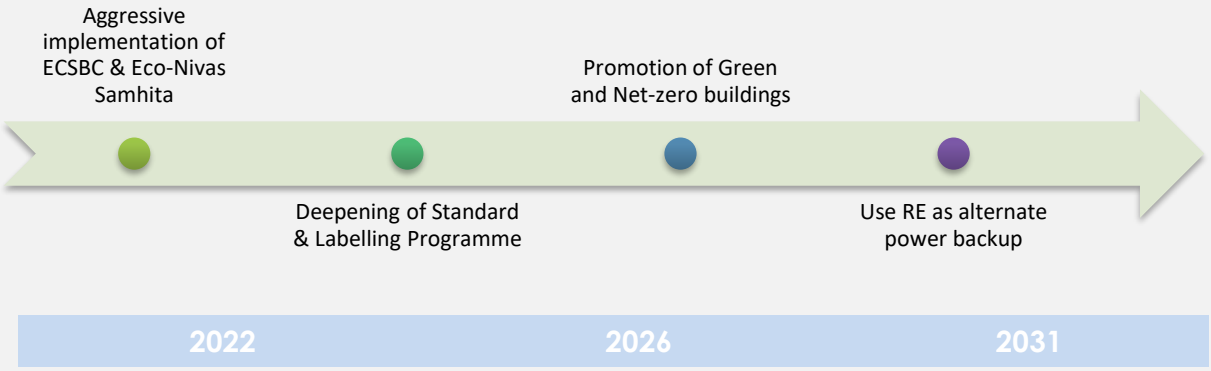
With Kerala's rapidly growing population and urbanization trends, there has been a substantial increase in the construction of residential and commercial buildings in the state. The demand for housing, both in urban and rural areas, has led to an increased construction of residential properties. Traditional Kerala architecture often blends with modern designs and amenities. In FY21-22, around 53% of the total electricity consumed by the state was attributed to domestic buildings. This underscores the need for enhancing energy efficiency in residential structures to reduce energy consumption and promote sustainable living.

With the state's growing economy, the demand for commercial spaces has surged. From corporate offices and shopping malls to hotels and restaurants, commercial buildings in Kerala have undergone a substantial transformation. The commercial building sector accounted for a share 20% of the state's electricity in FY21-22.

Efforts to promote energy efficiency in both residential and commercial buildings are crucial for Kerala. Such measures can encompass the use of energy-efficient appliances, lighting, HVAC systems, insulation, and sustainable construction materials.

6.2 Energy efficiency strategies in the buildings sector

The following strategies can be used to achieve the energy reduction targets of domestic and commercial sectors.



The policy interventions required for reducing the energy consumption of domestic and commercial sector is discussed in the subsequent section.

6.2.1 Strategy #1: Implementation of ENS

In the recent amendment to the Energy Conservation (EC) Act in 2022, a unified code called the "Energy Conservation and Sustainable Building Code" (ECSBC) has been introduced. This new code will include both commercial and residential buildings. Until the implementation of ECSBC in State/UT, the existing Energy Conservation Building Code (ECBC) and Eco-Niwas Samhita (ENS) will be referred to as ECSBC.

Eco Niwas Samithi (ENS) is a program launched by the Ministry of Power to promote energy efficiency in residential buildings. By promoting energy-efficient practices in residential

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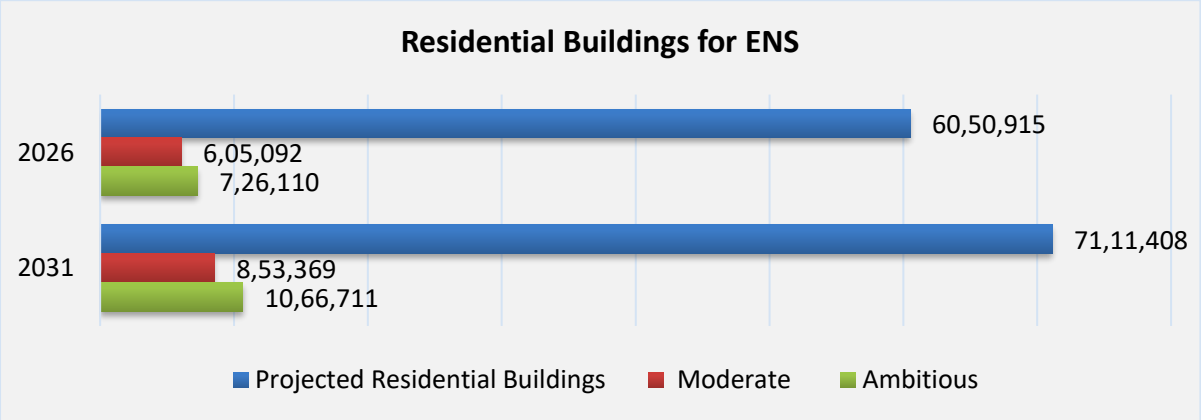
buildings, ENS can help reduce the demand for energy and promote the use of renewable energy sources. This, in turn, can help in achieving the state's goal of reducing its carbon footprint and mitigating the impact of climate change.

The strategy and its implementation are explained below.

Scope Boundary
ENS applies to "Residential buildings" with plot area ≥ 500m2. The policy applies to new residential buildings, including single-family homes, multi-family buildings, and gated communities. The policy provides guidelines and specifications for energy-efficient building design, construction, and operation. The policy covers various aspects of building design and construction, such as orientation, insulation, lighting, ventilation, and renewable energy systems.
Implementing Agency
• Department of Town and Country Planning • Kerala State – Housing Board • Bureau of Energy Efficiency • Third Party Auditors • Agency for New and Renewable Energy Research and Technology (ANERT) • Energy Management Centre (EMC)
Current Policy/Policies in Place
Draft ENS is notified for stakeholder inputs in Kerala.
Implementation Period
Phase 1 (2022-2025): Drafting Eco Niwas Samitha with threshold based on Kerala's residential sector analysis. Phase 2 (2026-2031): Mandating ENS based on state's building landscape.

According to the housing Census 2011 of Kerala state, there nearly 58 lac establishments which are further categorized into residence, offices, shops, schools, hotels, hospitals, factories, etc. Total number of households were projected to 2026 and 2031.



Energy Saving Potential

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The saving potential for FY 2031 is 0.04 under moderate scenario and 0.06 MTOE under ambitious scenario which is estimated by calculating energy saving per household (kWh/household) which is then multiplied with the projected households for FY2026 and FYFY 2030 for both moderate and ambitious scenarios. Similarly, the GHG saving potential for this strategy is 0.18 $MtCO_2$.

Table 11: Implementation of ENS- Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.02	0.03	0.04	0.06
GHG Emission Reduction Potential ($MtCO_2$)	0.06	0.10	0.12	0.18

Action Plans

This section describes several action plans that can be implemented across the residential sector for this strategy.

Behavioural Energy Efficiency Program (BEEP)

Objective: Promotion of energy efficiency among residential consumers through personalized Home Energy Reports (HERs) and an integrated web portal.

Case Study: Behavioural Energy Efficiency Program by BSES Rajdhani Power Limited (BRPL) in Delhi

BSES Rajdhani Power Limited (BRPL), one of the power distribution companies in Delhi, implemented a successful Behavioural Energy Efficiency Program. The program focused on providing personalized Home Energy Reports (HERs) and an integrated web portal to selected residential consumers, aiming to improve energy efficiency and reduce energy consumption.

Based on results in comparable markets, Home Energy Reports (HERs) have the potential to save 1-2% of BRPL‟s peak power demand. The program was rolled-out across South and West Delhi in the month of October, 2018. Considerable saving has been observed under this program[14]

Components:

- Home Energy Reports (HERs): Selected consumers receive personalized reports detailing their energy consumption patterns, comparisons with similar households, and energy-saving recommendations.
- Integrated Web Portal: An interactive online platform allows consumers to access their energy usage data, track their progress, and access energy-saving tips and resources.

[14] BSES Rajdhani Power Limited (BRPL) website

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- Behavioural Change Campaigns: Conduct awareness campaigns and programs to educate consumers about energy efficiency, energy-saving practices, and behavioural changes that lead to energy conservation.
- Incentives and Rewards: Provide incentives and rewards to encourage active participation and achievement of energy-saving targets.

Benefits:

- Improved Energy Efficiency: Personalized HERs and access to energy data empower consumers to make informed decisions, adopt energy-saving practices, and reduce energy consumption.
- Energy Cost Savings: By implementing energy-saving recommendations and efficient usage of appliances, consumers can reduce their energy bills and achieve cost savings.
- Environmental Impact: Reduced energy consumption contributes to a decrease in carbon emissions and environmental footprint, promoting sustainability.

6.2.2 Strategy #2: Deepening of Standard & Labelling Programme

The Standards and Labelling (S&L) program is an important initiative of the Bureau of Energy Efficiency (BEE) under the Ministry of Power, aimed at promoting energy efficiency in various appliances and equipment. Under this program, minimum energy performance standards (MEPS) are set for different categories of products and appliances, which are mandatory for manufacturers to comply with before they can sell their products in the market. Additionally, the S&L program provides for labelling of these products with star ratings to help consumers make informed choices.

Direct-cool refrigerator (29%) followed by colour television (21%) and frost-free refrigerator (14%), contributed to 54% of the total energy savings due to mandatory star rated appliances under S&L programme[15] during FY2018-22 in India.

[15]https://beeindia.gov.in/sites/default/files/publications/files/Impact%20Assessment%202021-22_%20FINAL%20Report_June%202023.pdf

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Figure 23 Energy Savings for Mandatory Appliances for FY 2018-22

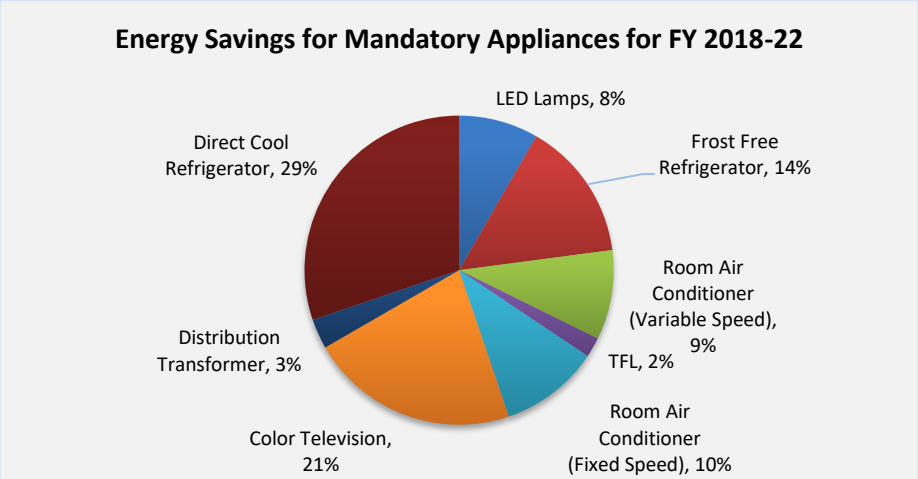
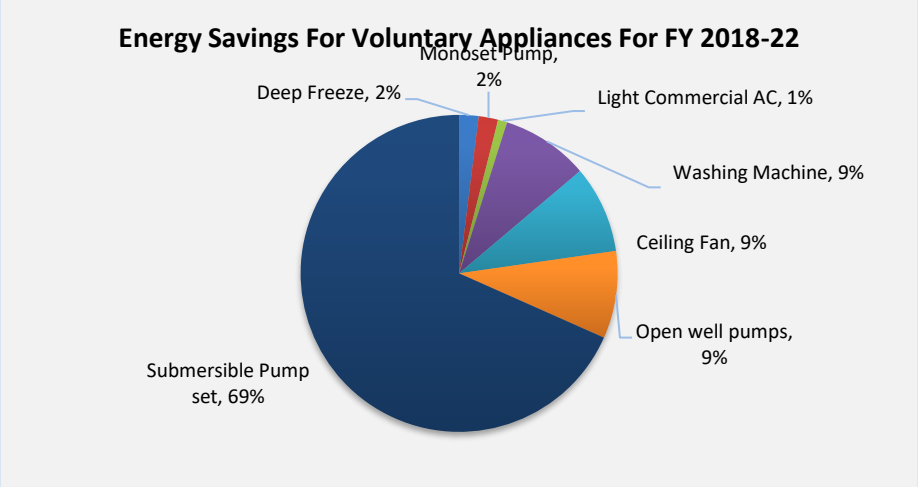


Figure 24 Energy Savings for Voluntary Appliances For FY 2018-22



With the growth in the number of refrigeration and air conditioning (RAC) units in Kerala state due to urbanization, there is a need to accelerate the ambition of MEPS and expand the scope of the S&L program. This will help to drive the adoption of energy-efficient RAC units and reduce the energy consumption and carbon footprint of the state. Additionally, the S&L program can help to create awareness among consumers about the benefits of energy-efficient appliances and incentivize manufacturers to innovate and develop more efficient products.

In FY20-21, the production of 5-star labelled was 32% of ACs and 79% of washing machines, indicating a positive trend towards energy-efficient appliances in India. However, there is a significant gap in the adoption of 5-star labelled appliances like refrigerators, ceiling fans, LED bulbs, and TFL bulbs. To address this disparity and accelerate the transition to energy-efficient technologies, "Deepening of Standard & Labelling Programme" is proposed.

The implementation of the strategy is explained below:

Scope Boundary
The policy will cover a wide range of energy-consuming products, including but not limited to household appliances (e.g., refrigerators, air conditioners, fans), lighting products, industrial equipment, and commercial appliances.

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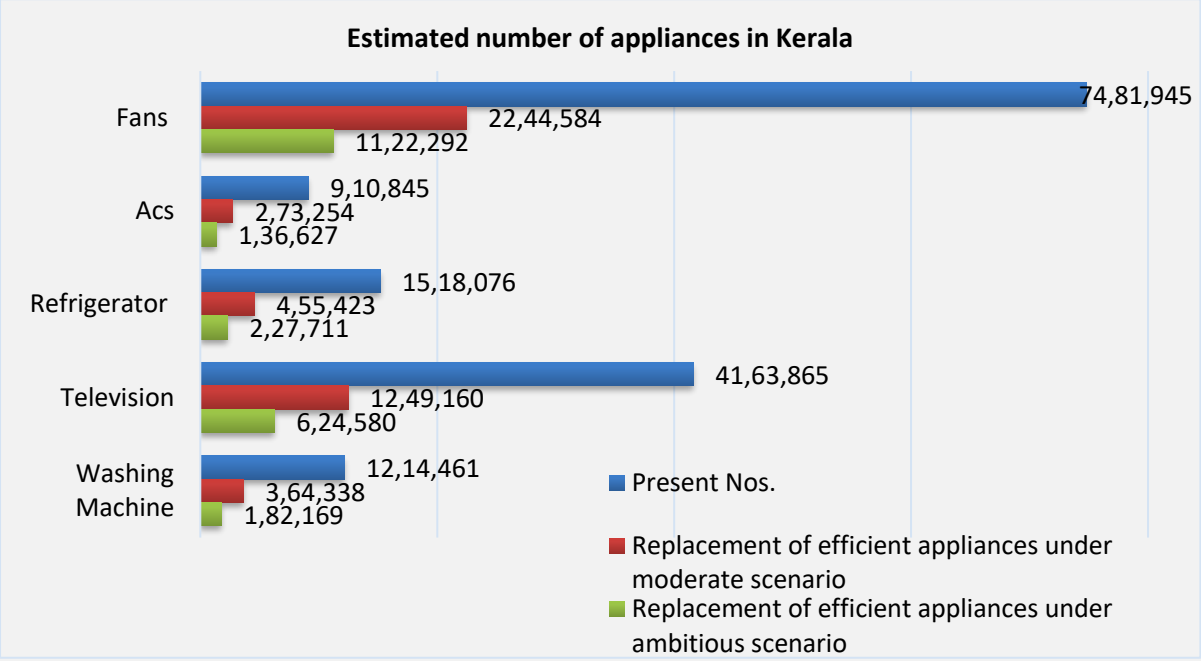
Implementing Agency
• Bureau of Energy Efficiency (BEE) • Energy Management Centre (EMC) • Kerala State Electricity Regulatory Commission
Current Policy/Policies In Place
BEE's "Deepening of Standard & Labelling Programme".
Implementation Period
Phase 1 (2022-23): Conduct a comprehensive review of existing S&L initiatives and identify gaps in the coverage of products. Develop an action plan for implementing the policy and creating public awareness. Phase 2 (2024-2031): Assess energy savings, and periodically update the efficiency standards to align with advancements in technology and evolving consumer needs.

Energy Saving Potential

The proposal aims to achieve a 15% upgradation of appliances to 5-star rated models in the moderate scenario and 20% of the total appliances in the ambitious scenario by the year 2031. These targets are based on the analysis of star label appliance production in India according to the BEE's report and trends observed over the past three years.

Figure 25 Estimated number of appliances in Kerala



By considering replacement of appliances, following energy saving potential can be achieved.

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Table 12: Deepening of Standard & Labelling Programme- Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.02	0.03	0.05	0.08
GHG Emission Reduction Potential ($MtCO_2$)	0.06	0.10	0.15	0.25

Action Plans

This section describes several action plans that can be implemented across the residential sector for this strategy.

1. **Promote Energy-Efficient and Low-GWP Refrigerant-Based Cooling:**

a) Launch awareness campaigns highlighting the benefits of energy-efficient and low-GWP refrigerant-based cooling systems for public and private stakeholders.

b) Introduce financial incentives, such as rebates or tax credits, for the purchase and installation of energy-efficient cooling systems.

c) Enforce regulatory measures that mandate the use of low-GWP refrigerants in cooling systems to reduce environmental impact.

2. **Energy-Efficient Public Procurement:**

a) Establishing a certification process for service technicians to ensure proper installation and maintenance of cooling systems.

b) Regularly update the Public Works Department (PWD) Schedule of Rates (SoR) to incorporate the latest energy-efficient materials and technologies in procurement projects.

3. **Demand Side Management Programs:**

a) Launch demand-side management programs similar to EESL's super-efficient ACs to incentivize consumers to adopt energy-efficient cooling appliances.

b) Offer financial incentives, subsidies, or discounts to consumers who choose to upgrade to energy-efficient cooling solutions.

c) Conduct consumer education campaigns to raise awareness about the benefits of energy-efficient appliances.

1. **Promotion of Heat Pumps**:

a) Provide subsidies and financial incentives to consumers and businesses for the installation of heat pumps for space cooling and hot water supply.

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b) Collaborate with manufacturers to promote research and development in heat pump technology and offer market-based incentives for adopting this technology.

5. **Mandatory Use of 4-Star Rated Appliances:**

a) Enforce regulations requiring the use of 4-star rated appliances in all commercial and government buildings to reduce energy consumption and greenhouse gas emissions.

b) Establish a monitoring and enforcement mechanism to ensure compliance with the mandatory rating requirements.

6. **Demand Aggregation for Star-Rated Appliances**:

a) Implement a demand aggregation model to incentivize the use of star-rated appliances in domestic settings by offering bulk purchase discounts.

b) Create financial incentives for consumers to replace old, inefficient cooling equipment with energy-efficient alternatives.

c) Consider introducing a Scrap to Energy Efficient Appliances (SEA) Policy, encouraging the responsible disposal of old appliances.

Case Study: Energy Efficient Air Conditioners in India by BEE and CLASP[16]
Objective The objective of the project is to accelerate access to energy-efficient air conditioners (ACs) in India, considering the country's growing middle-class population and rising disposable income. The focus is on creating awareness about energy-efficient schemes and interventions to influence purchase decisions and promote the adoption of high-quality and affordable AC products.
Project Activities: • The government of India expects that 300 million ACs will be purchased in India. Awareness of energy-efficient schemes and intervention campaigns will be key to purchase decisions. • CLASP collaborated closely with BEE by providing technical and institutional support to accelerate access to ACs in India. • AC efficiency policies were launched in 2006 in India, seeing an increase in energy efficiency by 47 %. The introduction of Minimum Energy Performance Standards (MEPS) and revised star rating plan are some policies by BEE with the support of CLASP. • Over the past 15 years, India has manufactured more than 63 million efficient AC units that reduced the country's electricity consumption by 85 TWh. Efficient ACs have also lowered electricity bills by an estimated USD 5.6 billion.

7. **Enhance Save Energy Mart Website**:

a) Invest in website improvements to enhance user-friendliness and accessibility.

b) Expand the range of energy-efficient products available on the Save Energy Mart platform, including cooling systems, lighting, and other energy-saving solutions.

[16] Increasing Access to Air Conditioners in a Heating India, CLASP

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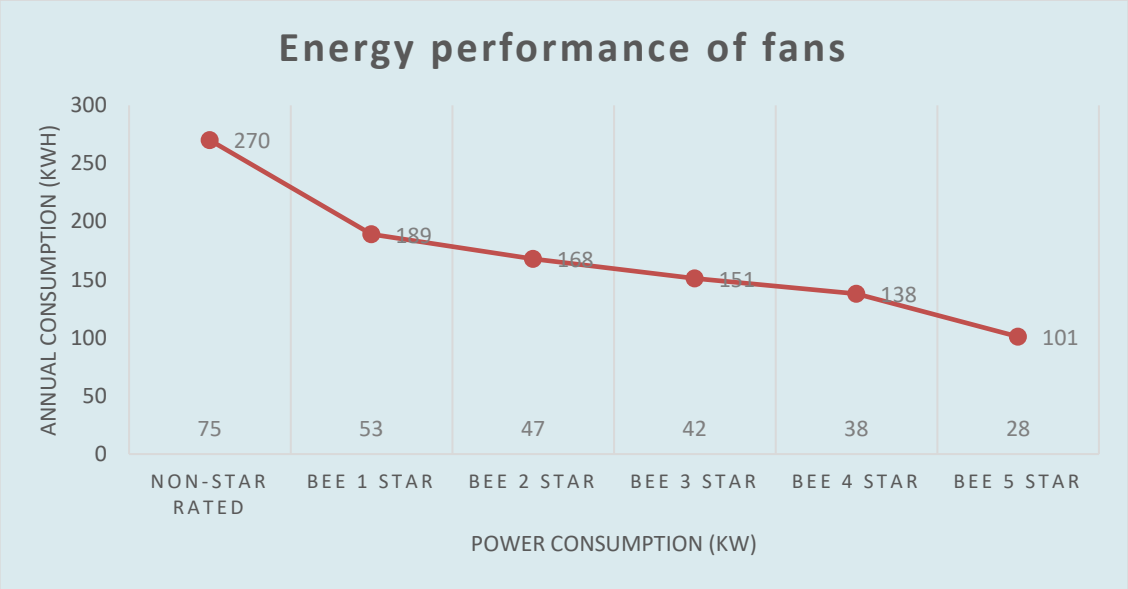
c) Provide comprehensive information on energy-saving options, including product specifications, energy ratings, and cost-saving benefits to empower consumers to make informed choices.

8. Bulk-purchase initiatives for superfan technologies

Fans play a vital role in the daily lives of people across India, especially in a state like Kerala with a tropical climate. However, it is also important to note that fans are one of the largest consumers of electricity in households and commercial spaces. In Kerala, the energy consumption by fans is estimated to be around 12% of the total energy consumption, which is significant.

To address this issue and promote energy-efficient fans, the state government can initiate a bulk-purchase scheme for superfan technologies like BLDC (Brushless Direct Current) fans. These fans are known for their energy efficiency and can save up to 50% of energy compared to traditional fans.



The scheme can be implemented by partnering with manufacturers of BLDC fans and offering bulk purchase orders at discounted rates. The scheme can also be extended to government offices, public institutions, and commercial buildings. Additionally, the existing five-star rating for fans can be promoted to become the new one-star minimum. This will encourage manufacturers to produce more energy-efficient fans and drive down the prices of energy-efficient fans further.

To ensure the success of the scheme, the state designated agency (SDA) can collaborate with the Bureau of Energy Efficiency (BEE) to create awareness among the public about the benefits of energy-efficient fans and the importance of purchasing energy-efficient products. The SDA can also work with local distribution companies to ensure that energy-efficient fans are available and easily accessible to consumers.

Case Study of Delhi: BEE 5 star rated Super Energy Efficient Fan Replacement Scheme[17]

BSES Rajdhani Power Limited (BRPL) has launched a limited period 'FAN Replacement Scheme' in partnership with leading BLDC FAN manufacturers like R R Kabel Ltd, Halonix Technologies Private Ltd, Atomberg Technologies Private Limited.

[17]https://www.bsesdelhi.com/web/brpl/other-initiative

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It will enable BRPL domestic consumers, to either exchange their old fans with the new BEE 5 star rated super energy efficient BLDC Fans (herein after referred as "BLDC Fans") or can directly purchase them. Consumers can avail discount up to 64%* on MRP under buyback mode and 62%* on MRP on new purchase of BLDC Fans

Wattage of the BLDC Fans offered in the scheme is 28 Watts whereas average wattage of old non star rated ceiling fans is around 75 Watts. Hence replacing the non-star rated ceiling fan with BLDC Fans would result in savings to the tune of 63%.

All the models in the scheme are Remote Controlled and has a sweep of 1200mm. Consumers can avail maximum 3 BLDC fans under buyback or maximum 2 BLDC fans under without buyback with an overall ceiling of 3 BLDC fans per CA. 50000 BLDC Fans are available on first come first serve basis valid till 20th March 2021 or till stocks last under which 40000 BLDC Fans are available for purchase under Buyback Mode and 10000 BLDC Fans are available for fresh purchase without any exchange of old fan

6.2.3 Strategy #3: Promotion Green Building Rating

The Kerala Government is actively endorsing the construction of eco-friendly buildings and has introduced various incentives for this purpose. The Local Self Government Department has granted approvals for substantial advantages, including potential reductions of up to 50% in one-time building tax, up to 1% in stamp duty, and up to 20% in property tax for projects that achieve green building certifications, such as those issued by the Indian Green Building Council (IGBC).

To further advance the adoption of green and net-zero building practices in the commercial building sector, it is essential to introduce additional policy measures. These interventions will contribute significantly to the state's goal of reducing energy consumption and fostering a more sustainable built environment.

The implementation of the strategy is explained below:

Scope Boundary
The policy will cover commercial buildings, including office complexes, malls, IT parks.
Implementing Agency
• Certification Body • Department of Country and Town Planning • Energy Management Centre (EMC)
Current Policy/Policies In Place
Kerala notified ECBC in April 2017 and incorporated it in the municipal building byelaws in March 2018. The state mandates energy audits for certain categories of buildings. Kerala Finance Corporation provides soft loans for ECBC-compliant construction and retrofits. However, the Star Rating and Shunya Rating of buildings is currently at a voluntary stage only.
Implementation Period
Phase 1 (2022-2024) • Launch public awareness campaigns to inform builders, developers, and the public about the advantages of energy-efficient and green building practices.

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- Create financial incentive programs to encourage voluntary adoption.

Phase 2 (2025-2028):

- Gradually introduce mandatory compliance for new building construction based on specific criteria.
- Develop technical resources and capacity for builders and architects to achieve high BEE star ratings and green building certifications.

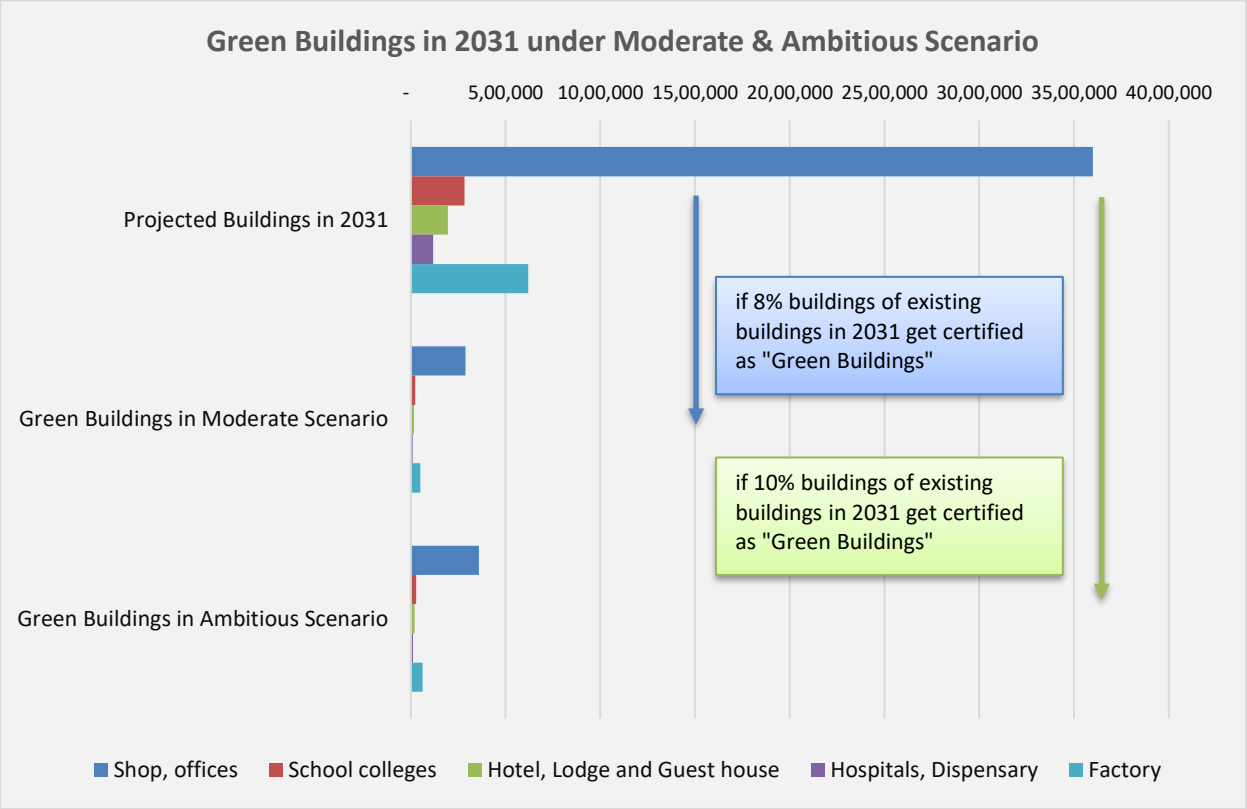
Phase 3 (2029-2031):

- Enforce mandatory compliance for a broader range of building categories.
- Monitor and evaluate the policy's impact on energy consumption and environmental sustainability.

Energy Saving Potential

As per the housing census data, commercial buildings are further divided into offices, schools, hotels, lodges, factories, etc. The total number for each of the category in the state is projected to 2026 and 2031 and 8% penetration is assumed for moderate scenario and 10% for ambitious scenario for both 2026 and 2031.

Figure 26 Green Buildings in 2031 under Moderate & Ambitious Scenario



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By considering penetration of green buildings as shown above figure, following energy saving potential can be achieved.

Table 13: Promotion of Green Rating- Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.11	0.16	0.20	0.28
GHG Emission Reduction Potential ($MtCO_2$)	0.36	0.51	0.63	0.8

Action Plans

This section describes several action plans that can be implemented across the commercial sector for this strategy.

1. **Development of Compliance Portal:**

   Develop and maintain an Energy Conservation Building Code (ECBC) compliance portal. This portal can serve as a resource for builders, architects, and contractors to access information on energy-efficient and green materials and technologies.

2. **Market Outreach and Awareness:**

   Conduct market outreach campaigns to promote ECBC-compliant products. Utilize various communication channels such as radio jingles, social media, and awareness programs to educate the public about the benefits of energy efficiency.

3. **Pilot Projects for Super ECBC:**

   Initiate pilot projects to showcase the of benefits of Net Zero (Energy) Rating. Select an initial set of 20 buildings as case studies to demonstrate the feasibility and advantages of higher energy efficiency standards.

4. **Home Energy Auditor Training:**

   Establish training programs for home energy auditors. Create a compliance structure that rewards residential projects for energy savings achieved through energy-efficient measures, such as insulation and lighting upgrades.

5. **Government Building Energy Audits and BEE Star Rating Target:**

   Issue directives to all government departments to conduct comprehensive energy audits of their buildings. Set specific targets for achieving BEE (Bureau of Energy Efficiency) Star Ratings for government-owned buildings. This will serve as a leading example for energy efficiency in the state.

6. **Periodic Energy Audits for Commercial Buildings:**

   Mandate periodic energy audits for commercial buildings, particularly based on their energy load. Offer incentives and recognition for buildings that achieve specific levels of BEE Star Ratings or demonstrate significant energy savings through audits.

7. **Capacity Building for Professionals:**

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Develop training and capacity-building programs for architects, building professionals, and developers focused on energy-efficient building design and construction practices. Encourage them to incorporate energy-efficient technologies and designs into their projects.

8. **Transformation of Iconic Government Buildings:**

   Identify and select iconic government buildings for transformation into Net-Zero energy buildings. Implement energy-efficient retrofits, renewable energy integration, and smart technologies to showcase the possibilities of sustainable construction and operation.

9. **Mandatory Temperature Set Point for ACs**:

   Enforce a mandatory minimum set point of 24°C for air conditioners in all government buildings.

10. **Cool Roof Programme**:

    a) Mandatory cool roofing for all the government, government-owned, non-residential and commercial buildings irrespective of site area/built up area.

    b) Mandatory cool roof application for all the residential buildings that have a plot area of 500m^2 and above.

6.3 Energy saving potential of the sector & monitoring mechanism

Energy saving potential of the building sector is 0.38 MTOE and 0.57 MTOE for moderate and ambitious scenarios FYFY 2030 respectively as seen from Table 10.

Table 14 Building sector- Summary of energy saving potential

Strategies	*Energy Saving Potential in 2031 (MTOE)*	
	Moderate	Ambitious
1. *Implementation of ENS-Residential buildings*	0.04	0.06
2. *Deepening of S&L in domestic buildings*	0.05	0.08
3. *Promotion of Green Rating of Buildings*	0.20	0.28
Total	0.29	0.42
Emission Reduction Potential (mTCO2)	0.9	1.3

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Following are the monitoring mechanisms that could be implemented to track the progress and effectiveness of the policies in the transport sector in Kerala state:

Particulars	Monitoring Mechanism
Reporting & Disclosure	Establishing a system for enforcing compliance with energy efficiency codes and standards under operating conditions every few years can help ensure that buildings are meeting the required standards for reducing carbon emissions.
Performance contracting	The government can encourage performance contracting, where third-party contractors are responsible for implementing energy efficiency measures in buildings. The contractors can be required to report on energy savings achieved and the government can monitor these savings.


AGRICULTURE
SECTOR

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7 FOCUS SECTOR 4: AGRICULTURE

7.1 Overview

The agriculture sector in Kerala is an important part of the state's economy, providing employment to a significant portion of the population and contributing to the overall GDP.

The sector is dominated by small-scale farmers who cultivate a variety of crops, including coconut, rubber, tea, coffee, spices, and cashew. The state is also known for its horticulture, with fruits like banana, mango, pineapple, and jackfruit being grown in large quantities.

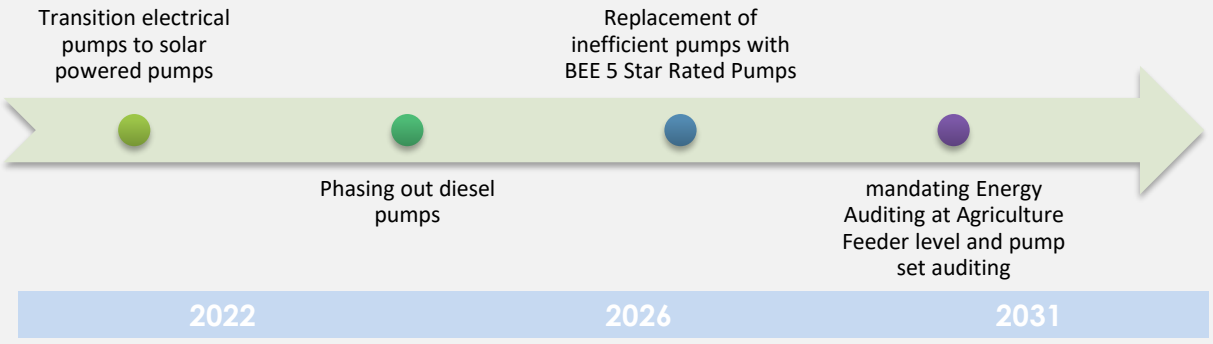
In recent years, there has been a growing focus on energy efficiency in the agriculture sector in Kerala. The state has implemented several initiatives to promote renewable energy in the sector, such as solar-powered irrigation systems, biogas plants, and biomass-based power generation.

Solar-powered irrigation systems have become popular in Kerala, particularly in areas where the power supply is unreliable or non-existent. These systems use solar panels to power the water pumps, reducing dependence on diesel generators or grid electricity. This has not only improved the reliability of water supply for agriculture but also reduced greenhouse gas emissions.

Biogas plants have also become popular in Kerala, particularly in rural areas where there is a ready supply of agricultural waste. These plants use organic waste to produce biogas, which can be used for cooking or generating electricity.

7.2 Energy efficiency strategies in the agriculture sector

The following strategies can be used to achieve the energy reduction targets of agriculture sector.



The policy interventions required for reducing the energy consumption of agriculture sector is discussed in the subsequent section.

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7.2.1 Strategy #1: Transition of diesel and electrical pumps to solar powered pumps

Transitioning to solar-powered pumps can improve energy access in remote and rural areas of Kerala, where electricity supply is limited or unreliable. According to a report by the Ministry of New and Renewable Energy, around 4.5 lakh households in Kerala are still without electricity. Solar-powered pumps can provide a reliable and sustainable source of energy for irrigation and other purposes, improving livelihoods and economic development in these areas.

Diesel and electrical pumps require a constant supply of fuel or electricity to operate, which can be expensive in the long run. In contrast, solar-powered pumps have a one-time installation cost and require minimal maintenance, resulting in significantly lower operating costs over their lifetime. A study by the International Water Management Institute (IWMI) found that solar-powered pumps can reduce irrigation costs by up to 80% compared to diesel pumps.

In conclusion, transitioning from diesel and electrical pumps to solar-powered pumps can significantly help in energy conservation in Kerala by reducing dependency on fossil fuels, lowering operating costs, and improving energy access in remote and rural areas. The adoption of solar-powered pumps in the state is still in its nascent stage, but there is significant potential for growth and expansion in the coming years. According to the Ministry of New and Renewable Energy, Kerala has a target of installing 2,500 solar-powered pumps by 2022, which will save around 9.75 lakh liters of diesel per year and reduce carbon emissions by 25,000 tonnes.

The strategy and its implementation are explained below:

Scope Boundary
The policy will encompass the establishment of solar feeder distribution networks to supply electricity for agricultural and irrigation purposes. The focus will be on transitioning existing electrical pumps used in agriculture to solar-powered pumps and completely phasing out diesel pumps.
Implementing Agency
• Bureau of Energy Efficiency (BEE) • Kerala State Electricity Board Limited • Anert- Agency for New and Renewable Energy Research and Technology • Energy Management Centre (EMC)
Current Policy/Policies In Place
Component-C of PM KUSUM Scheme is a new initiative from the Government of India aimed at ensuring reliable day time power supply for irrigation, reducing subsidy burden on DISCOMs. Under this Component, individual farmer having grid connected agriculture pump will be supported to solarise pump. Solar PV capacity up to two times of pump capacity in kW is allowed under the scheme, so that the farmer will be able to use the generated solar power to meet the irrigation needs and get additional income by selling surplus solar power to DISCOMs.
Implementation Period

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Phase 1 (2022-23):

- Conduct feasibility studies and identify potential locations for the pilot solar feeder distribution network.

Phase 2 (2024-25):

- Implement pilot projects in selected regions

Phase 3 (2026-2031):

- Scale up the solar feeder distribution network to cover a larger geographical area.
- Aim for widespread deployment of solar-powered pumps through the solar feeder network, gradually reducing the usage of electrical pumps.

Saving Potential

The energy saving potential for this scheme is estimated with following assumptions:

a) Transition of 100 % Diesel pumps to Solar powered pumps by FY 2026 and Transition of 50% electrical pumps to solar powered pumps by FY 2031.

b) Transition of 75% electrical pumps to solar powered pumps by FY 2031.

Following numbers are considered for the transition of diesel and electrical pumps to solar pumps for moderate and ambitious scenario.

Table 15 Agricultural Pumpsets as of 2018

Agricultural Pumpsets as of 2018		
Electric Pumps	Diesel Pumps	Total Pumps
4,45,223[18]	21,838[19]	4,67,061

Based on 1.31% growth rate of agriculture sector, following pumps are projected.

Table 16 Agricultural Pumpsets projections

Pumps Projected as of 2026	Pumps Projected as of 2031
5,18,313	5,53,164

[18] 2018 Pumpsets

[19] Assuming 10% of diesel consumed in agriculture sector is by pumps

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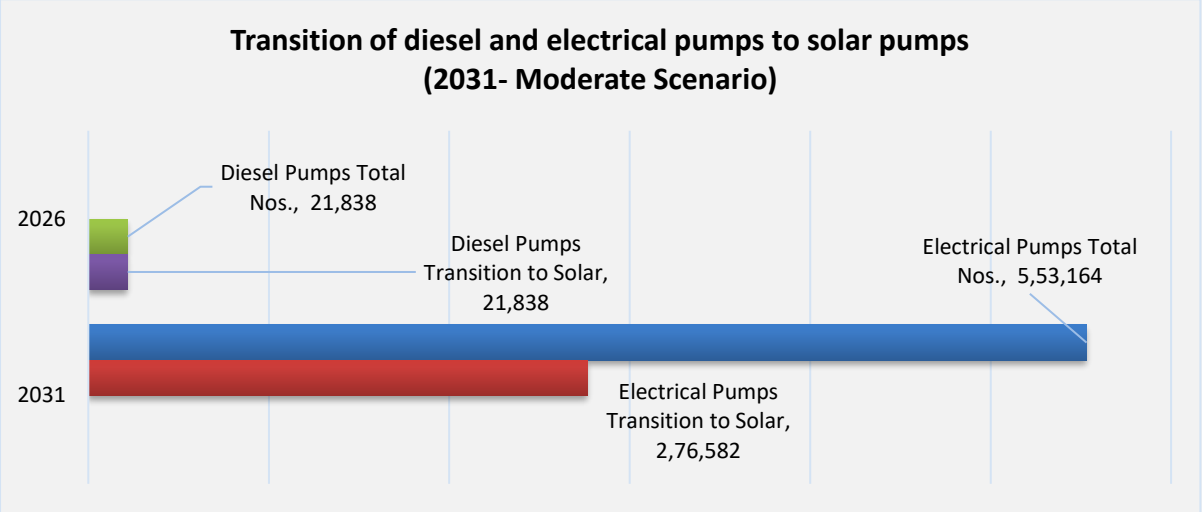
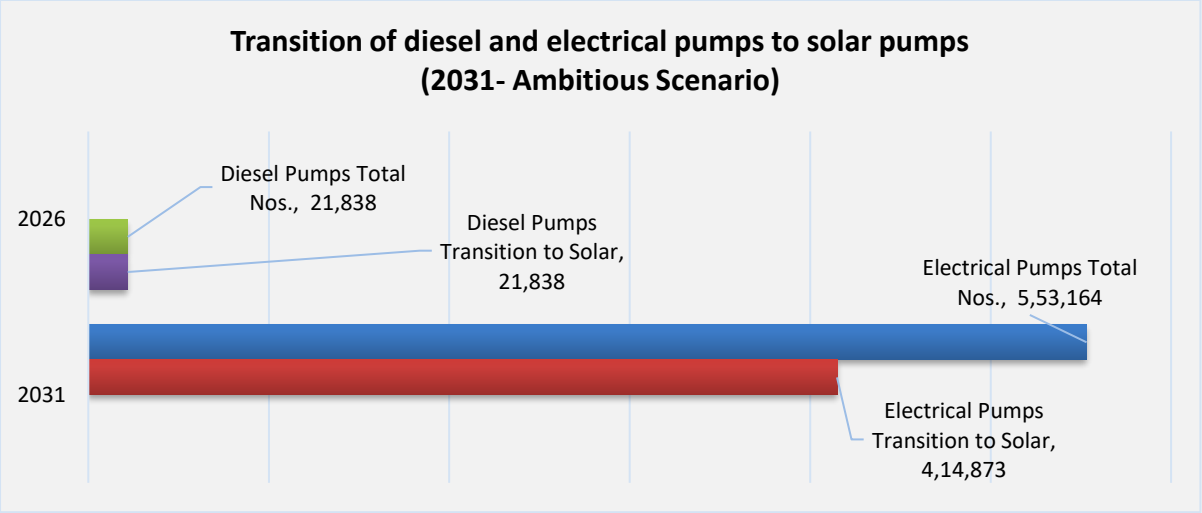
The projection of diesel pumps and electrical pumps in 2031 under moderate scenario is displayed below.

Figure 27 Transition of diesel and electrical pumps to solar pumps (moderate scenario)



The projection of diesel pumps and electrical pumps in 2031 under ambitious scenario is displayed below.

Figure 28 Transition of diesel and electrical pumps to solar pumps (ambitious scenario)



Energy Saving Potential

The calculation for estimating the "energy-saving potential" in the transitioning from diesel and electrical pumps to solar-powered pumps is based on the projected transition rates in two different scenarios:

By 2031, in moderate scenario, it is considered that 100% of diesel pumps are transitioned to solar pumps. and 50% of electrical pumps are transitioned to solar pumps by FY 2031.

In the ambitious scenario, by FY 2026, 100% of diesel pumps are transitioned to solar pumps. Furthermore, a more substantial 75% of electrical pumps are transitioned to solar pumps by 2031.

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Table 17: Promotion of Solar Pumps- Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.04	0.06	0.08	0.12
GHG Emission Reduction Potential ($MtCO_2$)	0.13	0.18	0.25	0.38

7.2.2 Strategy #2: Replacement of inefficient pumps with BEE 5 Star Rated Pumps along with smart control panel

According to a report published by the Bureau of Energy Efficiency (BEE), inefficient pumps account for a significant portion of the energy consumption in India's agricultural sector. The report states that up to 30% of the energy consumed by agricultural pumps in India is wasted due to inefficient pump sets, resulting in a loss of about Rs. 50,000 crores annually.

The BEE report also highlights that a large proportion of agricultural pumps in India are inefficient and outdated. Out of the estimated 20 million agricultural pumps in India, only 10% are estimated to be energy-efficient, while the remaining 90% are inefficient and consume more energy than required. This highlights the importance of replacing inefficient pumps in the agricultural sector with more energy-efficient options to reduce energy consumption and reduce electricity bills.

The strategy and its implementation is explained below:

Scope Boundary

This strategy will focus on the agriculture sector targeting inefficient agricultural pumps. It will cover the replacement of existing inefficient pumps with BEE 5-star rated pumps and smart control panels in agricultural fields and related irrigation systems.

Implementing Agency

- Bureau of Energy Efficiency (BEE)
- Kerala State Electricity Board Limited
- Energy Management Centre (EMC)
- EESL

Current Policy/Policies In Place

BEE's S&L programme.

Implementation Period

Phase 1 (2022-2024):

- Launch public awareness campaigns and training initiatives to inform farmers about the benefits of energy-efficient pumps and smart control panels.
- Create financial incentive programs to encourage voluntary adoption.

Phase 2 (2025-2031):

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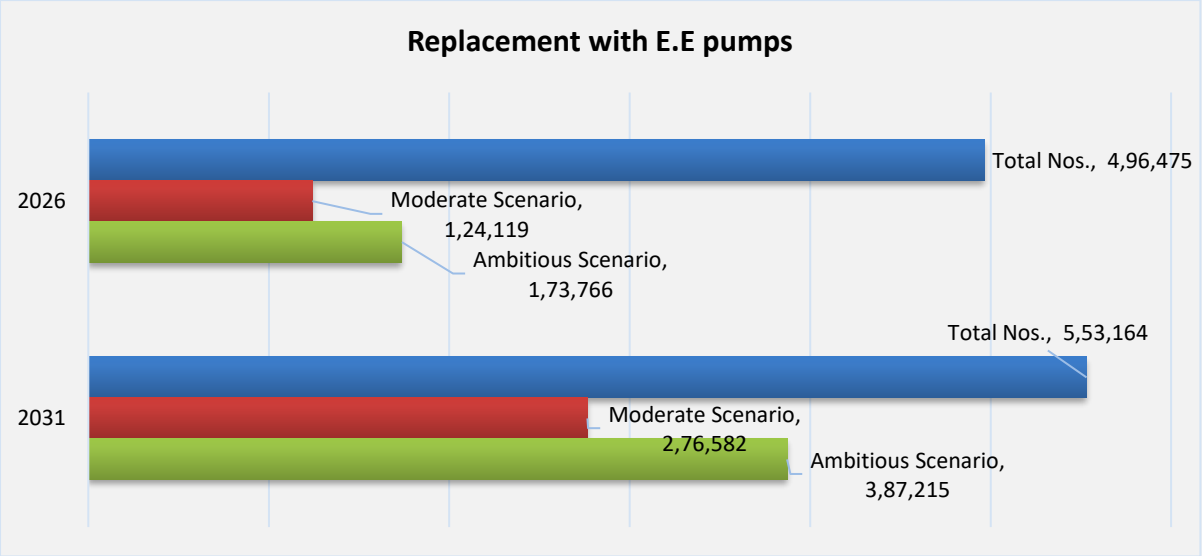
- Develop technical resources and capacity for farmers to implement energy-efficient solutions.
- Enforce mandatory compliance for a broader range of agricultural applications.
- Monitor and evaluate the policy's impact on energy consumption, cost reduction, and water resource management in the agriculture sector.

Energy Saving Potential

BEE 5 Star rated pumps are designed to consume less energy while maintaining or even improving their pumping capacity compared to inefficient pumps. This results in cost savings for farmers in terms of lower electricity bills and reduced maintenance costs. The energy-saving potential is estimated by calculating the difference in energy consumption between the inefficient pumps and the BEE 5 Star rated pumps that replace them.

In the moderate scenario, by FY2031, when 50% of the inefficient electric-powered pumps are replaced with BEE 5 Star rated pumps and in the ambitious scenario, when 70% of the inefficient electric-powered pumps are replaced with BEE 5 Star rated pumps, there is an expected reduction in energy consumption. This reduction represents the energy-saving potential achieved in this scenario.

Figure 29 Replacement with E.E pumps for FY 2030



Following energy saving can be achieved by transitioning from inefficient pumps to BEE 5 Star rated pumps in 2031. This transition promotes energy efficiency, reduces operational costs for farmers, and contributes to more sustainable agricultural practices.

Table 18: Replacement of inefficient pumps- Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.007	0.01	0.014	0.019
GHG Emission Reduction Potential ($MtCO_2$)	0.02	0.03	0.04	0.06

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Action Plans

This section describes several action plans that can be implemented across the agriculture sector for this strategy.

1. Conduct a thorough survey to identify inefficient agricultural pumps and their distribution across the state. Categorize pumps based on their energy efficiency and operational condition.
2. Launch awareness campaigns targeting farmers to inform them about the benefits of energy-efficient pumps and smart control panels.
3. Development of a phase-wise plan to implement Demand Side Management (DSM) scheme for replacing existing inefficient pumps through Energy Service Companies (ESCOs).
4. Establish a network of technical experts to assist farmers in selecting the right pump sizes and types according to their specific irrigation needs.
5. Provide guidance on the installation and integration of smart control panels.
6. Collaborate with financial institutions to offer low-interest loans designed for farmers to facilitate pump replacements.
7. Create specialized loan packages with favorable terms to encourage participation in the program.
8. Gradually introduce mandatory compliance for the replacement of inefficient pumps with BEE 5 Star Rated Pumps and smart control panels for specific agricultural applications.
9. Offer incentives such as additional subsidies or rebates for early adopters who comply with the mandate.

7.3 Energy saving potential of the sector & monitoring mechanism

Energy saving potential of the agriculture is shown below.

Table 19 Agriculture sector- Summary of energy saving potential

Strategies	*Energy Saving Potential in 2031 (MTOE)*	
	Moderate	Ambitious
1. *Transition to solar powered pumps*	0.08	0.12
2. *Replacement of inefficient pumps with BEE 5 Star Rated Pumps along with smart control panel*	0.01	0.02
Total	0.09	0.14
Emission Reduction Potential (mTCO2)	0.28	0.44

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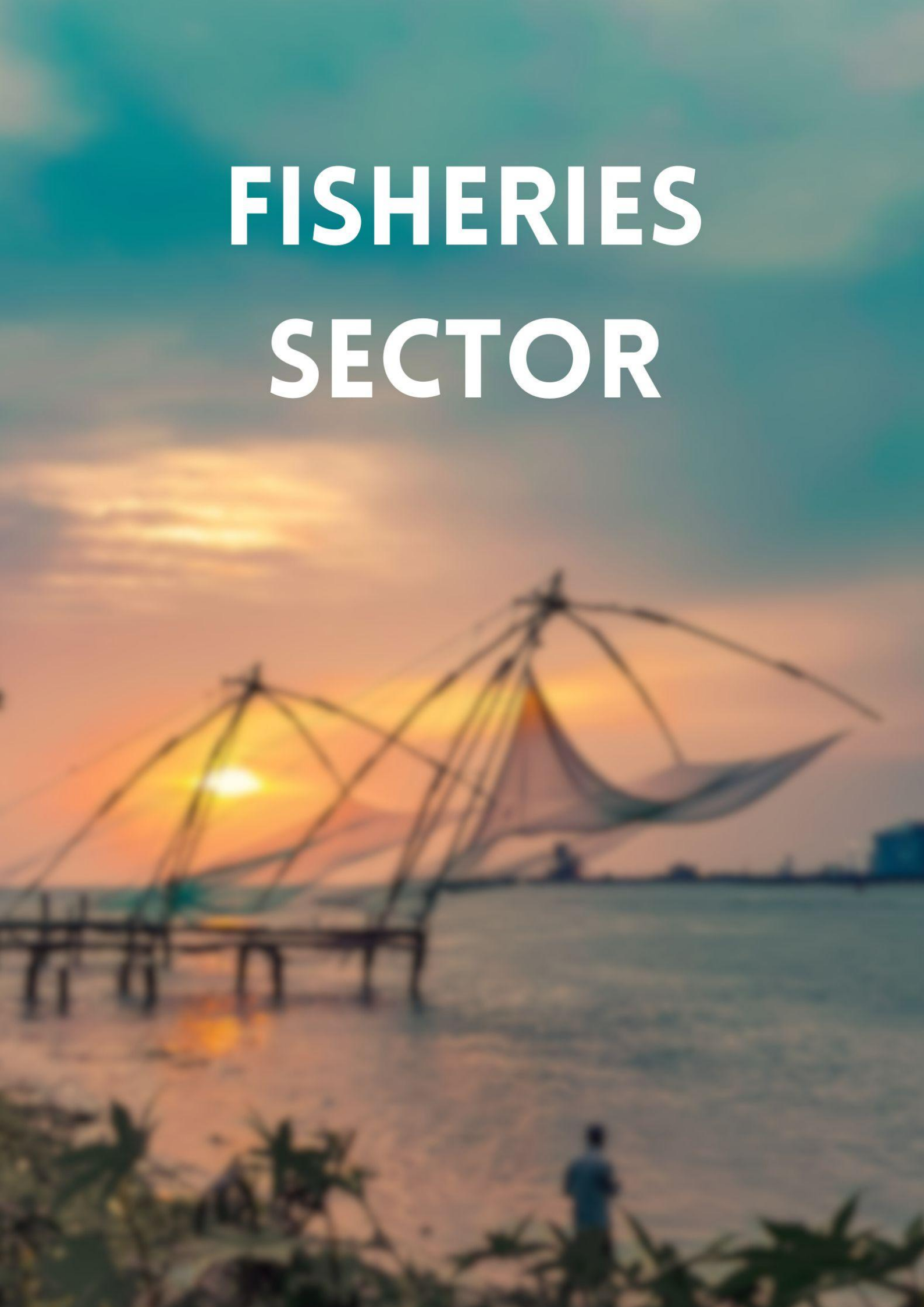
Following are the monitoring mechanisms that could be implemented to track the progress and effectiveness of the policies in the agriculture and fisheries sector in Kerala state:

Particulars	Monitoring Mechanism
Benchmarking	Benchmarking can be used to compare the energy consumption patterns of different farms in the same region. This can help identify the most efficient farms and highlight areas where other farms can improve their energy efficiency.
Awareness Programs	Educating farmers about the benefits of energy efficiency and providing training on energy-saving practices can help increase adoption rates and improve the effectiveness of energy efficiency policies.
Reporting and Monitoring	Regular reporting and monitoring can help ensure that energy efficiency policies are being implemented effectively and that progress is being made towards energy-saving goals. This can include regular reporting on energy consumption patterns, energy savings achieved, and greenhouse gas emissions
Data Reporting	Remote sensing and GIS mapping: Remote sensing and GIS mapping can be used to monitor changes in ocean temperatures and salinity, which can affect fish distribution and abundance. These tools can also help identify areas where vulnerable fish species are concentrated.



FISHERIES SECTOR

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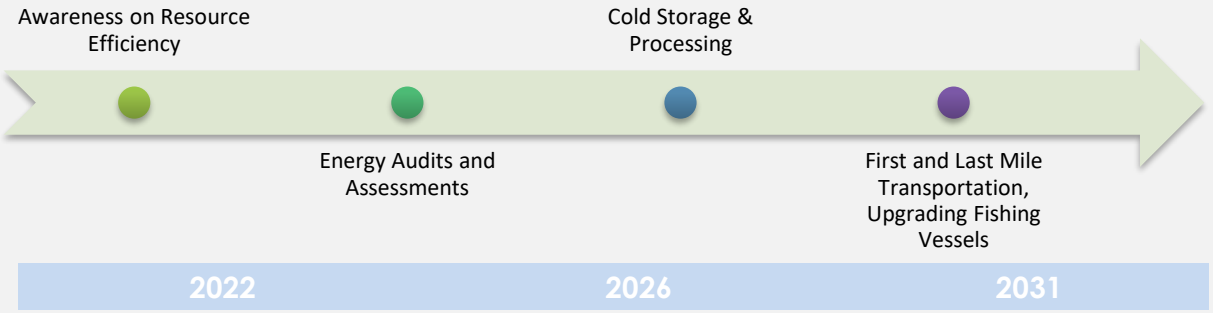
8 FOCUS SECTOR 5: FISHERIES

8.1 Energy efficiency strategies in the fisheries sector

The following strategies can be used to achieve the energy reduction targets of the fisheries sector.



The policy interventions required for reducing the energy consumption of fisheries sector is discussed in the subsequent section.

8.1.1 Strategy #1: Energy efficiency across value chain of fisheries

The state of Kerala, located in the southwestern part of India, has a coastline of about 580 kilometers along the Arabian Sea. The fisheries sector is a significant contributor to the state's economy, providing livelihoods to over one million people.

Marine fisheries are the dominant sector of Kerala's fisheries, accounting for about 85% of the total fish production in the state. The major fishing centers in Kerala are Thiruvananthapuram, Kollam, Alappuzha, Kochi, Thrissur, Kozhikode, Kannur, and Kasaragod. The most commonly caught fish species in Kerala include sardines, mackerel, tuna, prawns, crabs, and lobsters.

The marine fisheries are dominated by traditional, small-scale fishing operations using non-motorized boats, while the inland fisheries are largely based on freshwater aquaculture.

Inland fisheries in Kerala are carried out in rivers, lakes, reservoirs, and ponds. The state has a vast network of water bodies that support freshwater fish farming, which is an important source of livelihood for many small-scale farmers. The major inland fish species cultivated in Kerala include catfish, tilapia, carp, and prawns.

However, the fisheries sector in Kerala faces several challenges, including overfishing, habitat destruction, and unsustainable fishing practices. In addition, the sector is also highly energy-intensive, with significant energy consumption involved in activities such as fishing, processing, transportation, and storage.

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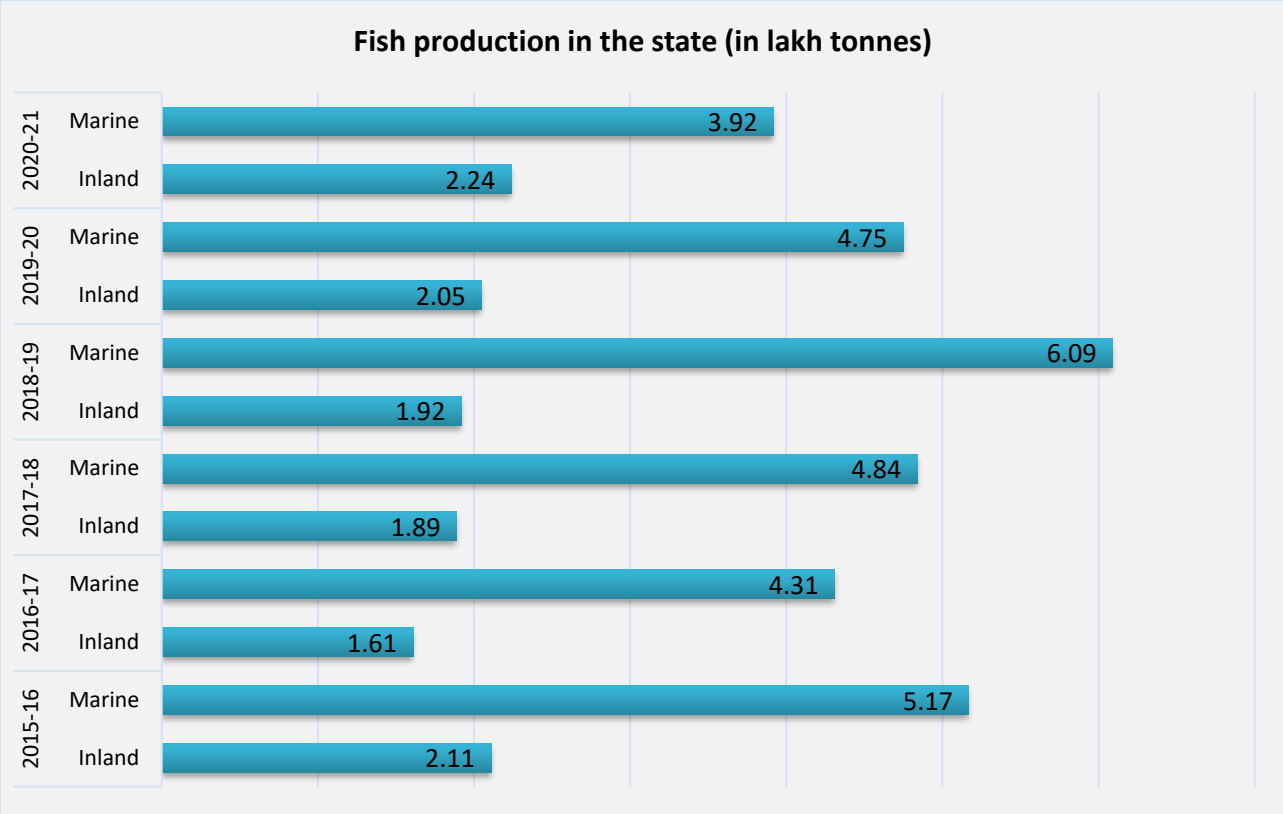
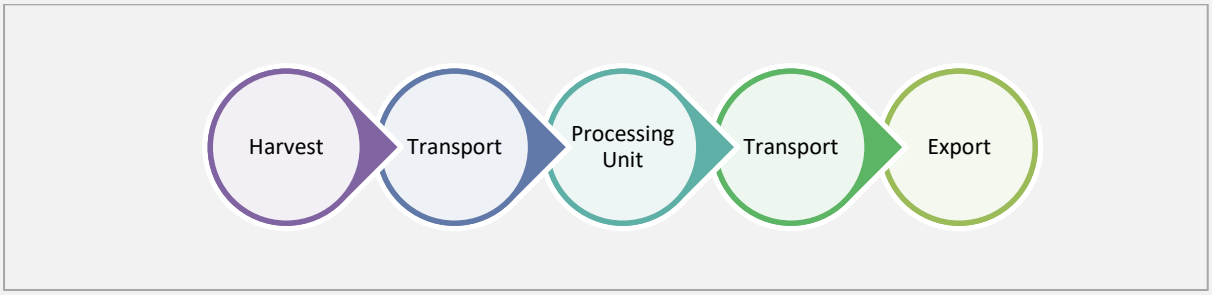
Figure 30 Fish production in the state



The fisheries sector in India encompasses a wide range of activities, from fishing to processing, marketing, and distribution of fish and fish products. Improving energy efficiency across all value chains in the fisheries sector can lead to significant environmental and economic benefits, including reduced greenhouse gas emissions, decreased energy consumption, and cost savings for fishers and processors.



In the processing and packaging stages, energy is mainly consumed for cooling, freezing, and drying of fish products. The use of energy-efficient refrigeration and drying equipment can significantly reduce energy consumption and associated costs. Additionally, adoption of renewable energy sources such as solar and wind can further reduce energy consumption and greenhouse gas emissions.

The transportation and distribution of fish and fish products also require significant energy input, mainly in the form of fuel for vehicles and refrigeration systems. The use of energy-efficient vehicles and refrigeration systems, as well as improved logistics and distribution systems, can reduce energy consumption and transportation costs.

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Overall, improving energy efficiency across all value chains in the fisheries sector in the state can bring numerous benefits, including reduced greenhouse gas emissions, cost savings for fishers and processors, and increased competitiveness in the global market.

The strategy and its implementation are explained below:

Scope Boundary
The policy will cover all aspects of the fisheries value chain, including fishing vessels, transportation vehicles, processing units, cold storage facilities, and related infrastructure. It will focus on adopting energy-efficient technologies and practices throughout the sector to minimize energy consumption and optimize resource utilization.
Implementing Agency
• Department of Fisheries, GoI • Department of Fisheries, Kerala • Bureau of Energy Efficiency (BEE) • Agency for New and Renewable Energy Research and Technology (ANERT) • Energy Management Centre (EMC)
Current Policy/Policies In Place
No current policy in the state centring around energy conservation in fisheries sector.
Implementation Period
• Phase 1 (First 2 years): Conduct a comprehensive assessment of energy consumption patterns and identify areas with high energy intensity in the fisheries value chain. • Phase 2 (Next 3 years): Initiate pilot projects to test and demonstrate the feasibility and effectiveness of energy-efficient technologies in select fisheries operations. • Phase 3 (Next 5 years): Scale up the adoption of energy-efficient practices and technologies across the entire fisheries sector, targeting major fishing hubs and processing centers. • Phase 4 (Next 10 years): Aim for widespread implementation of energy-saving measures across all aspects of the fisheries value chain in Kerala.

Saving Potential

The energy saving potential has been estimated by accounting for both thermal and electrical consumption across harvest, land transport, processing unit chain.[20]

Table 20: Energy Saving Potential

Particulars	*2026*		*2031*	
	Moderate	Ambitious	Moderate	Ambitious
Energy Saving Potential (Mtoe)	0.09	0.12	0.17	0.23

[20] Assumptions for thermal and electrical consumption in Annexures

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GHG Emission Reduction Potential ($MtCO_2$)	0.27	0.37	0.53	0.71

Action Plans

This section describes several action plans that can be implemented across fisheries sector for this strategy.

1. Provide skill development programs to fishermen and fishery workers, educating them on energy-efficient practices, equipment usage, and maintenance.
2. Conduct awareness campaigns to promote resource efficiency in the fisheries sector, including the use of cleaner refrigerants to reduce environmental impact.
3. Conduct energy audits and assessments of fisheries to identify areas of energy inefficiency and provide recommendations for improvement.
4. Promote energy-efficient transportation methods for the first and last mile, including the adoption of electric vehicles (EVs).
5. Encourage the use of PCM technology in coolers and freezers to improve energy efficiency in cold storage and transportation.
6. Promote the adoption of energy-efficient aerators in aquaculture and fish farming.
7. Support the installation of solar PV systems for fishery and cold storage facilities to reduce energy consumption.
8. Encourage the use of efficient ammonia or CO2 brine systems in cold storage.
9. Promote the use of evaporative condensers for cooling to improve efficiency.
10. Advocate for low-charge ammonia refrigeration systems to reduce environmental impact.
11. Implement mobile chilling solutions for reefer trucks to maintain the cold chain efficiently.
12. Explore the use of PCM materials for reefer transport to reduce energy consumption during transportation.
13. Promote the use of variable frequency drive solutions for refrigeration systems to optimize energy usage.
14. Encourage the adoption of electronic level control for refrigeration systems.
15. Implement Internet of Things (IoT) technology for better control and monitoring of refrigeration systems.
16. Provide subsidies to encourage fishermen and fishery enterprises to adopt solar-powered boats, refrigeration systems, and other equipment.
17. Highlight the benefits of solar-powered refrigeration units, which can reduce energy consumption by up to 70%, to encourage their adoption.
18. Promote the upgrading of traditional fishing vessels with efficient and eco-friendly engines.
19. Advocate for the installation of fuel-efficient engines to reduce fuel consumption by up to 30% and decrease emissions.

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Case Study: Energy Efficiency in Fisheries Value Chain

Objective

The project aims to conduct an energy and greenhouse gas (GHG) audit of selected fisheries sector value chains to identify opportunities for enhancing energy efficiency and reducing the use of refrigerants with high global warming potential and ozone-depleting substances. The focus is on promoting best practices in the cold chain of the fisheries sector and encouraging private sector participation.

Project Activities:

- Reviewing Local, National, and International Best Practices: The project will assess existing cold chain processes and identify energy-efficient methods and sustainable refrigerants used globally.
- Detailed Energy Audit: An in-depth energy audit of fisheries sector value chains in India will be conducted to establish mass balance and estimate benchmarks for specific energy consumption (SEC), GHG emissions, and overall energy consumption.

Value Chain	Elements	Resource savings (%)				GHG
		Electrical energy	Thermal energy	Water	Ice	
Aquaculture shrimp	Farm	16%	-	-	-	15%
	Processing	7%	43%	3%	40%	10%
IMC	Farm	20%	-	-	-	19%
	Processing	8%	24%	18%	40%	13%
Finfish	Processing	11%	-	-	-	11%
Crab and Lobster	Processing	6%	-	-	-	5%

- Value Chain Improvement Recommendations: Based on the audit findings, the project will propose measures and recommendations to enhance the efficiency of the fisheries sector value chains.
- National Design Challenge: A competition will be organized to invite innovative ideas for mobile kiosks for fish vending and live fish transport, promoting safety, hygiene, reduced waste, and energy efficiency.
- Stakeholder Consultations: Engagement with various stakeholders in the fisheries sector will facilitate the adoption of best practices and foster private sector involvement.

Impact:

- The energy and GHG audit of selected value chains provided crucial data on SEC, GHG emissions, and energy consumption benchmarks, enabling a better understanding of best practices in the fisheries sector.
- Some noteworthy technologies found during the cold chain assessment include the use of phase change material technology in coolers, solar PV systems for cold storage, electric vehicles for emission reduction, reefer trucks, aerators for water quality improvement, and VFDs for refrigeration systems.

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- The "National Design Challenge" received active participation from over 150 individuals and entities, including college students, innovators, start-ups, associations, and industry experts. The challenge aimed to find the most effective and efficient mobile kiosk for fish vending, promoting a circular economy and waste reduction.

Recommendations:

Based on the analysis and stakeholder consultations, the following recommendations are proposed to increase private sector participation in the fisheries sector:

- Develop an Investment Potential Compendium:
  Compile information on investment opportunities and highlight current best practices across different supply chains and value chains in the fisheries sector.
- Organize B-to-B Workshops:
  Facilitate workshops and networking events involving stakeholders and financing institutions to encourage collaborations and investments in the fisheries sector.
- Implement Pilot Projects:
  Initiate pilot projects showcasing successful practices that can be replicated, documented as case studies, and attract private investors to invest in sustainable fisheries initiatives.

8.2 Energy saving potential of the sector & monitoring mechanism

Energy saving potential of the fisheries is shown below.

Table 21 Fisheries sector- Summary of energy saving potential

Strategies	*Energy Saving Potential in 2031 (MTOE)*	
	Moderate	Ambitious
1. *Energy efficiency across all value chain in fisheries sector*	0.17	0.23
Total	0.17	0.23
Emission Reduction Potential (mTCO2)	0.5	0.7

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Following are the monitoring mechanisms that could be implemented to track the progress and effectiveness of the policies in the agriculture and fisheries sector in Kerala state:

Particulars	Monitoring Mechanism
Benchmarking	Benchmarking can be used to compare the energy consumption patterns of different farms in the same region. This can help identify the most efficient farms and highlight areas where other farms can improve their energy efficiency.
Awareness Programs	Educating farmers about the benefits of energy efficiency and providing training on energy-saving practices can help increase adoption rates and improve the effectiveness of energy efficiency policies.
Reporting and Monitoring	Regular reporting and monitoring can help ensure that energy efficiency policies are being implemented effectively and that progress is being made towards energy-saving goals. This can include regular reporting on energy consumption patterns, energy savings achieved, and greenhouse gas emissions
Data Reporting	Remote sensing and GIS mapping: Remote sensing and GIS mapping can be used to monitor changes in ocean temperatures and salinity, which can affect fish distribution and abundance. These tools can also help identify areas where vulnerable fish species are concentrated.

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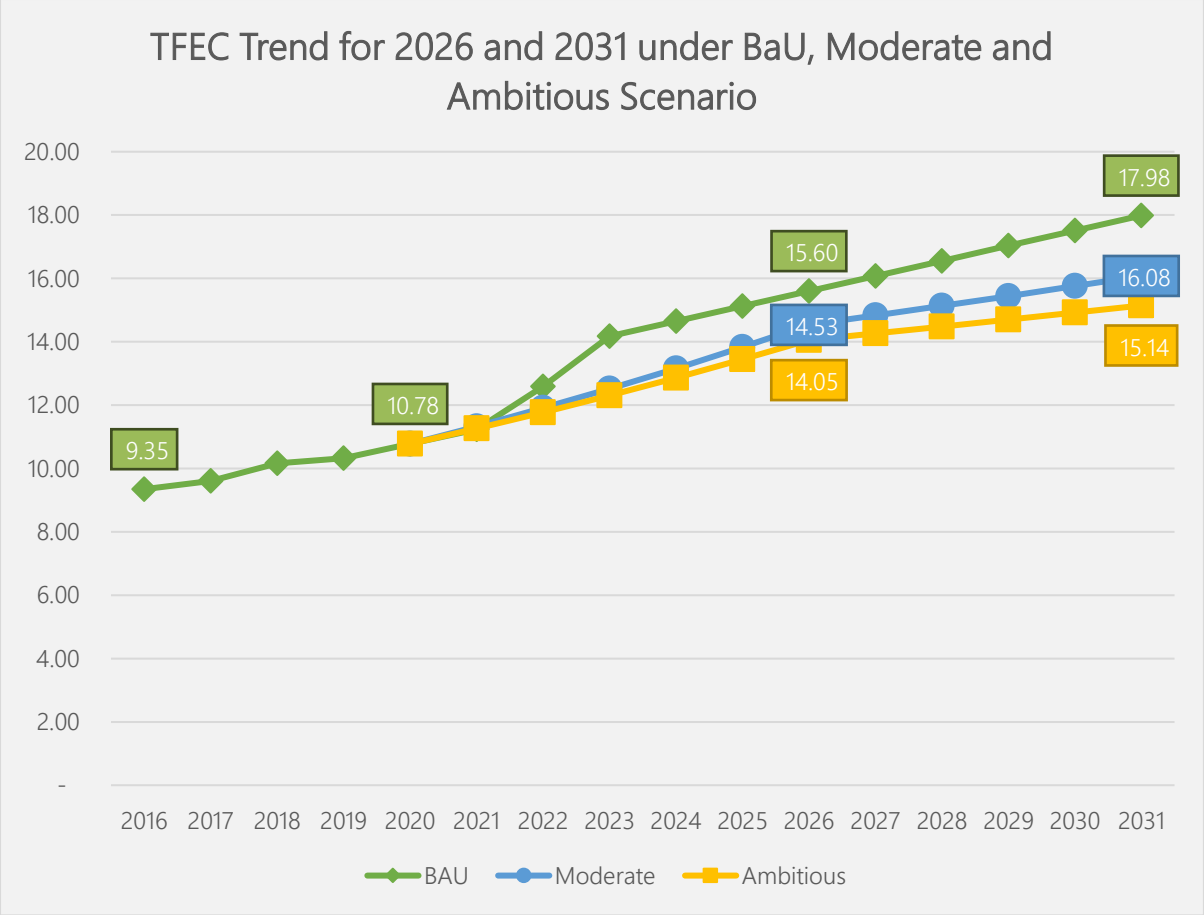
9 SUMMARY

The state energy efficiency action plan identifies significant energy-saving potential in Kerala through the implementation of energy efficiency and conservation strategies. The state has the opportunity to save 1.91 Million Tonnes of Oil Equivalent (Mtoe) by 2031 under the moderate scenario and nearly 2.84 Mtoe under the ambitious scenario.

Figure 31 TFEC Trend for 2026 and 2031



The figure above illustrates the Total Final Energy Consumption (TFEC) for the state in 2026 and 2031 under different scenarios. In the Business as Usual (BaU) scenario, TFEC is projected to reach nearly 17.98 Mtoe by 2031. This scenario assumes that present energy consumption patterns will continue without significant changes in policies, technology, or behaviour. The BaU scenario helps understand the likely trajectory of energy consumption without specific energy efficiency measures or conservation efforts.

In the moderate scenario, which assumes some moderate-level energy efficiency measures and conservation efforts will be implemented, TFEC is reduced to 16.08 Mtoe by 2031.

In the ambitious scenario, aggressive and transformative efforts are assumed to be implemented, aiming to significantly reduce energy consumption and achieve substantial energy savings. Under this scenario, the state can reduce its TFEC to 15.14 Mtoe by 2031.

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10 INVESTMENT POTENTIAL

The strategies outlined in the State Energy Efficiency Action Plan are designed to yield substantial energy savings across various sectors. These energy savings, in turn, translate into a reduced demand for energy generation. To effectively implement these strategies, there is a need for investments in energy efficiency projects and the development or modification of policies that create a conducive environment for such projects.

Investments in energy efficiency projects are critical for the successful execution of the plan and offer benefits, including:

- Economic Growth: These investments accelerate economic growth by creating job opportunities and fostering innovation in energy-efficient technologies and practices.
- Environmental Benefits: Energy efficiency investments lead to a significant reduction in greenhouse gas emissions, contributing to a cleaner and more sustainable environment.
- Energy Security: By reducing the state's energy consumption, investments in energy efficiency enhance energy security and reduce dependence on external energy sources.

The table below displays the economic opportunities that energy efficiency measures in each of the focus sectors present under ambitious scenario by FY 2031.

Sector	Emissions Reduction (MtCO2) - FY2031		Energy Consumption Reduction (Mtoe) - FY2031		Investment Potential[21]
	Moderate	Ambitious	Moderate	Ambitious	
	MtCO2 reduction	MtCO2 reduction	Mtoe Reduction	Mtoe Reduction	INR Crores
1) Transport	3.54	5.32	1.13	1.70	₹ 3,128
2) Industry	0.72	1.13	0.23	0.36	₹ 662
3) Buildings	0.91	1.31	0.29	0.42	₹ 773
4) Agriculture	0.28	0.44	0.09	0.14	₹ 258
5) Fisheries	0.53	0.72	0.17	0.23	₹ 423
Total	**5.98**	**8.92**	**1.91**	**2.85**	**₹ 5,245**

The energy saving investment potential of the state is estimated to be ₹5,245 crores by the year 2031, under the ambitious savings scenario, with the transport sector constituting highest energy saving investment potential followed by building and industry sector.

[21] The Ministry of Power, Government of India, in consultation with the Bureau of Energy Efficiency (BEE), has established a reference price for per metric tonne of oil equivalent. For the year 2018-19, this benchmark price stands at INR 18,402. This price serves as a benchmark for assessing the economic value of the energy saved through the energy efficiency measures.

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11 FINANCING MODELS FOR ENERGY EFFICIENCY

Energy efficiency stands as one of the most effective approaches for meeting the growing energy demand, curbing greenhouse gas emissions, and delivering socio-economic advantages. To fully harness the potential of energy efficiency, substantial investments are necessary to stimulate technological availability in the market and encourage energy efficiency adoption among end consumers. In this pursuit, numerous developed countries have successfully unlocked energy efficiency financing potential through innovative models, some of which are also under exploration in India, notably the Energy Service Companies (ESCOs) model. The present study delves into several financing models that could prove helpful across commercial, residential, and industrial sectors. In India, several financing strategies are already prevalent, including:

There are several other financing strategies employed globally and adopted by developed countries:

11.1 On bill financing model

On-bill financing can aid in increasing the household sector's adoption of climate-friendly and energy-efficient appliances (such as lighting, air conditioners, and refrigerators). Because it lowers monthly electricity costs and hence boosts purchasing power, it provides homes with a host of important advantages.

It has been demonstrated that basic energy efficiency measures like insulation, air sealing, heat pumps, and lighting upgrades produce an average energy savings of 25%. Through on-bill initiatives, an electric company or a third-party financier can cover the initial cost of energy-saving upgrades and equipment. Ratepayers can use a percentage of the savings realised as a consequence of the upgrades to pay down the cost of these investments through a monthly payment on their electric bill. On-bill financing makes energy-saving upgrades more accessible

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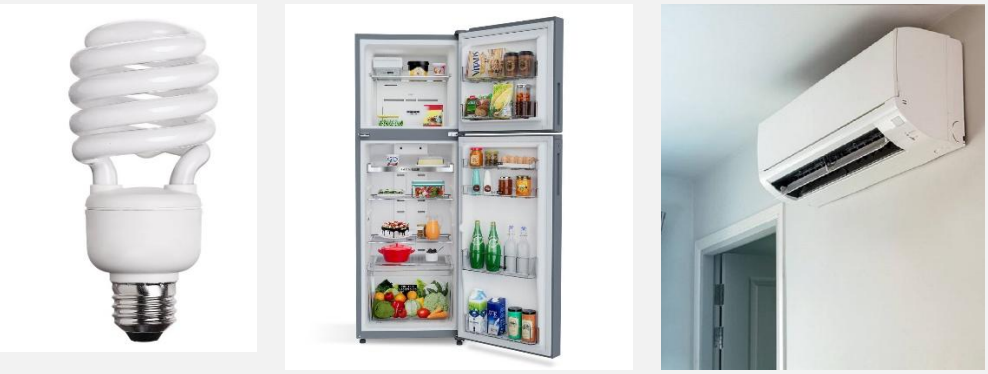
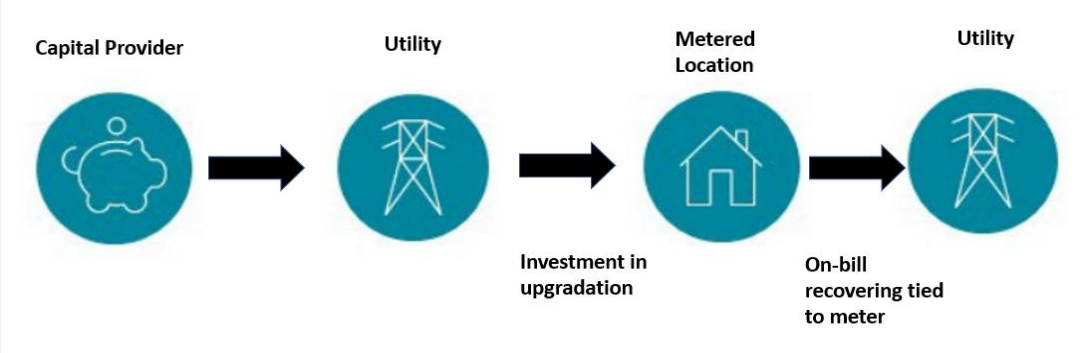
and affordable for consumers of all sorts and income levels by moving the initial costs to the utility.

Figure 32 Major common energy consuming appliances and equipment in Building sector



Energy efficiency is frequently the fastest-acting alternative to reduce the consumption of fossil fuels. The plan of delivering EE appliances to consumers may be more significant in order to offer them significant benefits. With the OBF model, consumers won't be put at a financial disadvantage because the payback is mostly funded by savings on electricity costs. The only party having an interest in the suggested model for using energy-efficient equipment will be the consumer.

Figure 33 Modality of financing energy efficiency projects through on bill financing model



Improvements in efficiency of houses and buildings are treated by tariffed on-bill programmes as an investment in system dependability and as the creation of less expensive distributed energy resources. The utility makes investments and seeks cost recovery through tariffs using its recognised authority while utilising the current systems for sending bills and collecting money. The investment in energy savings is linked to the location rather than a specific customer up until the point at which the utility's investment is recouped. A tariffed investment does not increase the owner's debt profile the same way a bank loan would.

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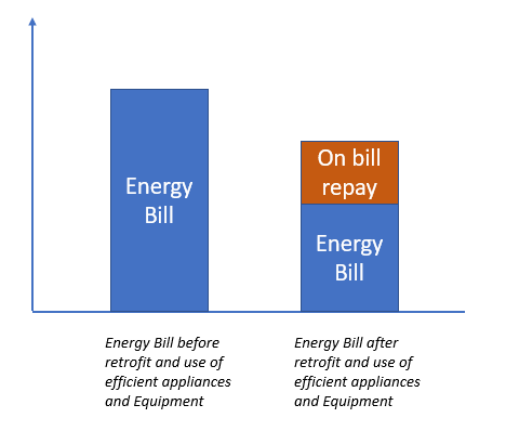
Figure 34 On bill financing structure



With adjustment of cost of appliances in monthly payment of electricity bills, this business model enables clients to access a wider choice of energy services, including demand response, electrification of transportation and heating systems, and efficiency enhancements.

Case Study: ECOFRIDGE-On bill financing

The government of Senegal (in 2020), in association with African Development Bank, United4Effciency, Renewable Energy and Energy Efficiency (ECREEE) &BASE offered efficient refrigerator and cooling product on EMI basis which was repaid through utility bills. The credit assessment of customer was done through their track record of payment of utility bill. As of Nov 2022, ECOFRIDGE GO model has achieved:

- Selling of 2527 new energy efficient ACs and emission reduction of 18824 MTCO2
- Total energy of 22,836 MWh energy saving
- Financing of 1 million USD

11.2 Energy service companies (ESCOs) Model of financing

Energy service companies (ESCOs) design, plan, construct, and secure funding for initiatives that lower energy use, energy expenditures, and maintenance and operations expenses at their clients' facilities. A project's technical and performance risks are typically assumed by ESCOs, who also serve as project developers for a wide variety of energy conservation measures (ECMs) (Energy Efficiency and Renewable Energy, n.d). Because they employ the performance-based contracting model, ESCOs set themselves apart from other businesses that provide energy-efficiency solutions. The payment made to an ESCO for a project is closely correlated with the real energy cost savings.

The utility might be able to reach economies of scale that would further reduce costs with strong user acceptance and bundling that offers a kind of "mass customisation." To guarantee programme success, the utility would keep handling billing, quality control, monitoring, and reporting. Customers' invoices would show the improvement measures' net energy cost

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reductions versus service fees. Customers may think about upgrading for extra services like new windows or a refrigerator when the initiative started to show benefits.

- ESCO in Industry

Energy service companies (ESCOs) are becoming one of the most popular off-balance-sheet methods of financing in the energy efficiency sector. Depending on the needs of the client, ESCOs engage in a variety of activities, including, but not limited to, conducting energy audits of existing facilities, designing and implementing energy efficiency projects, locating opportunities to save energy, outsourcing energy infrastructure and technology, and directly funding or arranging the financing of energy projects (Ablaza 2019c).

Ownership of the energy asset or infrastructure may lie with the ESCO (or even a third party) rather than the energy end user, depending on the contracting arrangement. Energy performance contracting (EPC), which aids in reducing the financial and performance risk associated with energy efficiency projects, is being used by an increasing number of ESCOs. Although an equipment replacement or retrofit tries to lower total energy consumption, the energy savings that the end user actually experiences may differ from what was anticipated or promised for a variety of technical reasons.

In an EPC, the ESCO guarantees energy savings as long as predetermined operational and maintenance guidelines are followed. Processes for measurement and verification are also put in place to make it easier to calculate the actual energy savings. The ESCO reimburses the energy end user with an amount equal to the gap if the project doesn't achieve the guaranteed energy savings. Because utility rate volatility is a market-based risk that should be managed separately from the energy efficiency project, performance guarantees are usually linked to energy savings (e.g., kWh) rather than monetary savings. There are two models in Energy Efficiency.

- Guaranteed Saving Model of ESCO

The energy savings promised by the ESCOs carrying out the projects equate to cost savings. The host facility's owner pays the ESCO a predetermined amount based on the guaranteed energy savings from the project.

The ESCO covers the shortfall if savings fall short of the guarantee. The ESCO may receive (but is not guaranteed) a bonus payment if the savings are greater. The M&V protocol and the ESCO's payment terms will be laid forth in the ESPC. According to this concept, the host facility or facility owner may raise equity capital, and the FI will cancel the ESCO's debt. The host facility or facility owner then offers a loan. The facility owner/host facility then uses its savings to pay the FI's interest and loan repayments.

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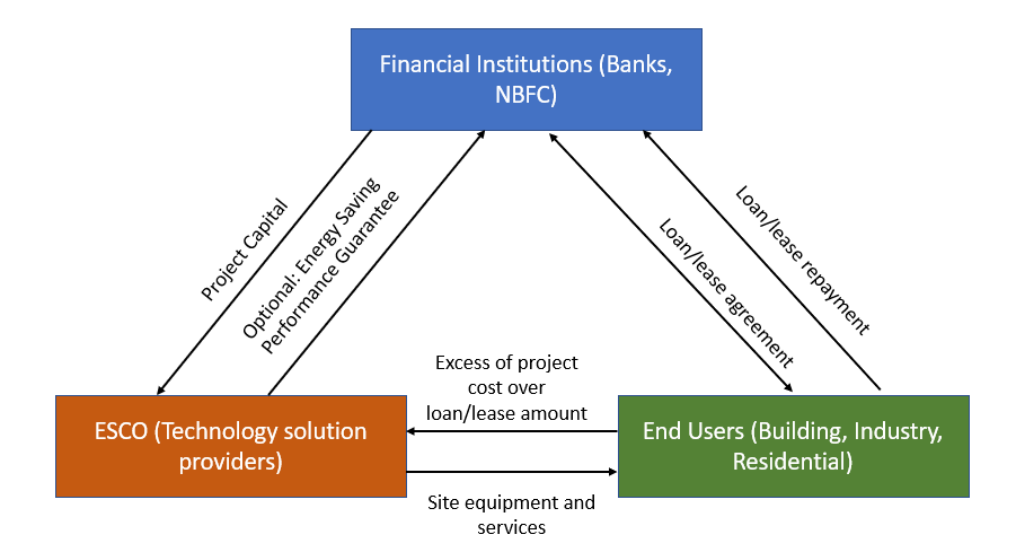
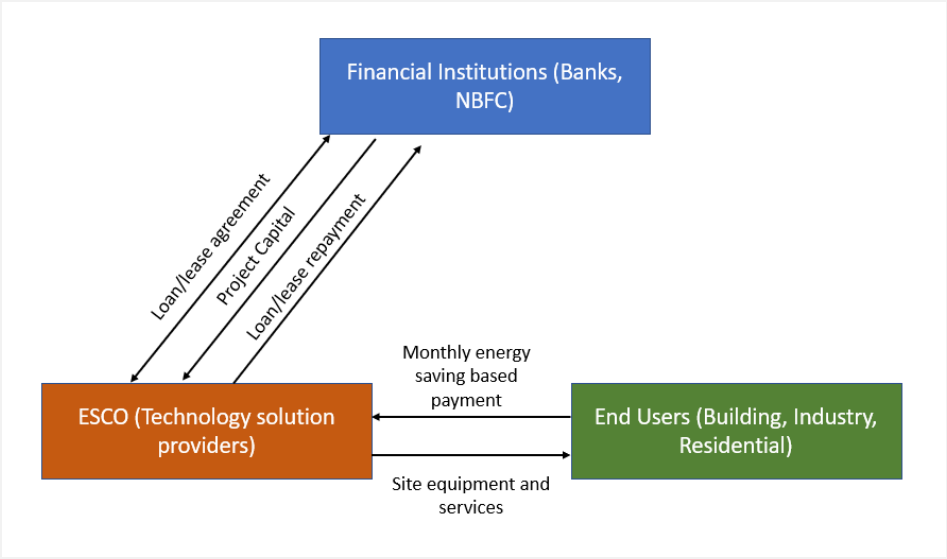
Figure 35 Guaranteed Saving Model



- Shared Saving Model of ESCO

Energy services companies deploy the Energy Savings Performance Contracting (ESPC) strategy in a turnkey manner. Design, engineering, construction, installation, commissioning, measurement, and verification are all part of ESCO services. Additionally, ESCOs handle training, financing, and operations and maintenance. The main criterion in this situation is to share the value of the energy savings, and this is what makes up the ESCOs' revenue stream. Beyond the duration of the contract, any savings are retained by the facility owner/host facility.

Figure 36 Shared ESCO saving Model



Various risk have been identified in the ESCO model through one of the research papers (Muhammad Ery Wijaya, et.al., 2021).

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Table 22 Various Risk in ESCOs Models

Risk category	Impact	Likelihood
Economic and Financial	High	Medium
Finance resources	High	Medium
Operational and Behavioural	Medium	Low
Awareness	Medium	Medium
Measurement and verification	Medium	Medium
Technical solution and services	Medium	Medium
Technology	Medium	Low
Regulatory	High	Medium

Source: Climate Policy Initiative, 2021

11.3 Dealer or retailer financing model

In direct dealer financing dealer directly provide loan to consumer or through partnership with third party financing institutions. Dealer can get access to finance by selling its purchase receivable portfolio to Bank. In indirect financing arrangement, dealer forward the consumer loan application form and other information to bank and bank access the credit worthiness of consumer before processing the loan. Consumer's repayment is directly to Bank and Dealer works as intermediary or facilitator.

Dealer financing lowers the cost of loan for consumers and easier access to credit facility. Dealer also helps the consumer to do all paper work, credit risk assessments etc. Dealer can negotiate with multiple finance provider for lending at discounted interest rates.

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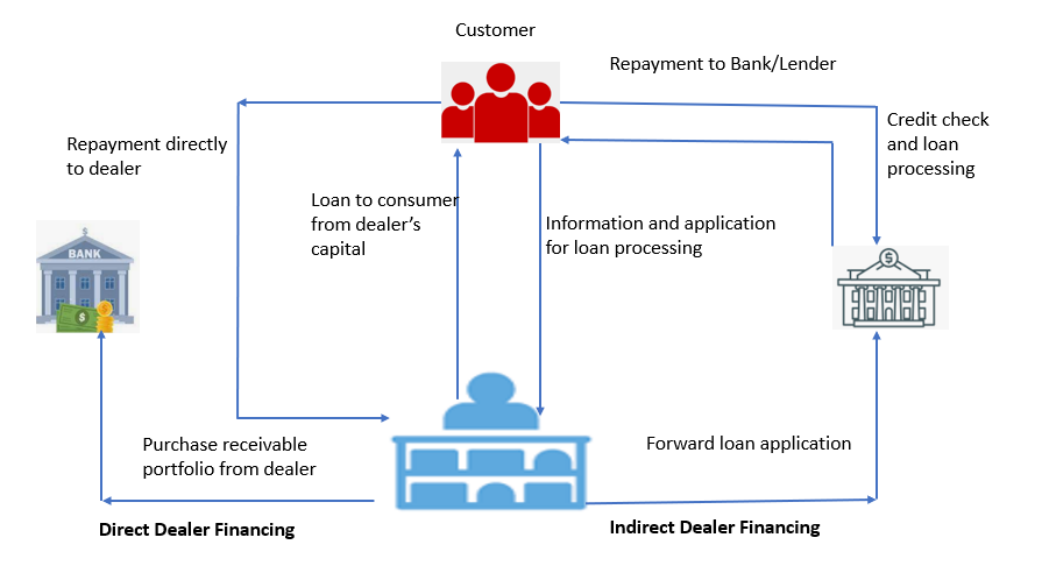
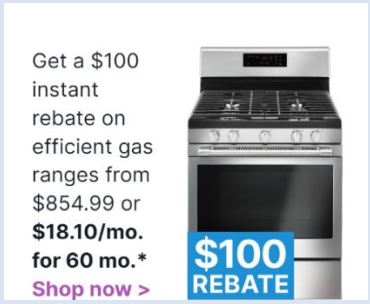
Figure 37 Dealer and retailer financing model



Case study: ECO-Financing Model by Enervee

Los Angeles based Enervee company, a provider of energy efficient appliances through online marketplace announced the ECO-Financing model for making energy efficient appliances affordable. The program was launched in collaboration with lenders Southern California Gas Company & the Sate of California. Enervee also partnered with best buy to provide end to end consumer services such delivery and installation. ECO-Financing model provided consumer favourable loan terms, low-cost EMI, no down payment facility and instant rebate. Consumer could buy the product upto $ 5000. Initially it was targeted to reach 5.7 million consumers of SOCalGas and expansion later. Under this program consumer could purchase Clothes washers/dryers, dishwashers, kitchen appliances etc.



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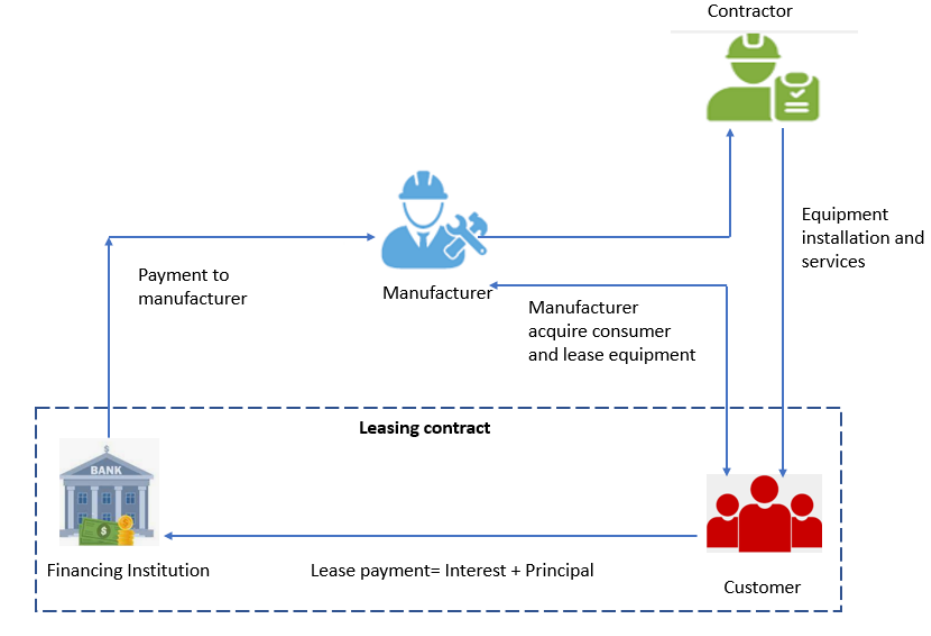
11.4 Leasing financing model

Leasing an asset-based financing where the financier (lessor) finances its assets to customer (lessee) for a fixed period of time through an agreement between lessor and lessee (IFC, 2009). In such model leasing is managed by partnership between financing institution, technology provider and contractor or service vendor.

Figure 38 Leasing financing model



Manufacturer install equipment through contractor or service provider at the customer end. Equipment is financed by banking or financing institution where the customer pays fixed monthly instalment to Bank and Bank pays fixed monthly payment to manufacturer. Manufacturer takes liability for services, maintenance.

Case Study: Ultimate Home Comfort by York: A leasing model by Johnson Control

Johnson Control, provides smart and sustainable cooling and heating solutions for building. It launched a 10 years leasing program for HVAC system for residential buildings under its brand YORK. This industry led program provided owners a new, energy efficient system with no down payment and service warranty for 10 years and even at low monthly payment. It provided stress free cooling and heating services to homeowners with 53% saving in energy. Financing was provided by third party- Fundient Capital LLC and YORK covered its cost from customer through fixed monthly payment. York initially piloted leasing program in United State for three years and made many contractor its partners which increased its profit. At the expiry of the contract the customer had following options:

- Lease to own and pay balance pending amount of loan to financier.
- No-renew and handover the equipment to financier.
- New 10 year lease with new equipment.
- Extension of lease for 2 years without maintenance and parts facilities

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11.5 Utilization of green finance

Any structured financial activity that is intent to improve environmental outcome and enhance the access of finance for environmental benefit can be referred to as a green finance (World Economic Forum, 2020). Green finance directly linked with Environment Social and Governance (ESG) factor. Green finance benefits the broader context of the business rather than traditional source of finance which look at the profitability and cashflow. Grant is also a part of green finance generally provided by either Government or Internationally established institutions (Non-profit). Example: Government Environmental Facility (GEF) fund. GEF is an independent operating financing organization that provides grants for projects under climate change, biodiversity, land degradation etc. Grants has big role for enhancing energy efficiency adoption at large scale.

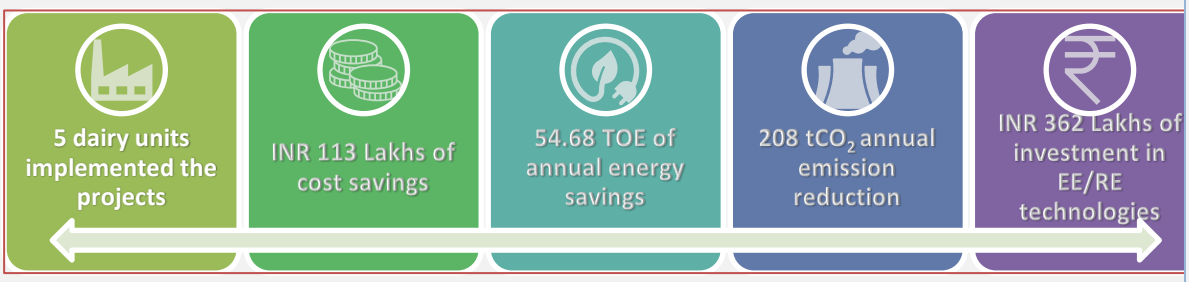
Case Study: CII's Dairy Project- Promoting Energy Efficiency and Renewable Energy in Selected MSME Clusters in India" initiated by GEF, BEE and UNIDO

In 2020 dairy cluster received grants for promotion of energy efficient technology under a program-"Promoting Energy Efficiency and Renewable Energy in Selected MSME Clusters in India" initiated by GEF, BEE and UNIDO.

The main objective of the project was to facilitate the implementation of energy efficient and renewable energy technologies in Rajasthan dairy clusters of India. The project of scaling up and expanding activities in Rajasthan dairy cluster had four major components:

- Component 1: Increasing capacity of suppliers in the category of Renewable and Energy efficient products.
- Component 2: Facilitate the implementation of energy efficient and Renewable energy technologies, best practices in MSMEs cluster of India.
- Component 3: Scaling up the project at national level.
- Component 4: Strengthening of policy, Institutional and decision-making frameworks.

And key outcomes of the project is as given below:



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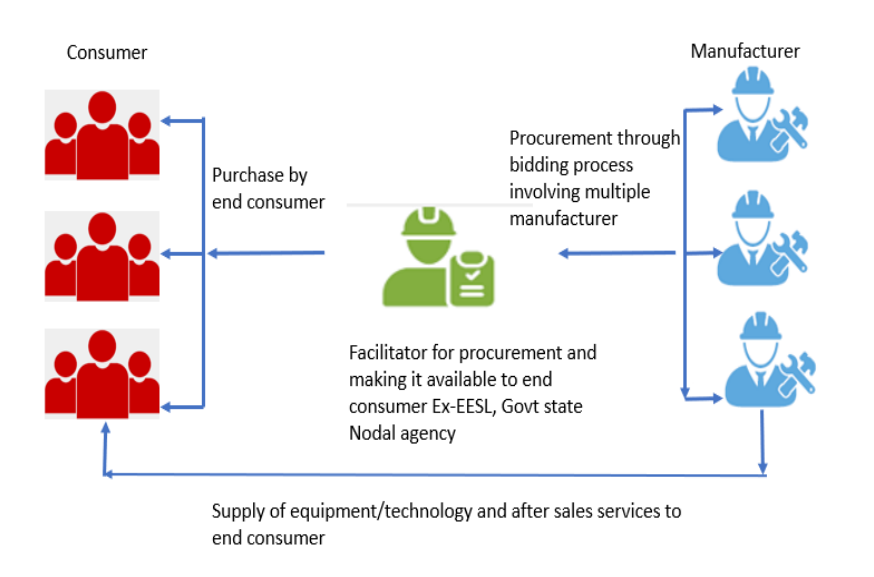
11.6 Bulk Procurement model

Procurement of appliances and equipment in large volume helps in achieving economies of scale and bulk procurement bring down the cost significantly and make it more affordable to end consumer.

Figure 39 Bulk procurement model



Bulk procurement model brings buyer and seller at a common platform where the manufacturer is able to generate profit through large volume and consumer gets product at lower price than market. Bulk procurement model providers negotiate with manufacturer and brings down the product price in multiple bidding round. The procurement costs are also down because of elimination of middle parties for selling the product in the market.

Bulk procurement model does not cover the financing requirements of consumer for purchasing the product rather brings down cost of the product.

Case study: Bulk Procurement model of EESL
Energy Efficiency Services Ltd. (EESL) targeted a program for replacement of standard motors with energy efficient motors for end consumers (PAT Industries and SMEs). The additional benefit of such bulk procurement model through EESL was the extend warranty of motors, Motor price reduction, information sharing on best practices and training to industries on operation and maintenance.

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As shown in below table EESL, procured IE-3 motors, in bulk at price less than the market price and helped industries to save energy consumption and money.

Motor specification (IE-3)	*No of motors procured.* *(Nos Lakh)*	*Market price of Motor (Rs Lakh)*	*EESL Procured price (Rs Lakh)*
1.10	0.15	0.08	0.05
1.50	0.15	0.08	0.06
2.20	0.15	0.11	0.07
3.70	0.15	0.14	0.09
5.50	0.15	0.20	0.13
7.50	0.15	0.23	0.16
11	0.10	0.47	0.25
15	0.10	0.49	0.31
22	0.10	0.65	0.40

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12 WAY FORWARD

The "State Energy Efficiency Action Plan" report for Kerala provides a roadmap for the state to achieve its energy efficiency goals.

The report outlines opportunities for energy savings and greenhouse gas emissions reductions across multiple sectors, including industry, buildings, transportation, and agriculture. The proposed strategies are designed to help the state allocate resources to meet its targets in line with the NDCs.

To achieve these objectives, the state should publish the report as a guiding document and consider the proposed strategies when developing policies.

To successfully implement the action plan, it is essential to create a task force or working group comprising representatives from government, industry, NGOs, energy experts, and other stakeholders. This group should establish priorities, timelines, and progress monitoring.

Adequate funding, including grants, loans, and public-private partnerships, must also be secured to support the plan. Additionally, innovative financing mechanisms, such as energy efficiency bonds, can be used to attract private investment in energy efficiency projects.

The implementation of the plan also requires training and capacity building for stakeholders, and the government should encourage innovation and research in energy-efficient technologies through collaborations between industry and academia/research institutes.

Overall, the "State Energy Efficiency Action Plan" report provides a comprehensive framework for achieving energy efficiency goals in Kerala. The successful implementation of the plan will require the involvement of various stakeholders and the allocation of sufficient resources. By adopting the above strategies, the state can achieve its energy efficiency goals, reduce greenhouse gas emissions, and contribute to a sustainable future.

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13 REFERENCES

Sr No.	Description
1.	CEA General Review Report
2.	Indian Petroleum & Natural Gas Statistics
3.	Coal Directory of India
4.	Energy Statistics India 2021, Ministry of Statistics and Programme Implementation (MoSPI)
5.	NITI Aayog: India Energy Dashboards
6.	Kerala Statistical Abstract
7.	Annual Survey of Industries
8.	BEE PAT Cycle
9.	Vahan Dashboard
10.	Census of India 2011

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14 ANNEXURES

Table 23 Assumptions for charging stations

	Charger Types	Daily-Km driven	Battery Capacity	Driving range in km/full charge	Daily charging demand in kWh	Total no of-EVS by 2026 (Moderate)	kWh required/day	kWh required/annual	60% by renewable energy
E-2w	Single phase 15A charge	40	2.5	80	1.3	4,08,869	5,11,086	15,33,25,868	9,19,95,521
E-3W (passenger / cargo)	Single phase 15A charger	120	7	100	8.4	39,479	3,31,623	9,94,86,811	5,96,92,087
E-car (personal)	Type-2 AC (70%) 50kW DC charger (30%)	40	30.2	312	3.9	1,51,727	5,87,454	17,62,36,204	10,57,41,722
E-car (commercial)	Type-2 AC (60%) 50kW DC charger (40%)	100	21.2	181	11.7	9,013	1,05,565	3,16,69,610	1,90,01,766

Table 24 Gross Calorific Value of Indian Coal (in kcal/kg)

Gross Calorific Value of Indian Coal (in kcal/kg)							
	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Coal – Import	5,534	5,586	5,586	5,541	5,557	5,659	5,852
Coal dispatch- Power Sector	4,384	4,384	4,384	4,388	4,367	4,281	4,242
Coal Dispatch - Non - Power	5,548	5,548	5,548	5,644	5,669	5,564	5,624

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Table 25 Gross Calorific Value of Fuels

Type of Fuel	kcal/kg
Crude Oil	10,237
Liquefied Petroleum Gases	11,318
Motor Gasoline	10,717
Gasoline Type Jet Fuel	10,717
Kerosene Type Jet Fuel	10,667
Kerosene	10,467
Gas/Diesel Oil	10,357
Fuel Oil	9,866
Naphtha	10,767
Non-specified Oil Products	9,616

Table 26 Assumptions for number of appliances

Appliances	Assumptions
Fans	1. Assuming 3 fans per urban household 2. Assuming 1 fan per rural household
AC	1. Assuming 1 AC every four urban households
Refrigerator	1. Assuming 1 fridge every three urban households
Television	1. Assuming 1 TV per urban household 2. Assuming 1 TV for 5 rural household
Washing Machine	1. Assuming 1 per urban household in 40% houses

Table 27 Fisheries saving potential[22]

Marine Catch		2019-20
Particular	Unit	Value
Fuel Consumption	lit/Tonnes	933
Equivalent energy	kgoe/tonne	860
Equivalent energy	TOE/Tonnes	0.86
Emission	Tco2/T	2.5

[22] Based on CII study on fisheries sector

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Ice	T/T	4
Production	Lakh Tonnes	6.8
Fuel Consumption	MTOE	0.5848
Energy saving-Moderate	%	15%
Energy saving-Ambitious	%	20%
Energy saving-Moderate	MTOE	0.088
Energy saving-Ambitious	MTOE	0.117
Processing Unit		2020
Electricity Consumption	kWh/tonne	550
Thermal Energy	kg toe/tonne	350
Overall energy toe	kg toe/tonne	450
Energy consumption for 2031		
Fish for processing	Lakh Tonnes	4.76
Fuel Consumption	MTOE	0.2142
Energy saving-Moderate	%	15%
Energy saving-Ambitious	%	20%
Energy saving-Moderate	MTOE	0.032
Energy saving-Ambitious	MTOE	0.043

Proposed committee for State Energy Efficiency Action Plan

Sr No	Department	
1	Chief Secretary to State Government	Chairman
2	State Electrical Distribution Companies	Member
3	State Generation & Transmission Companies	Member
4	State Department of Industries & Commerce	Member
5	State Transport Department	Member
6	State Irrigation Department	Member
7	State Housing Corporation Limited	Member
8	State Agriculture Department	Member
9	State Department of Development/Planning	Member
10	State Department of Finance	Member
11	The Chief Electrical Inspector to Government	Member
12	Municipal Administration & Urban Development	Member
13	MSME Development Department	Member
14	State Department of Environment & Forest	Member
15	Other invitees as considered by the Chairman and as per the agenda of the respective meeting	Member (s)
16	State Designated Energy Agency	Member Convenor

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NOTES

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