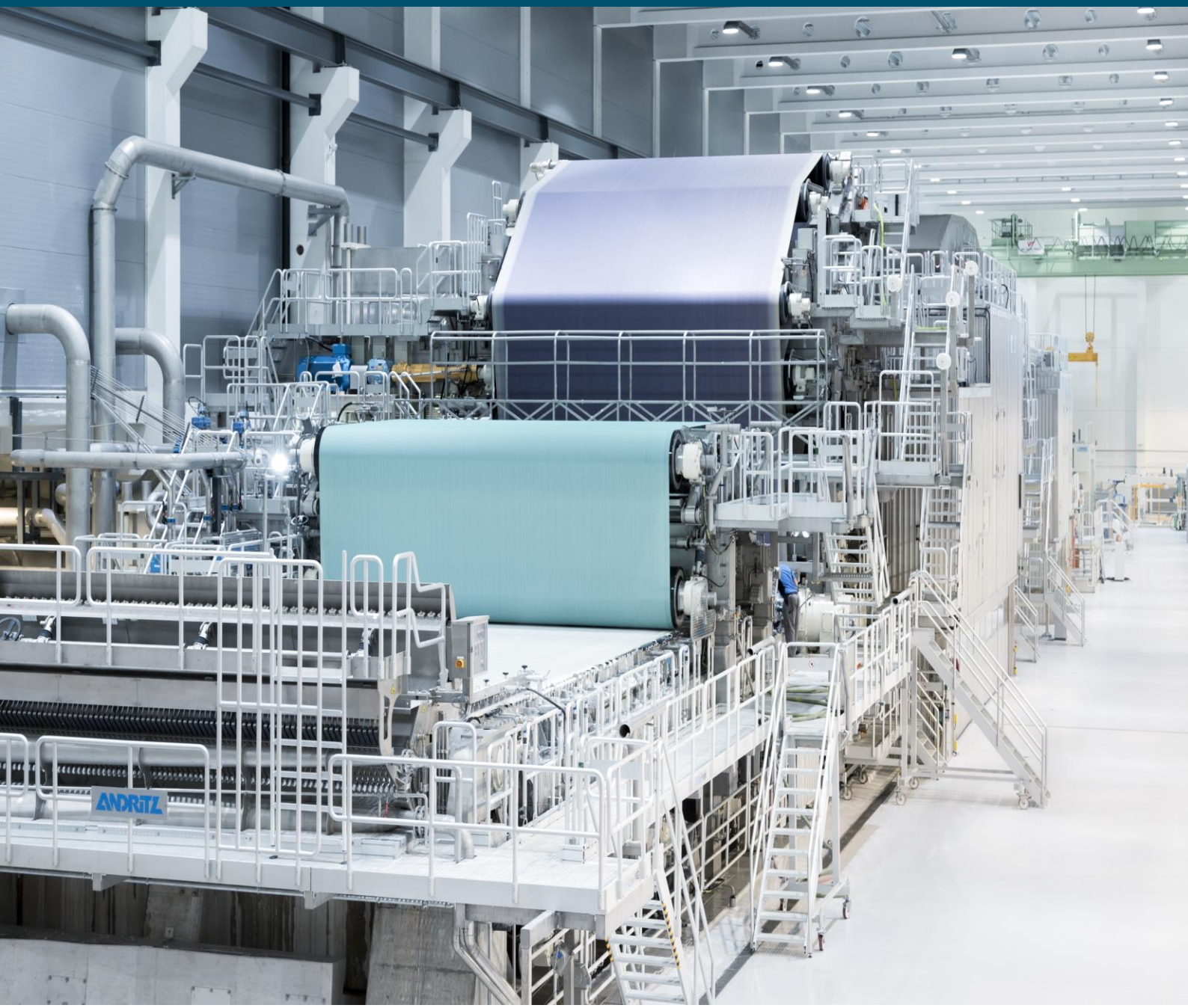
Energy and Resource Mapping of MSMEs in India

Paper Sector Report



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Last but not the least, it is worth mentioning the efforts and enthusiasm shown by all the paper plant personnel towards energy conservation and sustainable growth. We found all the personnel keen to implement the possible energy conservation aspects.

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Abbreviations

APH	Air Pre-Heater
BEE	Bureau of Energy Efficiency
CW	Cooling Water
D.G.	Diesel Generator
DC	Direct Current
DO	Dissolved Oxygen
DSOCC	Double Sorted Old Corrugated Container
ECM	Energy Conservation Measures
EMS	Energy Monitoring System
ETP	Effluent Treatment Plant
FD	Forced Draft
ID	Induced Draft
IE	International Efficiency
kcal	Kilo Calories
kL	Kilo litre
kV	Kilo Volt
kVA	Kilo Volt Ampere
kVAr	Kilo Volt Ampere Reactive
kW	Kilo Watts
kWh	Kilo Watt Hour
LF	Load factor
MG	Machine Glazed
MSME	Micro, Small and Medium Enterprises
MT/T	Metric Ton
NDLKC	New Double Lined Kraft Cuttings
NMRP	National Motor Replacement Program
OCC	Old Corrugated Cardboard
PCC	Primary Centri Cleaner
PF	Power Factor
PDF	Poly Disc Filter
SCC	Secondary Centri Cleaner
SEC	Specific Energy Consumption
TCC	Tertiary Centri Cleaner
TDR	Tri Disc Refiner
VSM	Vibrating Screen Machine
TOE	Tonnes of Oil Equivalent
TPH	Tonnes per hour
MTPA	Million Tonne Per Annum

1. Introduction

The Indian paper sector contributes around 4.7% of total global paper output, and it directly employs 0.5 million individuals, whereas indirectly it employs over 1.5 million people[1]. Furthermore, the paper industries contribute significantly to India's GDP, amounting to approximately USD 500 billion. This sector is projected to grow at a 6% CAGR with expected paper production of 39.2 million tons by 2030. Paper clusters are energy-intensive in their operations and generally use a mix of both modern as well as conventional technologies for their day-to-day functioning, but at the same time, this sector holds immense potential for energy efficiency and the upgradation of technologies in routine processes.

The Bureau of Energy Efficiency (BEE) has developed various comprehensive programs to address the challenges confronting MSMEs in India. Still, at the national level, the energy mapping across different energy-intensive MSME sub-sectors is missing, which provides data on various parameters like production, type and quantity of fuel consumption, energy-saving potential, details on energy-efficient technologies, and future growth scenarios. These data points are not readily available and, in a way, hampers the process of designing sector-specific policies.

Given the need for energy mapping within Indian paper clusters, ICF Consulting India Pvt. Ltd., with support from BEE, has executed the project "Energy efficiency and Resource Mapping of the MSME Sector" for the Paper clusters in India. This exercise focused on estimating the energy consumption, production, technical aspects and conducting detailed techno-economic assessments for the selected cluster. This report provides a complete energy mapping along with benchmarking of various processes. Policy recommendations with a road map for implementation measures are also covered under this report to make the paper sector energy & resource-efficient, and environment friendly.

1.1 Project Objectives

Given this background to the paper industry in India, the objectives of the study include the following:

1. Mapping the energy-intensive paper sectors from an energy perspective
2. Conducting an in-depth study of existing scenarios on energy consumption and identifying opportunities for energy and resource-saving
3. Prepare a roadmap along with timelines to make the sector energy and resource-efficient as well as environment friendly

1.2 Project Methodology

ICF proposed to carry out this assignment in a five-step approach which will be integrated to meet the objective of the project. Our methodology consists of five work streams namely:

1. Project Inception
2. Research and sensitization workshop
3. Energy Audits and post-activity workshop
4. Sectoral Benchmarking
5. Policy Recommendation/Implementation Roadmap

[1] https://india.paperex-expo.com/News/Indian-paper-industry-growing-at-7-IPMA

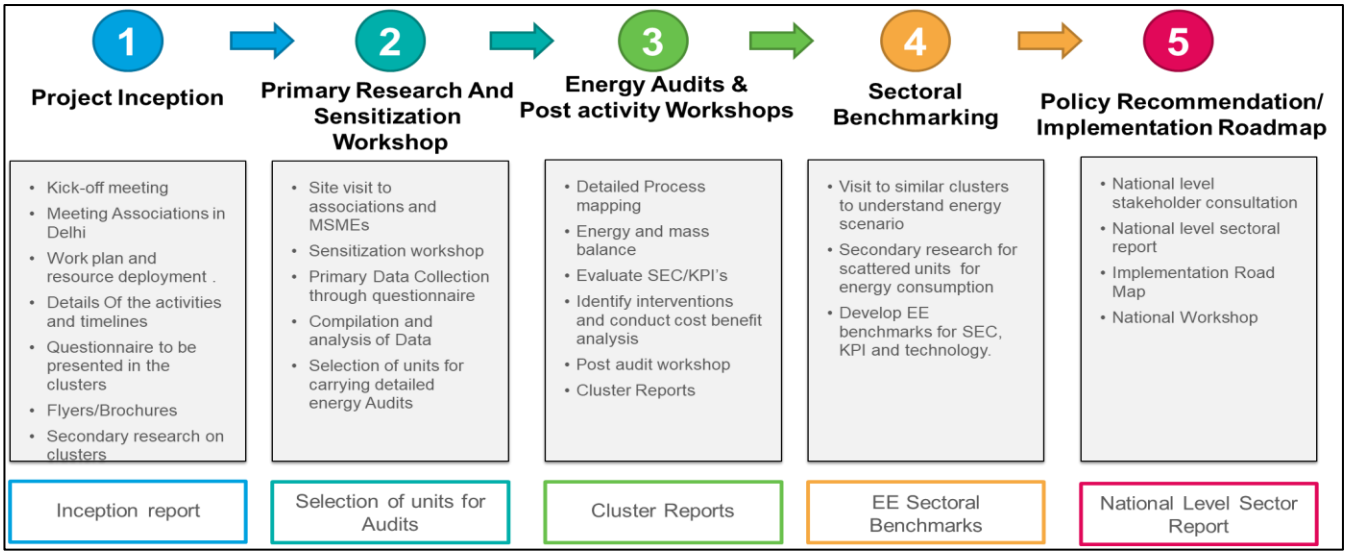


Figure 1: Approach and Methodology

1.2.1 Project Inception

ICF team conducted the kick-off meeting with the Bureau of Energy Efficiency (BEE) team on 26th December 2019. The purpose of this meeting was to discuss the overall approach, specific task areas, lines of communication, and the project schedule. ICF team has provided the preliminary project plan encompassing the following:

- The work plan for completing each of the identified tasks
- Deliverables and interim work products and project timelines
- Secondary and primary research about the cluster
- Existing contacts of industry associations and MSME units
- Finalization of the questionnaire (Sample attached in Annexure E1)
- Flyer of the project (Sample attached in Annexure E2)

ICF team started preparing for the primary and secondary research along with the sensitization workshops for the five clusters. The purpose of these workshops is to spread awareness regarding energy, productivity, and environment, and motivate MSME units to participate in the project for the smooth collection of data and information for developing the benchmarking manual based on the Key Performance Indicators (KPIs).

1.2.2 Research and Sensitization Workshop

Research

The activity started with primary as well as secondary data research which includes desk review of the existing MSME clusters, number of MSME units in operation, production capacity, energy efficiency/audit reports of the cluster/ sector (whichever available), energy directory (wherever available), technology needs assessment documents, international best practices in the sector and current practices.

In our primary research, we conducted meetings with the industrial associations in all the identified clusters. The discussion points were broadly outlined in the table below. The primary objective of the research was to build a database (or inventory) for developing the baseline.

MSMEs and industrial associations had provided support in collecting legitimate data from the MSMEs and also ensured their participation in workshops and project activities.

Figure 2: Discussion points with Industrial Associations

Data Collection Templates (Questionnaire)

The project team developed the Questionnaire for data collection from MSMEs, which is divided into two parts, the first is basic information and the second is the energy consumption detail section. The detailed questionnaire is attached in Annexure E1.

Sensitization Workshops

The project inception workshops were conducted in selected clusters to sensitize the stakeholders about various project activities and their benefits for the sustainable development of the MSME sector.

Following participants were targeted for the workshops:

- MSME units - represented by plant manager or factory owner
- Cluster/Industry associations or Local Chamber of Commerce and Industries
- BEE officials
- Local MSME Development Institutes

Figure 3: Workshop Methodology

Sample Agenda for the inception workshops is attached in Annexure E3 and the feedback form is attached in Annexure E4.

1.2.3 Energy Audits, Process mapping and developing of Key Performance Indicators (KPIs)

Onsite visits & Energy Audits

Based on the information gathered about product type and the energy usage pattern above, the process mapping exercise for each product type in selected units was conducted using the following work steps. Before starting the process mapping, it was pertinent to identify the units for which detailed energy assessment can be conducted. The selection process was guided by the following key parameters:

- Depending on the size and energy consumption profile
- Covering the complete product segment of the sector

The project team conducted an onsite industry assessment to assess the various parameters for the identification of KPIs. The detailed energy assessments were conducted for at least 10 units to arrive at KPIs.

Following key questions guided the audit process:

1. Which MSME units are to be selected for conducting the audits?
2. Which options or interventions are possible?
3. What is the potential of savings?
4. What is the economic feasibility of implementation?

To find answers to the above-mentioned questions, we had included four components in the investment-grade audits. They are shown in the graphic below:

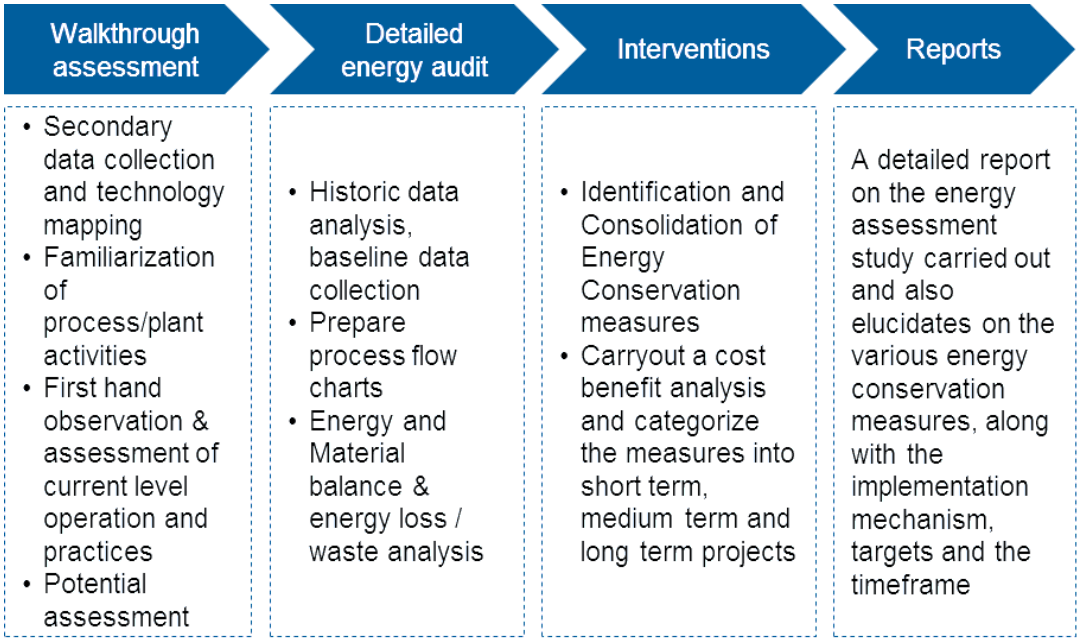


Figure 4: Detailed energy audit methodology

Thus, the audit process includes:

1. Select units based on interactions and data collection
2. Prepare a database of generic and sector-specific technology options, and identify the scope of applicability of these options during the detailed audit process
3. Establish the baseline consumption and the energy and resource savings potential by collecting data and taking measurements at the site
4. Conduct benefit-cost analysis of the identified options

Interventions

The Identified list of improvement options that apply to MSME units audited based on cost and ease of implementation. A database of improvement options was available to the auditor while conducting the audits. During the detailed audit process, the auditors based on their experience and knowledge (based on site conditions) explored the suitability of deploying an option listed in the database and shortlist the most attractive option. ICF compiled a library of energy conservation options based on the following:

- ICF's existing database developed over the years working on energy and resource efficiency
- Web scrapping of case studies published by organizations such as IEA, UNIDO's National Cleaner Production Centre, etc.
- Post identification of different technologies, we have categorized the technologies based on different criteria as highlighted above.
- The existing database was also be improved based on the energy audit reports that are available with BEE through various Energy Efficiency (EE) programs.
- The database also included renewable energy-based options.

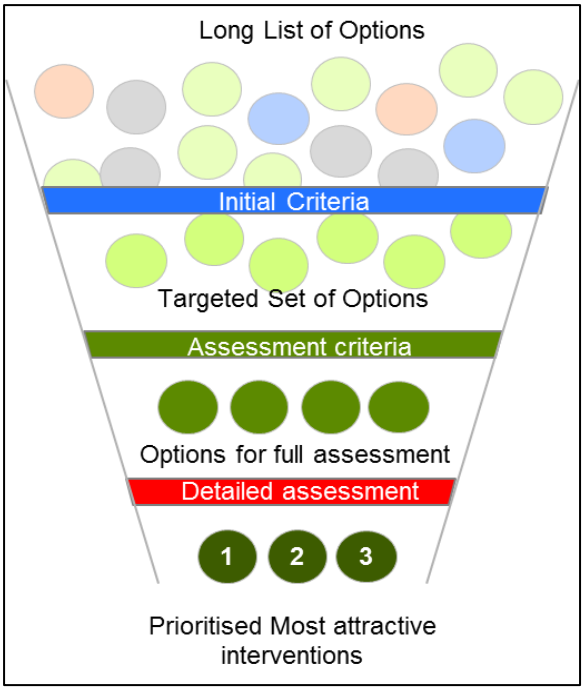


Figure 5: Funnel Diagram for identifying interventions

Details of Process Flow

The basic process flow diagram was developed along with energy and resources utilizations in the different steps of paper manufacturing.

Based on the data collected through research using the templates mentioned above, we performed a trend line analysis of product output and energy consumption of a few MSME units. Using monthly data from the units, we developed trend line and mean median, and mode. If the unit produces multiple products, then the energy consumption and KPIs are estimated for each product separately.

Identification of key performance indicators (KPIs)

Based on the processes and parameters as identified in the previous task, a few key parameters which reflect the electrical, as well as thermal energy consumption of the units, are selected. These parameters are acting as the key results in the benchmarking section. These processes are related to critical parameters, which if, monitored on regular basis, will help the MSME units in establishing their existing performance and improve it gradually. The project team has developed process and sub-process level KPIs. In the case of the non-availability of data, the assumptions/estimations/expert opinion were considered to arrive at KPIs.

Post Cluster Workshop

Findings based on energy audits including inter-cluster studies and comparisons of energy efficiency among clusters were presented in the post-cluster workshops. Interventions for the sector are determined based on the energy audits.

1.2.4 Sectoral Benchmarking

Energy efficiency benchmarking is regarded as the technique to compare the industry with international best practices and technologies for implementation. Site visits in clusters to understand their energy scenario and compare the results of the five clusters with similar other clusters and international benchmarks were conducted. The identified improvement options that apply to these MSME units are based on cost and ease of implementation. A database of improvement options is made available to MSME units for reference. It is an integrated Excel-based sheet that can easily be updated as changes occur or as customization is needed.

Compared the baseline technologies employed in each of the audited MSME paper units with Best Available Technologies (BAT) along with assessing the readiness for technology adoption through a comprehensive review of technologies available / deployed/demonstrated in comparable regions.

1.2.5 Policy recommendation/implementation roadmap

End-stage of the project includes a national-level stakeholder consultation, sectoral report, policy implementation, and roadmaps.

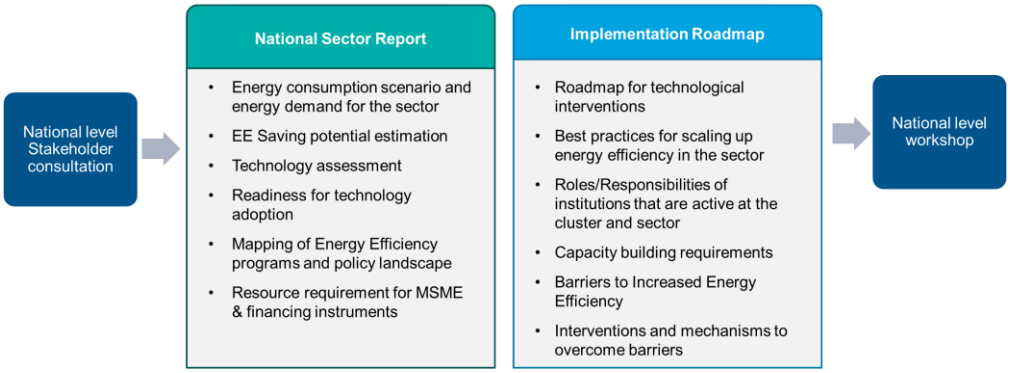


Figure 6: National level stakeholder and dissemination workshop structure

2. Paper sector overview

The Paper industries are one of the fastest-growing industrial sub-sectors in India as the continuous demand for paper increased in education and literacy, growth in organized retail, eCommerce, Fast-moving consumer goods (FMCG), pharmaceuticals, and healthcare. The demand for quality packaging, as well as an increase in the ban on plastics and increment in eco-friendly paper bags, has added to the expansion of paper industries. Till now, paper clusters in India have seen a shift in production from 10.99 MT in 2010 to 19.36 MT in 2019[2] (CPPRI 2020). Further, this sector is expected to grow at a 6% CAGR, with paper production of around 39.2 million tons by 2030[3] (IPMA 2018).

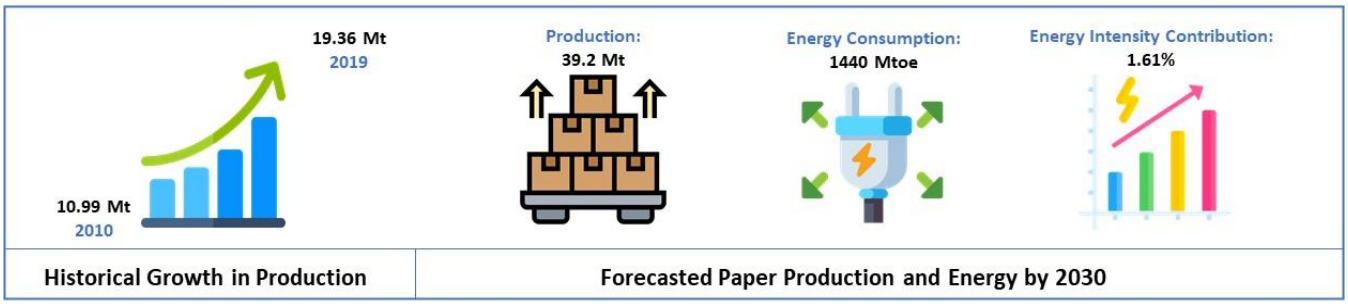


Figure 7: Historical and future trends of the Paper sector in terms of production and energy

With the increase in production, the energy consumption for the paper sector will increase from 464 Mtoe in FY 2012 to 1440 Mtoe in FY 2030. This further increases the energy intensity contribution from 1.05% in 2012 to 1.61% in 2030 as per the estimates of BEE.

2.1 Indian Paper Sector

Indian Paper market has a share of more than 17 MT in 2019-20 of paper and growing at around 7% per annum. As can be seen, from Figure 8, the market share of the paper products in India is given below:

a) Newsprint has 2.58 MT of market share and growing at 2.1%.
b) Writing and printing paper (uncoated + coated) has 5.06 MT of market share and growing at 4.9% per annum.
c) Packaging paper/ paperboard (kraft paper/ paperboard and duplex paperboard) has an 8.71MT market share and growing at 8.4%.
d) Magazine variety/poster has 0.24 MT of market share and growing at 2% while tissue paper has 0.17 MT and growing at 17.8%. In contrast, other paper/paperboards have a 0.36 MT market share and grow at 10.8% per annum.[4]

The total energy consumption of the paper sector in India was 659 Mtoe in 2015[5] , which is projected to reach 1440 Mtoe by 2030.[6]

[2] http://www.dcpulppaper.org/gifs/ShortTreatise.pdf
[3] https://www.printweek.in/news/indian-paper-industry-growing-at-7-ipma-41553
[4] https://www.printweek.in/news/indian-paper-industry-growing-at-7-ipma-41553
[5] Improving Energy Efficiency in Pulp and Paper Sector (Achievements and way forward), PAT, September 2018
[6] India Energy Outlook, Year 2015 - IEA

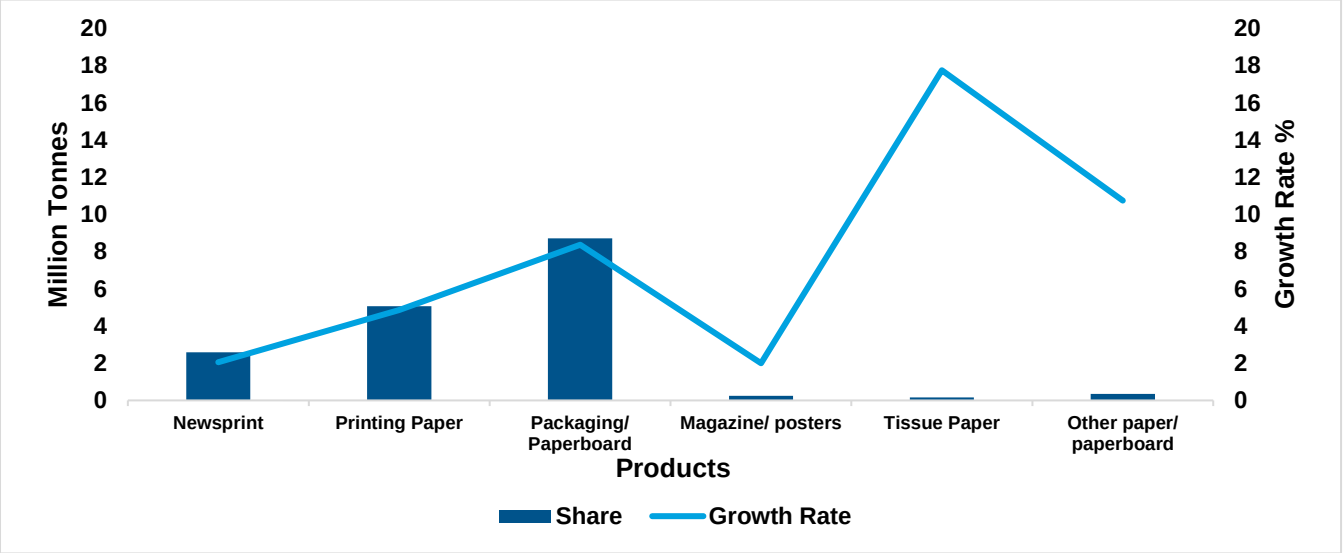


Figure 8: Production market share and growth rate of paper by category

2.1.1 Classification of Paper Industry

The paper sector can be classified in three ways, based on the category (Micro, Small, Medium, Large), raw material, and products that the MSMEs are manufacturing. This classification can be easily understood from Figure 9 below:

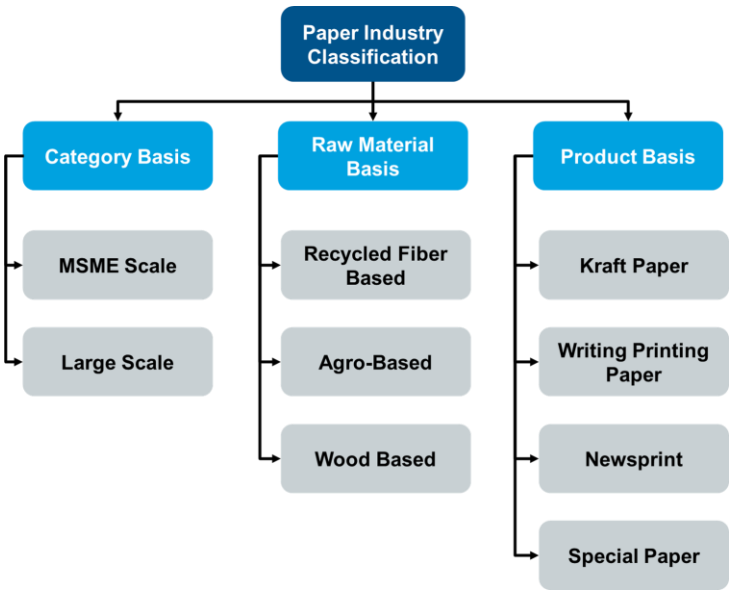


Figure 9 Paper sector classification

The paper industry classification is based on three categories. The first category is capacity (tons per annum) i.e., MSME and Large Industries. The project covers almost all the paper mills from the MSME category whereas Large industries include paper mills under the PAT scheme. The second category is based on the type of feedstock used for the paper generation which includes Wood-based, Agro-based, and Recycled Fiber (RCF)

based paper plants. The third category includes paper grades for classification. The paper grades are Kraft, Writing & Printing, Newsprint and Specialty, and Others.

2.1.1.1 Classification on Category Basis

The Indian paper sector is primarily categorized based on Large industries and MSMEs. Total paper production in India accounts for 19.34 MTPA[7] (CPPRI 2020). As depicted in figure 11, approximately 41% of production is from large enterprises (under PAT scheme), and 59% of the output is from the MSMEs. Further, 37% of the MSMEs are covered under the project.

2.1.1.2 Classification on Raw Material Basis

The paper mills use various raw materials encompassing wood, bamboo, recycled fiber, bagasse, wheat straw, and rice husk. In India, in terms of share in total production, approximately 25% are based on wood, 58% on recycled fiber, and 17% on Agro-residues (Figure 12). The geographical spread of the industry and the market are mainly responsible for the regional balance of production and consumption[8].

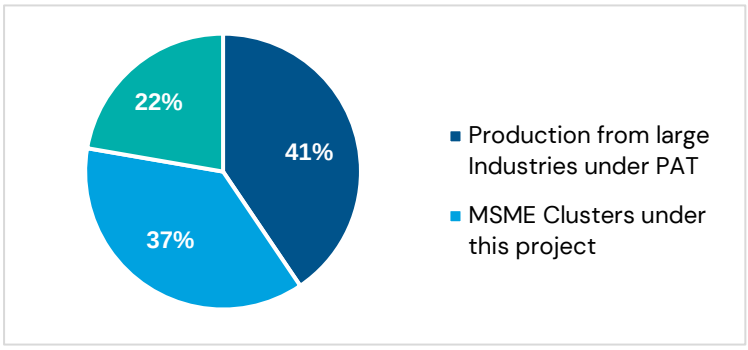


Figure 11: Classification of Paper Sector on Category Basis

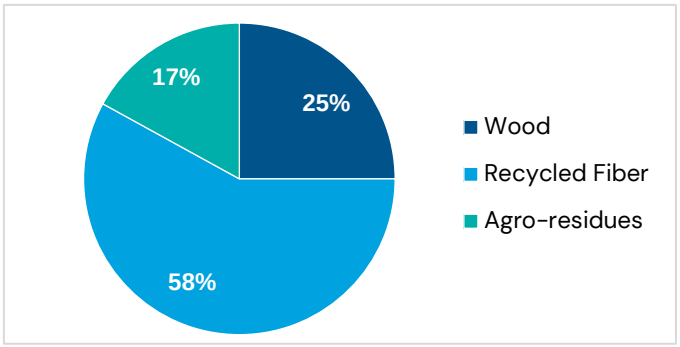


Figure 12: Percentage of paper mills by raw material

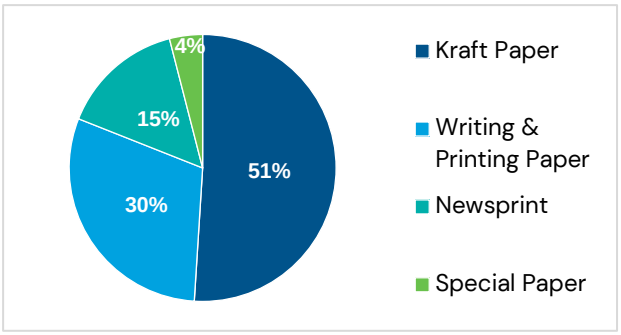


Figure 10: Percentage of paper mills by end products

[7] http://www.dcpulppaper.org/gifs/ShortTreatise.pdf
[8] Indian Paper Manufacturers Association (IPMA)

2.1.1.3 Classification on End Product Basis

Paper products can be majorly classified into four categories:

a) Kraft and Packaging
b) Newsprint
c) Writing and Printing Paper
d) Special Paper (Ex. Tissue paper)

In India, in terms of share in total production, approximately 51% production is of Packaging paper/ paperboard (kraft paper/ paperboard and duplex paperboard), 30% of Writing and printing paper (uncoated + coated), 15% of newsprint paper, and 4% of special paper which includes Magazine variety/poster, Tissue, and other paper/ paperboard (Figure 10).

2.2 Key growth drivers of the market

The paper sector is one of the most vibrant sectors among the different industrial sectors. Several growth drivers will further drive the paper industry to flourish even further. Some of the key growth drivers are:

a. **Growth in the education sector:** The government has increased its effort to provide education and improve the literacy rates in India. The result has been increased expenditure on textbooks and notebooks, providing a good opportunity for paper companies. Additionally, with higher literacy levels, other print media, such as newspapers, have also increased.
b. **Increased corporate activity and lifestyle change:** Economic development and global trade have led to increased corporate activity and paper consumption per capita. At the same time, the increase in sales activity has encouraged the demand for integrated assets. Lifestyle changes also increased the need for special paper, such as tissue paper.
c. **Growth in press publications:** India is the second-largest printing market in the world. The printing and packaging industry has been a successful yearly growth rate of more than 16.2 percent since 1989. Strong growth in the printing industry is expected to exacerbate the demand for paper further.
d. **Increased demand for packaging:** India's packaging, the Indian FMCG sector, is growing rapidly due to strong demand from a large and growing middle class. As a result, there is likely an increase in demand for corrugated boxes.
e. **The growing affluence of the population:** GDP has grown by more than 8 percent over the past decade, increasing wealth. This has led to an increase in all types of consumption in major urban areas and rural markets. High individual consumption leads to a high level of newspapers and magazines, increasing the demand for paper.

2.3 Key Challenges

Small and Medium Enterprises (SMEs) play a vital role in the growth of the Indian economy. Despite the importance of the MSMEs in Indian economic growth, the sector is facing challenges. Understanding the bottlenecks and challenges is very important for resolving the issues that are crippling the paper sector. These challenges are explained by Figure 13:

Figure 13: Paper sector challenges

I. **Raw material availability issue:** Most of the paper production in India is from raw materials like RCF and Agro residue. Sustained availability of low-cost and good quality raw material is one of the challenges for the paper sector.
II. **Scale of Operation issue:** Lack of access to working capital coupled with Poor productivity from inefficient processes and an unskilled workforce poses a challenge in scaling up the operation.
III. **Technological Obsolescence issue:** Most of the paper industries are still using outdated equipment due to technological unawareness.
IV. **Waste disposal issue:** The disposal of wastes like plastics generated by the pulping section is one of the major issues concerning the paper industry.
V. **Water Consumption issue:** Paper industries are very water-intensive. The availability of water required varies from cluster to cluster. To make available fresh water in the cluster for such a water-intensive sector is a major issue in every cluster.
VI. **Environmental Issues:** The disposal of chlorinated compounds, dioxins, and furans, wastewater is known to poses major environmental issues.
VII. **Competition in Global Markets:** Quality products at competitive prices are necessary for effective global competition. Currently, the Indian paper industry is struggling to compete with the global markets.
VIII. **Financial Issue:** Liquidity crunch, Availability of Credit and poor management of finance are major financial issues faced by the paper industry.

The cluster unit faces various challenges related to Financial, institutional, policy, technical, infrastructure, Raw Material, and Manpower or skill barriers.

2.3.1 Financial barriers

The higher cost of energy-efficient technologies is a major reason for many MSMEs' inability to adopt them. Difficulty in accessing loans and higher cost of finance - which can make repayments difficult, acts as a big impediment for adopting energy-efficient technologies. MSMEs are also wary of the documentation formalities involved and are hence not often considering applying for a loan. Some of the MSMEs who have availed the loan have experienced non-transparent or hidden charges in the loan. Further, from the business perspective

for any industry owner, it is more viable, and convenient to invest in project expansion for improving the production capacity, rather than make a piecemeal investment in retrofit and replace options for energy savings. Lack of interest in investing in the new technologies, as these industries getting profits with the existing technologies.

2.3.2 Policy barriers

The general policies at the national and state levels send a strong signal in favour of EE uptake, there are still barriers related to policy that have been identified which inhibit the effective functioning of the market. Some of the policy barriers which have been identified –

2.3.2.1 Lack of coprocessing of plastic waste to energy by paper mills

Typically, plastic is around 1-2 per cent of the total paper that goes into the pulping machine. Around 400 MT of plastic waste is used to get generated in the Vapi industrial area itself. Traditionally, this waste was collected and stored at a place outside the town. Its disposal, therefore, was a big issue, and most industries either used to dump it into landfills developed for the disposal of the industrial hazardous waste or would make heaps of it at a location outside town, in remote locations, where it would be stored for months. Such heaps would catch fire and would burn for days, generating toxic fumes in addition to greenhouse gases.

As waste plastic does not have defined properties/characteristics, a suitable technology such as waste to energy boiler can be adopted. Every 1,000 MW of power generated by Waste to energy boiler plant cuts carbon emissions by 1 million tons.

2.3.2.2 Lack of proper mechanism for paper recycling

The recovery rate of wastepaper in India is quite low (~30%) due to the lack of an effective collection mechanism. With issues like the availability of quality raw material at competitive prices, the players depend on the imports of pulp, wastepaper, and even pulpwood to meet their raw material needs and often have to pay a premium for availing them thereby impacting profitability and capacity addition. To alleviate this significant challenge, the Government of India could frame a policy to allow access to degraded forest land for paper mills to raise pulpwood plantations for increasing pulp availability and reduce import dependence; further, the government can ensure collection mechanism be strengthened to increase usage of wastepaper which can be achieved by creating awareness programs and through policy measures. In India, the industry can also find opportunities for job creation as cooperatives for recycling and waste collectors play an increasingly important and legitimate role in the recycling industry.

The following options can be considered for improving the collection and recycling of paper in India:

- Announce a scheme to provide incentives to municipalities to meet source segregation targets by making it obligatory for households to segregate the wastes and impose a fee on commercial users.
- Guidelines for allocation of land on lease for the development of sorting centers/ warehouses for sorting, baling, and storage of waste paper could be developed by the Ministry of Urban Development. These sorting centers/warehouses may be developed through the PPP route by bidding system so that collected, sorted & baled wastepaper is directly sent to recycling units.
- Regulations may be formulated mandating the use of shredders by all offices and collection of shredded waste paper through contract agreements on an annual basis.
- Voluntary guidelines to contribute to wastepaper collection efforts under CSR could be put in place by industry and industry associations to encourage private sector participation.

2.3.2.3 Lack of market-driven policies to reduce the emissions from the sector

There is a critical requirement of some market-driven policies like – Emission trading scheme and carbon pricing initially at the voluntary phase to reduce the emissions from the sector.

Emission Trading Scheme (ETS)

The ETS scheme requires a cap set for maximum emissions to be emitted by the units. The surplus entities (achievers) who have reduced the emissions (from the target) can trade with the non-achievers, who have surpassed the targeted emissions (non-achievers). This policy will push the units for cleaner and more energy-efficient technologies and the adoption of renewable energy. It can be initially started as a voluntary program and could be mandated with higher caps and trading. The Gujarat government has piloted the cap-and-trade program in 158 industries and has achieved around a 29% reduction in emission from the units that participated in the pilot project.

Carbon pricing (Polluters pay principle)

The emissions produced by industries are a negative externality for the environment and the economy since their true social cost is not reflected by the market price of carbon-intensive goods and services. Instituting a price that reflects the true cost of these emissions seems like an intuitive solution to address these climate change issues. This will drive the industry to push for alternative energy sources, cleaner fuel & renewables. The UK has introduced the Carbon tax of $25 per ton in 2013 which has reduced coal usage sharply.

2.3.3 Infrastructure & Technology barriers

The infrastructure and technology are the backbones of the MSMEs. In the current scenario, the MSMEs are using outdated technologies and have outdated infrastructure. Most of the vendors present in the paper sector are also selling outdated technology. The global paper sector is witnessing various improvements in paper-making technologies such as shoe press, jumbo press, drum pulpers, etc., but these improvements are not currently reflected in the Indian MSMEs due to lack of knowledge, lack of finances, and lack of service providers. Though LSPs are available in the cluster, they don't have technical strengths for the supply of efficient equipment. Also, there is concern over production loss during the implementation of the energy-saving proposals

2.3.4 Raw Material Quality

Most of the paper mills in the clusters use recycled fiber (RCF) as a raw material to produce different grades of paper. A large part of this is imported from the U.S, U.K, and other countries. However, the quality of imported recovered paper is not uniform, and a substantial portion of the imports are unsorted scrap paper. Poorly sorted paper is also associated with a larger proportion of byproducts such as plastics, high-density materials, packaging waste, deinked sludge, and more.

To improve the quality of the imported Recycled fiber (RCF), the government of India has deployed the policy of a 1% contamination limit which would help mill owners get high-quality raw material with lesser byproducts and increased yield percentage.

Wastepaper is recycled and it is the main raw material for the clusters, but these paper industries are going through a tough phase with the novel coronavirus (Covid-19) pandemic affecting supply, compounded by the non-availability of shipping containers and China importing huge quantities of kraft paper from India.

2.3.5 Manpower or skill set barriers

The majority of the entrepreneurs in a paper cluster do not have any in-depth technical expertise and knowledge on energy efficiency. They are dependent on local technology suppliers, service companies, or limited in-house technical expertise, who normally also rely on established and commonly used technology. The lack of technical know-how has made it difficult for the paper unit owners to identify the most effective technical measures. A few demonstration projects may motivate them to take up the projects.

2.4 Geographical coverage

A detailed and holistic study was conducted in five paper clusters across the country to have an Energy and Resource outlook of the paper sector. These five clusters were selected through secondary research, field visits, and stakeholder consultations. In addition to the selected five clusters, three additional paper clusters were also chosen for the walkthrough surveys. The cluster selection was governed keeping in view different matrices given in table 1 below:

Detailed cluster selection matrix can be referred to from figure 14. Five clusters selected for detailed study include:

- Uttar Pradesh – Muzaffarnagar & Saharanpur
- Uttarakhand- Kashipur
- Gujarat - Morbi
- Gujarat – Vapi
- Tamil Nadu – Erode-Coimbatore

In each of the above five clusters, ten units were selected for conducting detailed energy audits. Three clusters selected for the additional survey include:

- Uttar Pradesh – Meerut
- Andhra Pradesh – East Godavari
- Andhra Pradesh – West Godavari

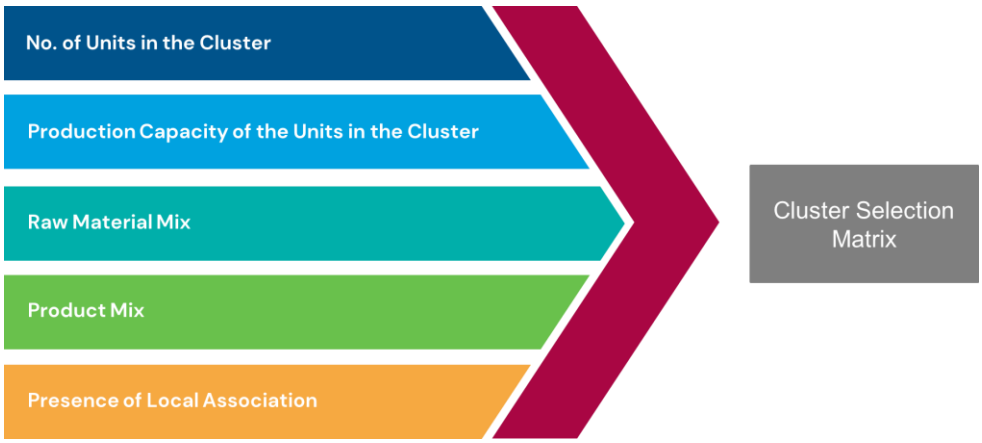


Figure 14: Cluster Selection Matrix

The selected clusters are shown in the map below (Figure 15):

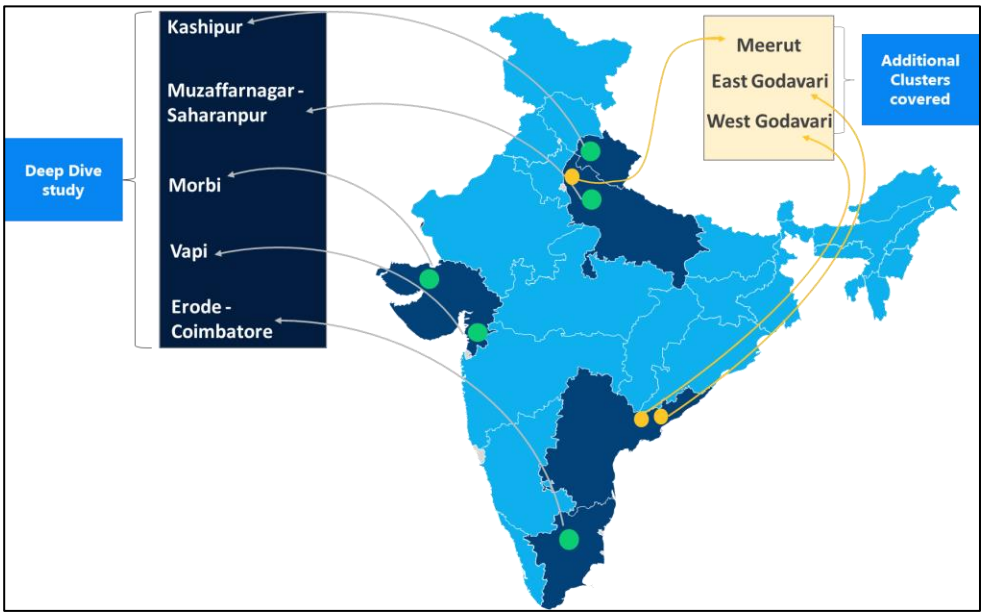


Figure 15: Clusters covered under this project

Table 1: Cluster selection matrix

S.L. No.	State	Cluster	No. of Mills	Technology - Paper Mill classification			Products Manufactured
				Wood-Based Mills	*Wastepaper Based*	*Agro Residue Based*	
1	Uttar Pradesh	Muzaffarnagar & Saharanpur	26		✓	✓	Kraft Paper, special paper, writing/printing paper & Newsprint
2	Uttarakhand	Kashipur	23	✓	✓	✓	Writing/printing paper, Kraft paper, Newsprint paper
3	Gujarat	Vapi	36		✓		Kraft Paper, special paper, Newsprint, writing/printing paper
4	Gujarat	Morbi	50	✓	✓		Kraft Paper, special paper
5	Tamil Nadu	Erode-Coimbatore	27		✓		Kraft paper, Newsprint paper, writing/printing paper
6	Uttar Pradesh	Meerut	14		✓		Kraft paper, Newsprint paper, special paper, writing/printing paper
7	Andhra Pradesh	East Godavari	14		✓		Kraft paper, Newsprint paper,

S.L. No.	State	Cluster	No. of Mills	Technology - Paper Mill classification			Products Manufactured
				Wood-Based Mills	*Wastepaper Based*	*Agro Residue Based*	
							writing/printing paper
8	Andhra Pradesh	West Godavari	13		✓		Kraft paper, Newsprint paper, writing/printing paper
9	Gujarat	Ahmedabad	9	✓	✓	✓	Writing/printing paper, Kraft paper, Newsprint paper
10	Maharashtra	Mumbai	17	✓	✓	✓	Kraft paper, Newsprint paper, special paper, writing/printing paper
11	Maharashtra	Aurangabad	11		✓		Kraft paper, special paper
12	Maharashtra	Nashik	7		✓		Kraft paper
13	Maharashtra	Pune	7		✓		Kraft paper, Newsprint paper, writing/printing paper
14	Maharashtra	Thane	7		✓		Kraft paper, Newsprint paper, writing/printing paper
15	Punjab	Amritsar	10		✓	✓	Kraft paper, Newsprint paper, writing/printing paper
16	Punjab	Ludhiana	10		✓		Kraft paper
17	Telangana	Hyderabad	10		✓		Kraft paper, Newsprint paper, special paper, writing/printing paper
18	Telangana	Medak	10		✓		Kraft paper, special paper
19	Karnataka	Bengaluru	9	✓	✓		Kraft paper, special paper
20	West Bengal	Howrah	8		✓		Kraft paper
21	West Bengal	Kolkata	6		✓		Kraft paper, Writing Paper

2.4.1 Overview of selected paper cluster

The five clusters were selected through secondary research, field visits, and stakeholder consultations. All these clusters are dominated by paper manufacturing industries and these industries have a strong presence in their respective clusters. The brief details of the five selected clusters are presented below:

2.4.2 About Muzaffarnagar-Saharanpur cluster

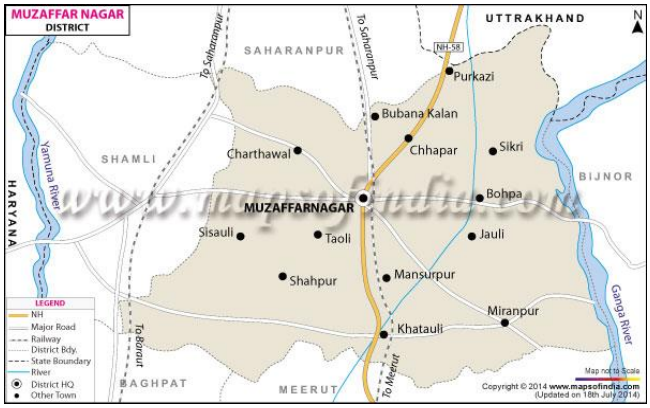
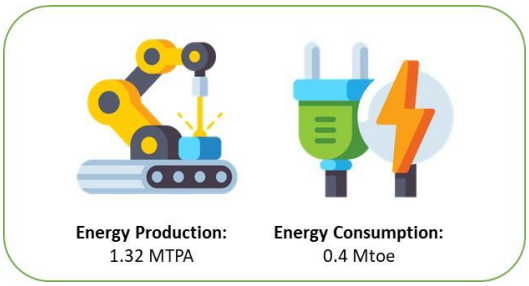


Figure 16: Muzaffarnagar-Saharanpur cluster map

Muzaffarnagar is a large industrial town in Western Uttar Pradesh, with paper, sugar, and steel as its primary industrial products. There are around 26 paper manufacturing units in the Muzaffarnagar paper cluster. The Muzaffarnagar and Saharanpur cluster has about 26 MSME units. The cluster provides direct employment to over 50,000 skilled and unskilled people and indirect employment to over 150,000 people.



The total production in Muzaffarnagar and Saharanpur clusters is around 1.32 MTPA, and the total energy consumption is approximately 0.40 Mtoe. About 53% of the total units belong to the medium category, 8% and 31% belong to the Micro and small category, respectively. There are also 8% mills belonging to the Large (Non-PAT Category). The number of units falling under a different category of MSME with the average production capacity is tabulated below (Table 2):

Table 2: Different categories of MSME units in Muzaffarnagar-Saharanpur Cluster

	Micro	Small	Medium	Large (Non-PAT)
Percentage of units	**8%**	**31%**	**53%**	**8%**
Number of Units	2	8	14	2
Average production Capacity (TPD)	<50	50-150	150-300	>300
Total annual production (MT)	0.008	0.297	0.776	0.241

2.4.3 About Kashipur cluster

Kashipur is a city in Udham Singh Nagar district, one of its seven subdivisions in Uttarakhand, with paper and sugar as its primary products. The town of Kashipur is emerging as a major industrial center. The Kashipur cluster has about 23 micro, small, medium & large-scale paper units. One of the paper mills in the Kashipur

cluster uses imported wood pulp and bagasse as the raw material. Six industries were producing high-quality writing and printing, and two units produced special kinds of paper. The Kashipur cluster map is shown below:

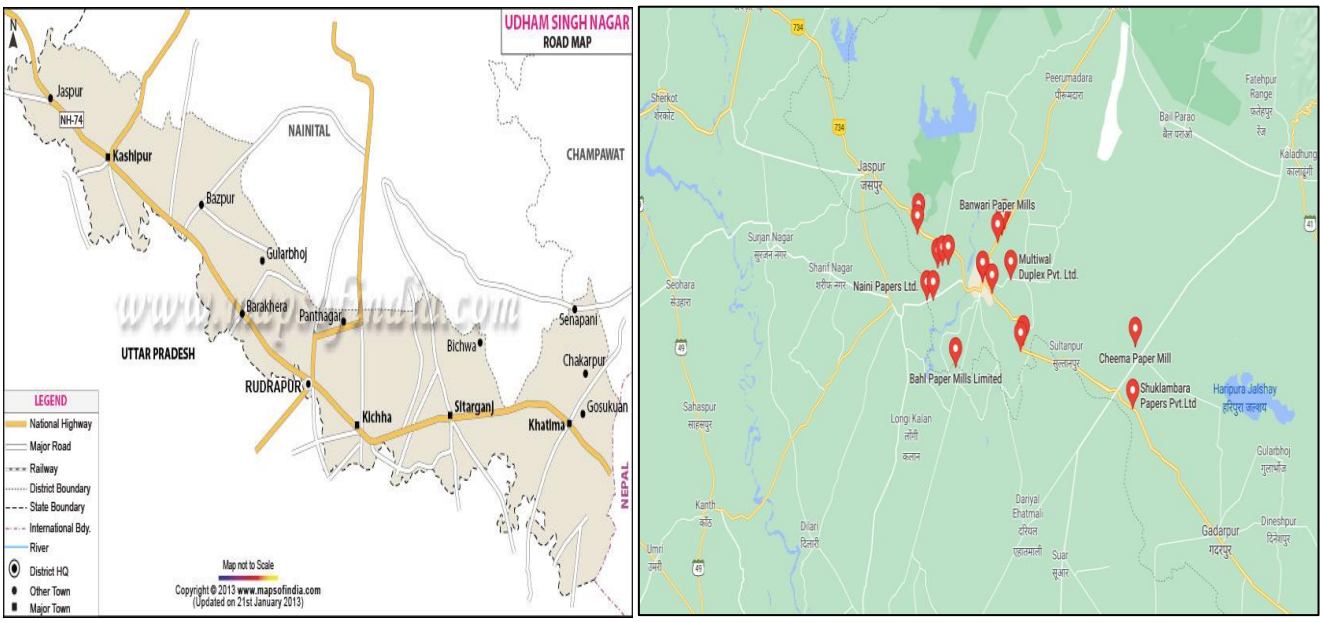


Figure 17: Kashipur cluster map

The total production in the Kashipur cluster is around 1.37 MTPA and the total energy consumption is around 0.496 Mtoe. About 48% of the total units belong to the medium category, 43% and 9% belong to the small and large category. The number of units falling under a different category of MSME with the average production capacity is tabulated below (Table 3):

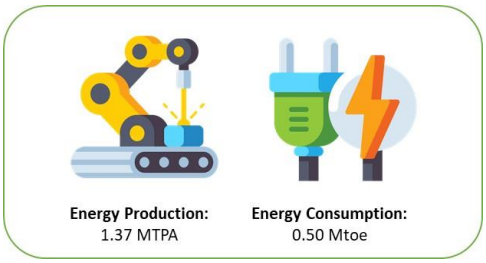


Table 3: Different categories of MSME units in Kashipur Cluster

	Small	Medium	Large
Percentage of units	43%	48%	9%
No. of Units	10	11	2
Average production Capacity (TPD)	107	244	502
Total annual production (MT)	0.32	0.74	0.31

2.4.4 About Morbi cluster

Morbi is a district of the state of Gujarat, India. The district has five talukas – Morbi, Maliya, Tankara, Wankaner (previously in Rajkot district), and Halvad (previously in Surendranagar district). The industrial units are diverse and consist of ceramic, pulp and paper, mills, clock, roof tile, and laminates. Paper Units in the Morbi cluster produces a mostly unbleached variety of packaging grade paper, including the duplex paper board. Availability of raw material at a cheaper rate in the area and the government of India's effort to represent Morbi as an industrial town is a cause for such a high concentration of mills. The Morbi cluster map is shown below (Figure 18):

Figure 18: Morbi cluster map

The Morbi cluster has about 40 micro, small, medium & large (non-PAT) – scale paper units. The total production from the cluster is about 1.86 MTPA, and the total energy consumption is about 0.44 Mtoe. All the paper mills in the cluster are using wastepaper as the raw material. All units are producing Kraft and packaging paper, including the duplex paper board.

About 45% of the total units belong to the medium category, 38% and 15% belong to the small and large category. Only 2% belong to the Micro category. The number of units falling under a different category of MSME with the average production capacity is tabulated below (Table 4):

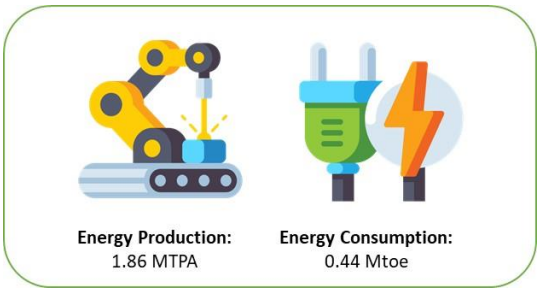


Table 4: Different categories of MSME units in Morbi Cluster

	Micro	Small	Medium	Large
Percentage of units	2%	38%	45%	15%
No. of Units	1	15	18	6
Average production Capacity (TPD)	30-100	30-100	100-200	200-500
Total annual production (MT)	0.04	0.40	0.87	0.55

2.4.5 About Vapi cluster

Vapi is the biggest industrial town in Asia in the Valsad district of south Gujarat, developed by Gujarat Industrial Development Corporation (GIDC). The Vapi cluster has about 36 small, medium & large (non-PAT) – scale paper units. The total production from the cluster is about 1.17 MTPA, and the total energy consumption is around 0.25 Mtoe. All the paper mills in the cluster are using wastepaper as the raw material. Apart from all units producing Kraft and packaging paper, there was 1 unit producing high-quality writing and printing, three units producing newsprint, and two units producing special kinds of paper. The Vapi cluster map is shown below (Figure 19):

Figure 19: Vapi cluster map

About 36% of the total units belong to the medium category, 50% and 14% belong to the small and large category. The number of units falling under a different category of MSME with the average production capacity is tabulated below (Table 5):

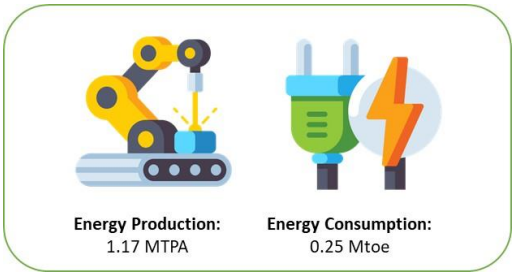


Table 5: Different categories of MSME units in Vapi Cluster

	Small	Medium	Large
Percentage of units	50%	36%	14%
No. of Units	18	13	5
Average production Capacity (TPD)	30-100	100-200	200-500
Total annual production (MT)	0.37	0.43	0.37

2.4.6 About Erode-Coimbatore cluster

In 1979, the Coimbatore district was bifurcated into Coimbatore and Erode districts. Again in 2008, four taluks from Coimbatore District, namely Tiruppur, Udumalpet, Palladam, and Avinashi (Part), were carved out to form part of the newly formed Tiruppur district. Erode district, predominantly agriculture in nature, is emerging gradually but steadily as an Industrially Promising District. The Erode-Coimbatore cluster map is shown below (Figure 20 and 21):

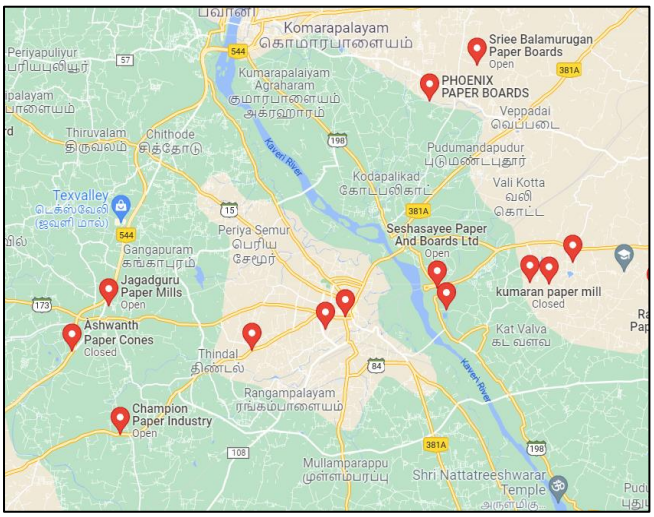


Figure 20: Paper mill's location in Erode

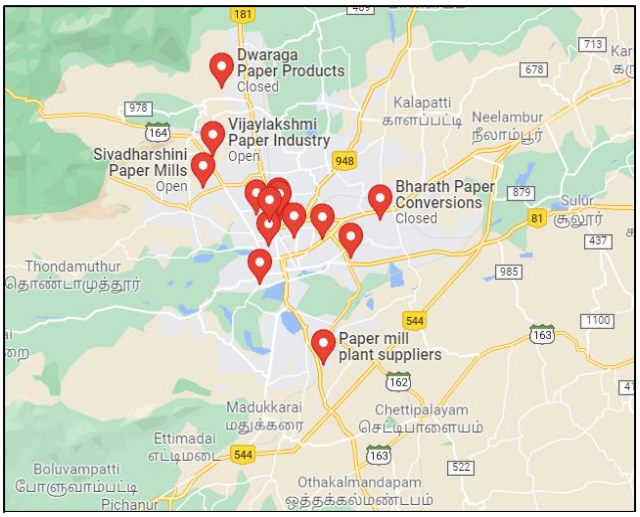


Figure 21: Paper mill's location in Coimbatore

The Erode-Coimbatore cluster has about 27 small, medium & large (non-PAT) – scale paper units. The total production from the cluster is about 0.605 MTPA, and the total energy consumption is around 0.124 Mtoe. All the paper mills in the cluster are using wastepaper as the raw material. Apart from all units producing Kraft and packaging & Writing/Printing paper, two units produced high-quality special paper, and one unit produced newsprint.

About 74% of the total units belong to the medium category, 19% and 7% belong to the small and large category. The number of units falling under a different category of MSME with the average production capacity is tabulated below (Table 6):

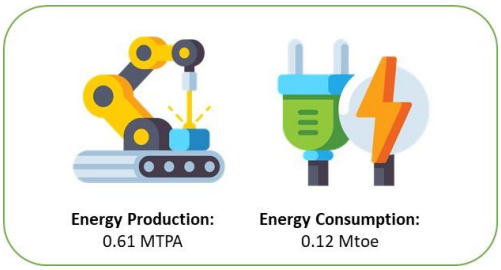


Table 6: Different categories of MSME units in Erode-Coimbatore Cluster

	Small	Medium	Large (non-PAT)
Percentage of units	19%	74%	7%
No. of Units	5	20	2
Average production Capacity (TPD)	<40	40-150	>150
Total annual production (MT)	0.04	0.43	0.14

2.5 Sector level Stakeholders

During the project, the project team has interacted with multiple national and cluster level associations for having as many stakeholders for having their views at different stages of the product. A detailed list of stakeholders is shared in Annexure E6:

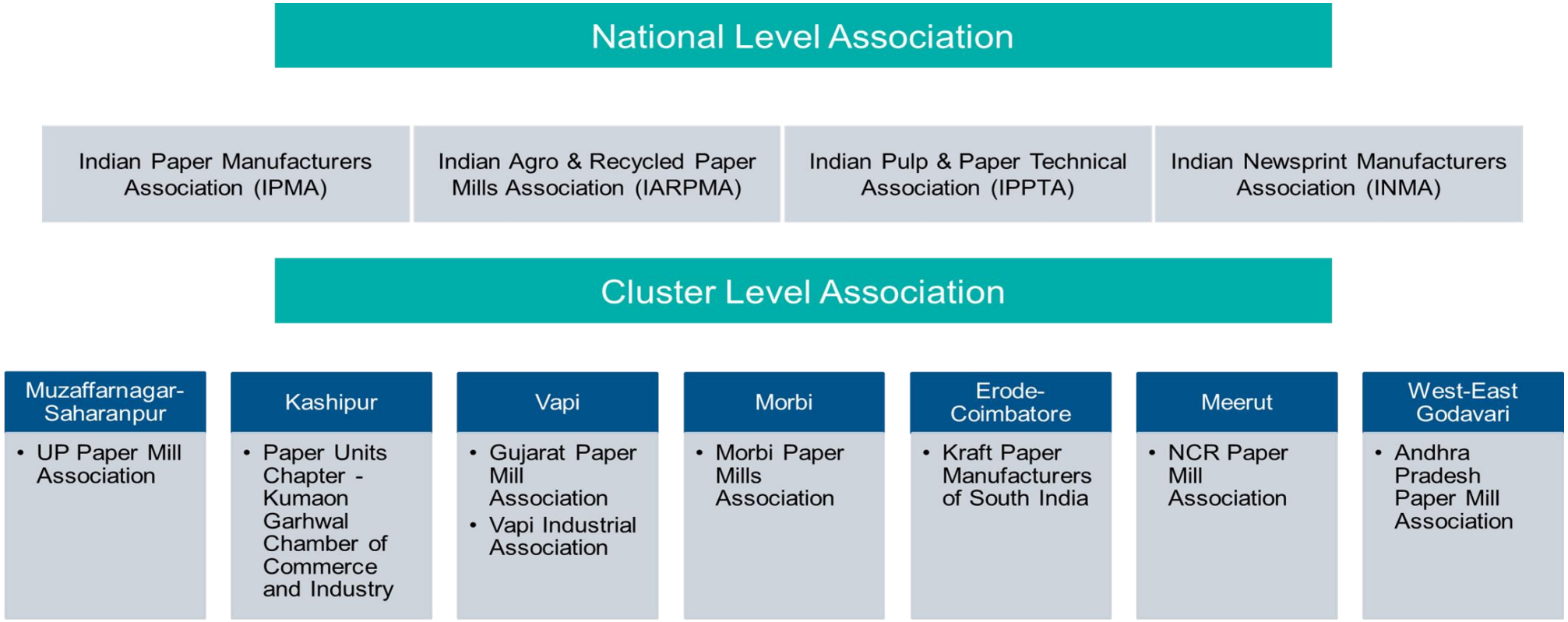


Figure 22: Paper Sector Associations

3. Energy consumption and Benchmarks

ICF has done a holistic study in the paper sector. After doing the secondary research on all the different paper clusters of the country, ICF has selected 5 paper clusters for the detailed study and 2 additional clusters for the walkthrough surveys. These 5 clusters are chosen in such a way that they can be used as the representative sample of the whole paper clusters of India. The outline of the Indian paper sector which will be discussed in the following sections is based on the audits and the surveys in the selected clusters.

Category & Production

Selected paper clusters comprise 86% of the small and medium category, followed by the large (non-PAT) (11%) industry. Only 2% of industries fall in the micro category. The maximum share of MSMEs is found in the Erode-Coimbatore cluster as they have only 7% of the large industries, followed by Muzaffarnagar – Saharanpur, and Kashipur. The remaining Morbi and Vapi clusters have 14-15% of the large industries. The percentage of Paper MSMEs in the selected clusters (Figure 23) as per the size is shown below:

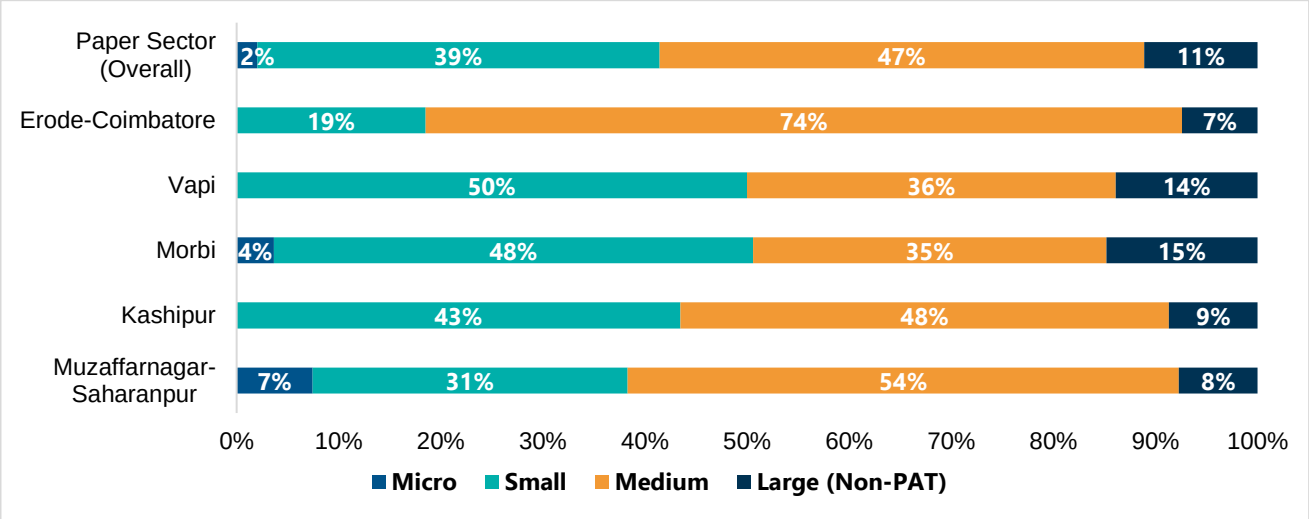


Figure 23: Percentage distribution of Paper MSMEs in clusters

There are also considerable differences observed in the TPD production of the mills falling in different clusters in the same MSME category. In almost all clusters, medium category units have a significant share in production whereas the share of small and large (non-PAT) category units is lower. The percentage of micro category units is lowest in Muzaffarnagar-Saharanpur and Morbi, with the remaining three units having no micro-units in their cluster.

Product mix

The paper mills in all the clusters majorly produce the Kraft paper from Recycled Fiber. However, some mills in the clusters also produce Writing-Printing Paper, Newsprint & Special Kind of paper in the clusters. These products are also available in different Grams per square meter (GSM) [9] & Burst Factor (BF) [10]. The product-wise production in all clusters is presented in Figure 24:

[9] https://www.pacorr.com/blog/importance-of-gsm-and-how-to-calculate-it/

[10] https://www.prestogroup.com/blog/how-to-check-bursting-factor-for-paper-and-board/

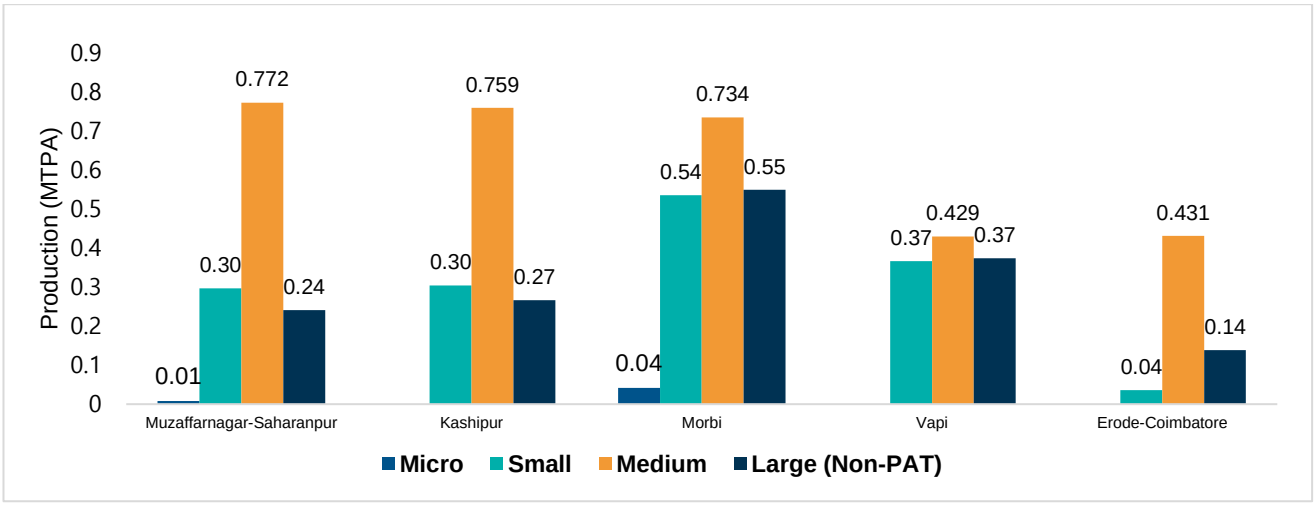


Figure 24: Category-wise production in selected clusters

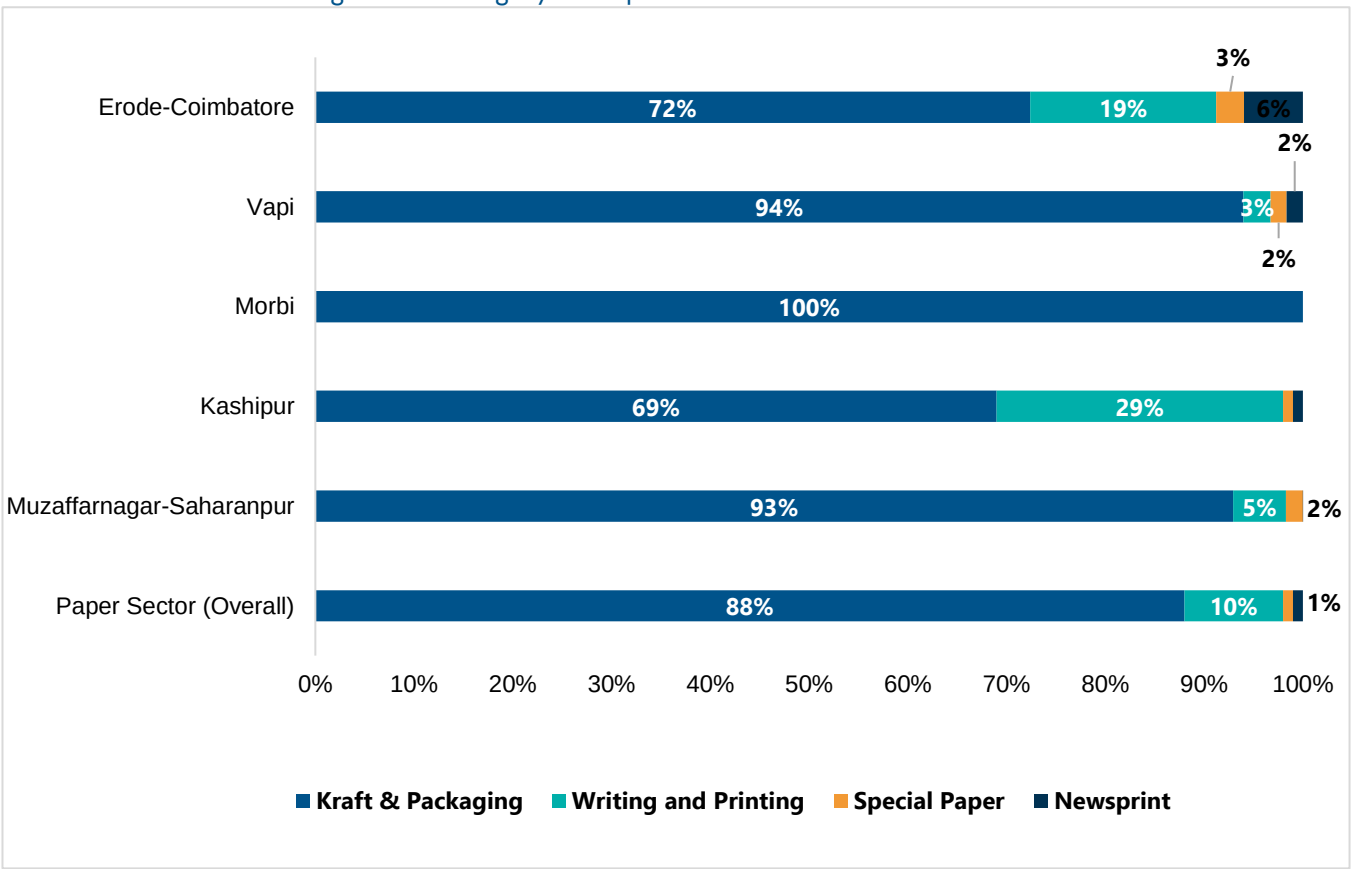


Figure 25: Product wise Production (%) in clusters

The Morbi cluster has the highest production of 1.86 MMTA in the kraft & packaging category, whereas Kashipur has the highest production of 0.39 MMTA in the writing & printing category. It can also be inferred that the SEC of Morbi and Vapi will be lower than the other three clusters as the share of kraft & packaging is higher in Morbi and Vapi. The energy consumed in paper production is generally lower for the kraft & packaging category when compared to writing & printing, and other grades of paper.

Raw Materials

Almost all the paper industries in the selected paper clusters use recycled fiber-based raw material. There are only a very few industries that are using Agro-based raw material. There is only one unit in Morbi that is using wood as raw material, but it falls under the Large (non-PAT) category.

Table 7: Raw Material mix in clusters

Clusters	Recycled Fiber Based (RCF)		Agro-Based		Wood-Based	
	Mills (No.)	Production (MTPA)	Mills (No.)	Production (MTPA)	Mills (No.)	Production (MTPA)
Muzaffarnagar-Saharanpur	27	1.43	1	0.06	0	0
Kashipur	23	1.16	4	0.17	0	0
Morbi	40	2.03	0	0	1	0.06
Vapi	36	1.31	0	0	0	0
Erode-Coimbatore	27	0.68	0	0	0	0
Total	**153**	**6.61**	**5**	**0.23**	**1**	**0.06**

Throughout India, it's a general trend that most of the MSMEs paper plants use Recycled carbon fiber (RCF) based raw material for paper production (Figure 26). There are only a few industries that use Agro-based raw material and only a handful of MSMEs uses wood-based raw material. As MSME paper units mostly produce cardboard and corrugated boxes, they can consume low-quality raw material or wastepaper as input for paper production, and hence RCF contributes around 96% of total raw material consumption for these units.

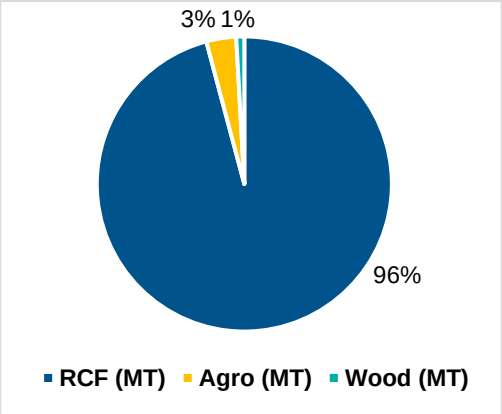


Figure 26: Percentage split of raw material consumption in paper sector

3.1 Energy Benchmarking

3.1.1 Fuel & Electricity mix

The MSME clusters which are located nearer to the seashore are majorly using coal as the fuel in their paper plants. In contrast, the paper mills which are far away from the seashore are majorly using biomass as the source of energy. These mills are also using electricity provided by the state electricity boards. It's been observed that using cogeneration to produce electricity is not such a common practice in the paper industries in many clusters however there are paper mills in every cluster that are using microturbines to produce electricity. Some of the Mills in the Erode-Coimbatore region are also using wind power in their paper factories.

Table 8: Energy tariff rates in selected clusters

Clusters	Details (HT Industry having contracted load above 88kVA/75 kW)	Energy Charges (INR/kWh)	Demand Charges (INR/kVA/month)
Muzaffarnagar-Saharanpur		7.1*	300
Kashipur	Upto 1000kVA Load factor upto 40%	4.2*	310
	Upto 1000kVA Load factor above 40%	4.6*	310
	More than 1000kVA Load factor up to 40%	4.2*	370
	More than 1000kVA Load factor above 40%	4.6*	370
Vapi	Upto 500kVA	4.0	150
	From 500kVA to 1000kVA	4.2	260
	From 1000kVA to 2500 kVA	4.2	475
	Above 2500 kVA	4.3	475
	In excess over contract demand	4.3	555
Morbi	Upto 500kVA	4.0	150
	From 500kVA to 1000kVA	4.2	260
	From 1000kVA to 2500 kVA	4.2	475
	Above 2500 kVA	4.3	475
	In excess over contract demand	4.3	555
Erode-Coimbatore		6.35	350

* Energy Charges Unit in Muzaffarnagar and Kashipur are in INR/kVAh.

From Table 9, it can be understood that Energy charges are highest for Muzaffarnagar – Saharanpur which is Rs. 7.1/kVAh, and Erode-Coimbatore, which is Rs. 6.35/kVAh. For the other three clusters, it is in the range of Rs. 4.0/unit to Rs. 4.6/unit depending on load factor and kVA load requirement. Muzaffarnagar –

Saharanpur, and Erode-Coimbatore have fixed demand charges, whereas the other three units have demand charges based on load factor and kVA load requirement.

Table 9 Time of Day (ToD) structure of two paper clusters

Muzaffarnagar-Saharanpur		Kashipur	
Summer Months (April to September)		***Summer Months (April to September)***	
5 AM - 11 AM	-15%	11 PM - 7 AM	-15%
5 PM - 11 PM	15%	6 PM - 11 PM	15%
Winter Months (October to March)		***Winter Months (October to March)***	
5 PM - 11 PM	15%	6 PM - 10 PM	15%
		6 AM - 9 AM	15%
11 PM - 5 AM	-15%	10 PM - 6 AM	-15%

The above tables show the ToD structure of clusters for all clusters except Erode-Coimbatore, whereas Morbi and Vapi have a Power factor penalty and rebate system.

Table 10 Power Factor Penalty and Rebate System in Morbi and Vapi Clusters

	Morbi and Vapi
10 PM - 6 AM	Concession on energy charges @ Rs. 0.45/kWh
Other time	No concession/ Normal charges
Power factor penalty	1% on the total amount of electricity bill for the month under the head "Energy charges' for PF below 0.90 up to 0.85 for every 1% drop; similarly, 2% for PF below 0.85
Power factor rebate	0.5% on the total amount of electricity bills for the month under the head Energy charges for PF above 0.95 for every 1% rise

Table 11: Type of fuel consumed in clusters

Types of Thermal Energy	Calorific value (kCal/kg)	Price per unit (INR/Tonne)
Coal	3,250 to 6,000	3,500 to 7,000
Lignite	2,500 to 3,000	2,800 to 3,500
Wood	2,500 to 4,800	2500 to 3,000
Wood Chips	3,000 to 3,400	3,260 to 6,000
Rice Husk	3,000 to 3600	3,000 to 4400
Bagasse	2,200	1,500 to 1,600
Dry Leaves	3,000	2,000 to 2,200
Waste Sludge	3,150	2,500
Pith	1,800	1,600
Ground Nut Shells	3,500	3,260
Paddy Husk	3,000	3,000
Sawdust	2,500	2,900
Wastepaper	2,200	600

The calorific value and fuel cost for each type of fuel consumed in various clusters are given in Table 11. As can be seen, the price of most of the fuels is comparable to the coal price. Most of these units which consume biofuels are near agricultural land and forest. For units from clusters such as Morbi and Vapi which are nearer to Port, where biofuel prices are relatively higher prefer using manly coal. Figure 27 shows thermal and electrical energy consumptions cluster-wise; it can be seen that Erode-Coimbatore is having the highest share of grid electrical energy with 16.5% and Muzaffarnagar-Saharanpur is having the highest share of cogeneration with 10.3%.

3.1.2 Energy Mix

In India, paper mills use a different variety of fuels to fulfill their energy demands. These different fuels are indicated in table 11. The paper mills also use electricity and steam as the source of secondary energy. The steam is produced in a boiler which is run by various fuels. The steam produced is used in two ways, first to produce electricity by cogeneration and second by directly using them in the paper machine. The total energy consumed by MSME paper plants can be classified into thermal energy (process), thermal energy (cogeneration), and grid electrical energy. The following figure 27 gives information on the contribution of these three types of energy in various clusters. As can be understood from the figure, the share of thermal energy (cogeneration) is highest in Muzaffarnagar-Saharanpur with 10.3% and lowest in Vapi (0.5%) and Erode-Coimbatore (0.02%). The share of grid electrical energy is highest in Erode-Coimbatore with 16.5% and lowest in Muzaffarnagar-Saharanpur with 3.5%.

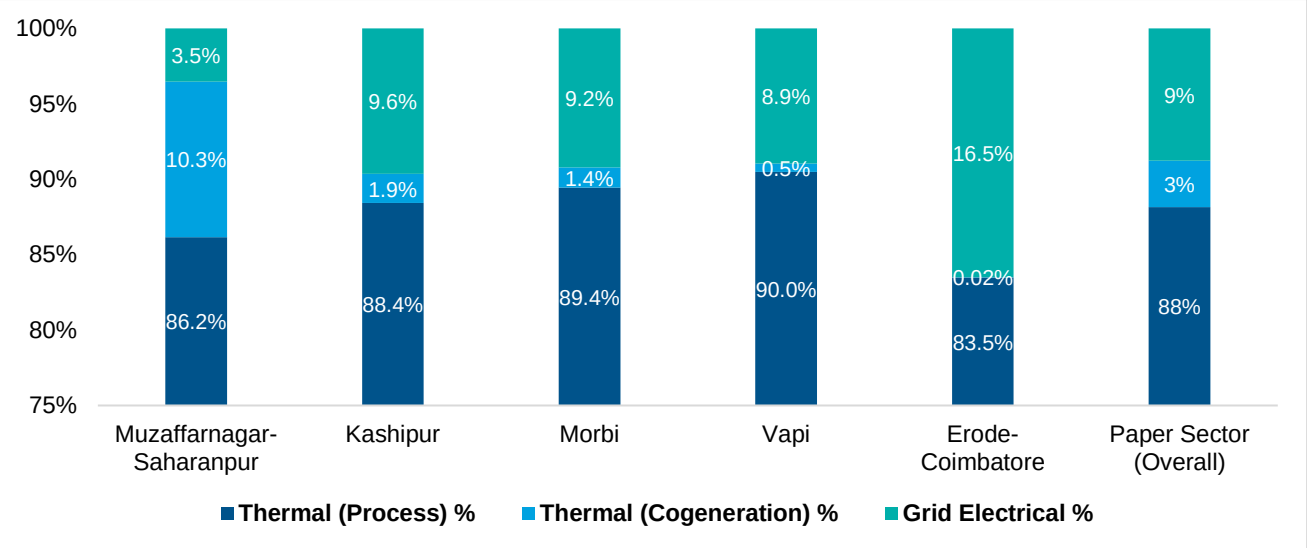


Figure 27: Cluster wise energy mix

3.2 SEC Comparison across various clusters in India

3.2.1 Specific Energy Consumption (KPI's)

It is generally observed that the Kraft Paper mills consume the least amount of energy per tonne of product and writing-printing paper consumes the highest amount of energy per tonne of product. The energy consumption increases as we increase the level of refining of the paper pulp hence the difference in the energy consumption is observed. The variation of the overall specific consumption is shown in figure 28 below. As seen from the figure the Morbi and Vapi cluster have significantly lower overall SEC levels as Kraft

paper constitutes a major portion of the production at these clusters. The overall SEC levels for Muzaffarnagar-Saharanpur, Kashipur, and Erode-Coimbatore are 0.284, 0.253, and 0.248 respectively.

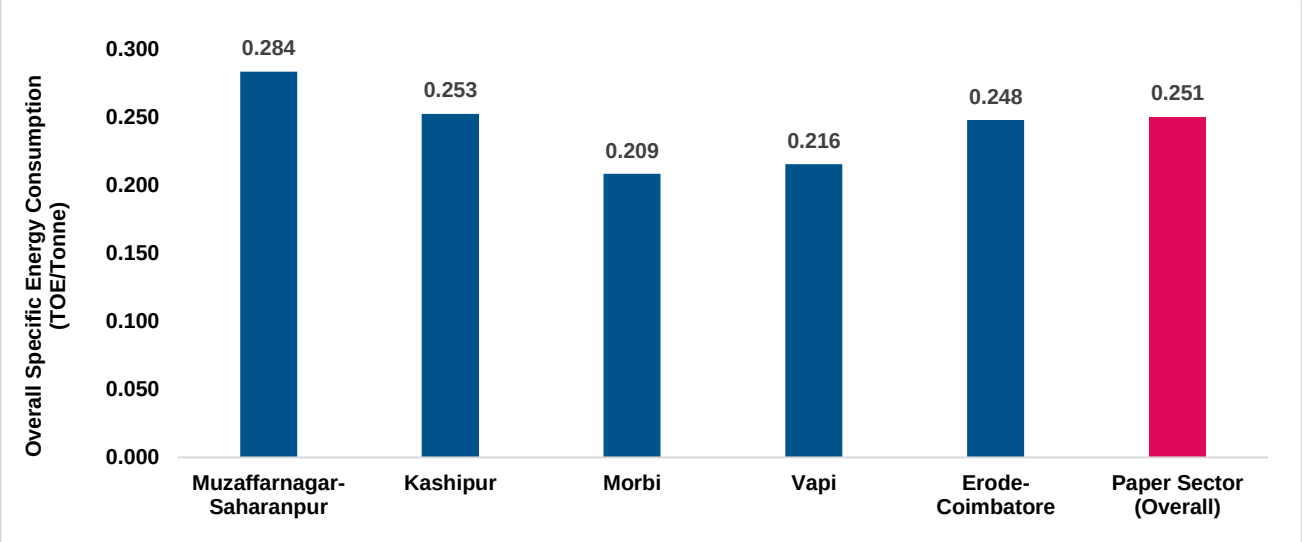


Figure 28: Overall SEC in selected clusters

3.2.2 Thermal Specific Energy Consumption

The variation of the thermal-specific energy consumption is shown in figure 29 below. As seen from the figure the Morbi and Vapi clusters have significantly lower thermal SEC levels as again Kraft paper constitutes a large portion of the production at these clusters, which have lower thermal SEC footprint. The thermal-specific energy consumption for Erode-Coimbatore is also observed to be very low (0.213).

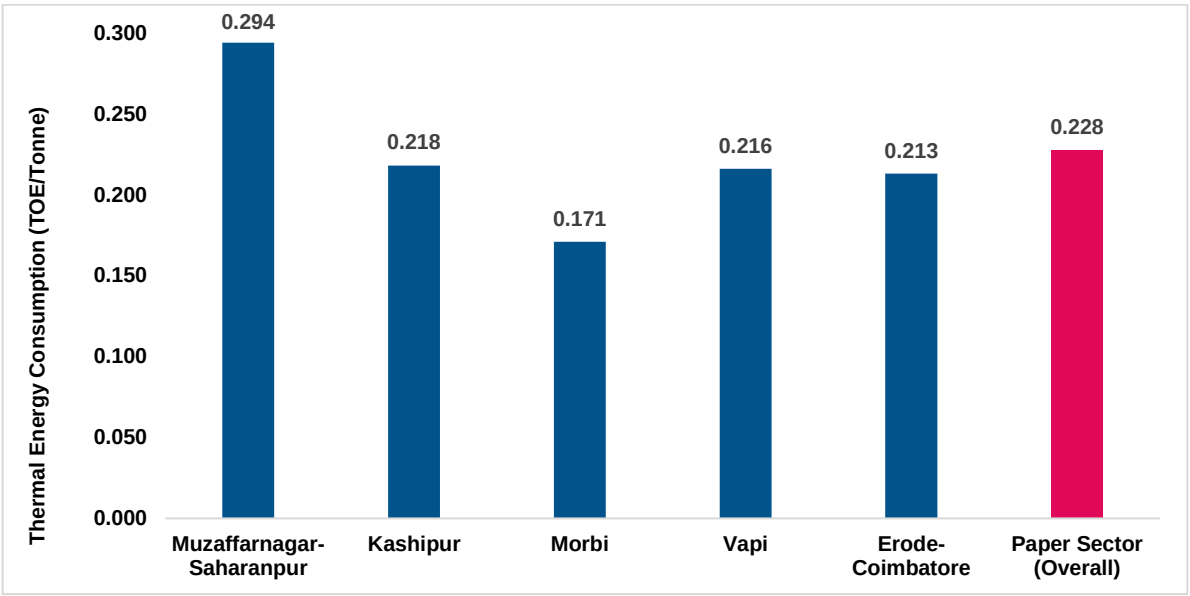


Figure 29: Thermal specific energy consumption in selected clusters

3.2.3 Electrical Specific Energy Consumption

The variation of the electrical specific consumption is shown in figure 30 below. As seen from the figure the Morbi and Vapi cluster have significantly lower electrical SEC levels as Kraft paper constitutes a large portion of the production at these clusters.

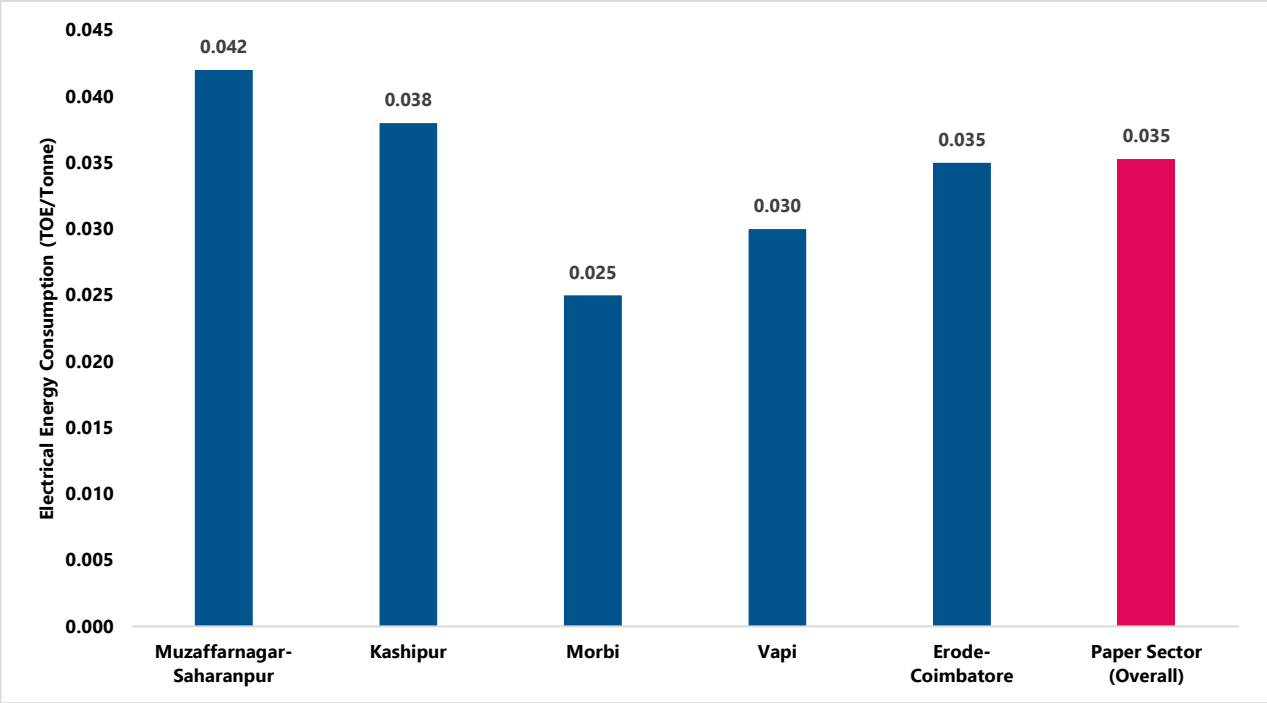


Figure 30: Electrical specific energy consumption in selected clusters

3.2.4 Specific Steam Energy Consumption

The variation of the specific steam consumption is shown in figure 31 below. As seen from the figure the Morbi and Vapi cluster have significantly lower thermal SEC levels as Kraft paper constitutes a large portion of the production at these clusters.

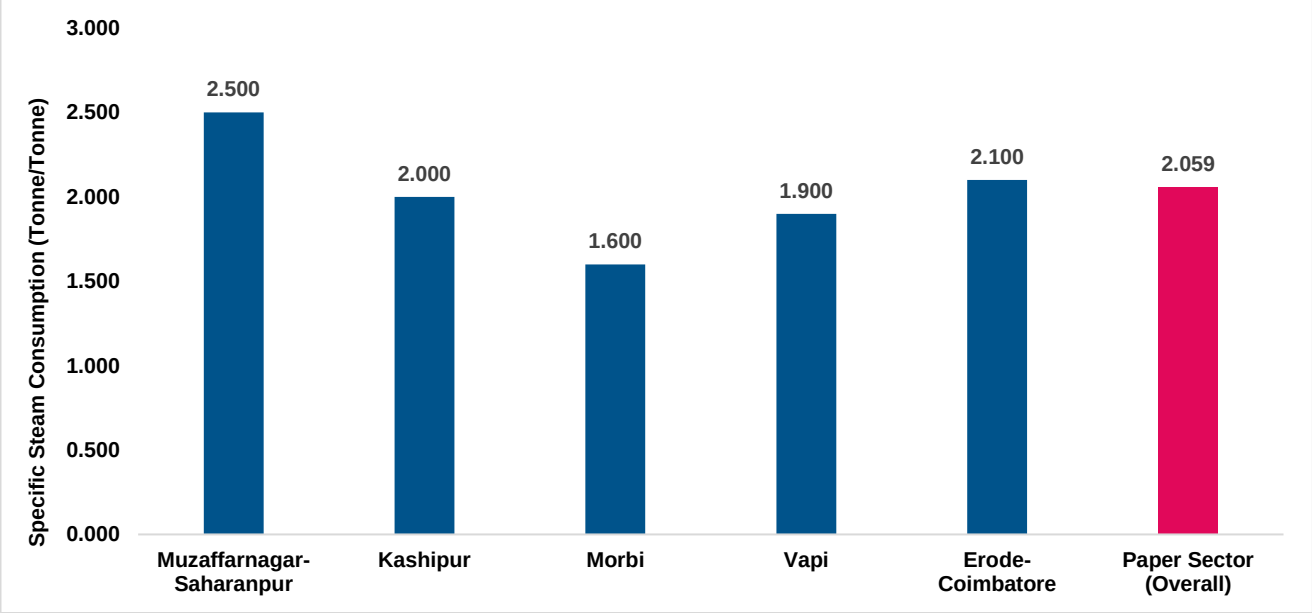


Figure 31: Specific steam consumption in selected clusters

3.2.5 Specific Water Consumption

The variation of the specific water consumption is shown in figure 32 below. As seen from the figure the Morbi and Vapi clusters have significantly lower water consumption levels as Kraft paper constitutes a large portion of the production and also due to stringent water consumption norms at these clusters related to the reduction of freshwater consumption, wastewater discharge, and pollution load, zero effluent discharge, and monitoring of freshwater consumption and wastewater generation through the use of sensors.

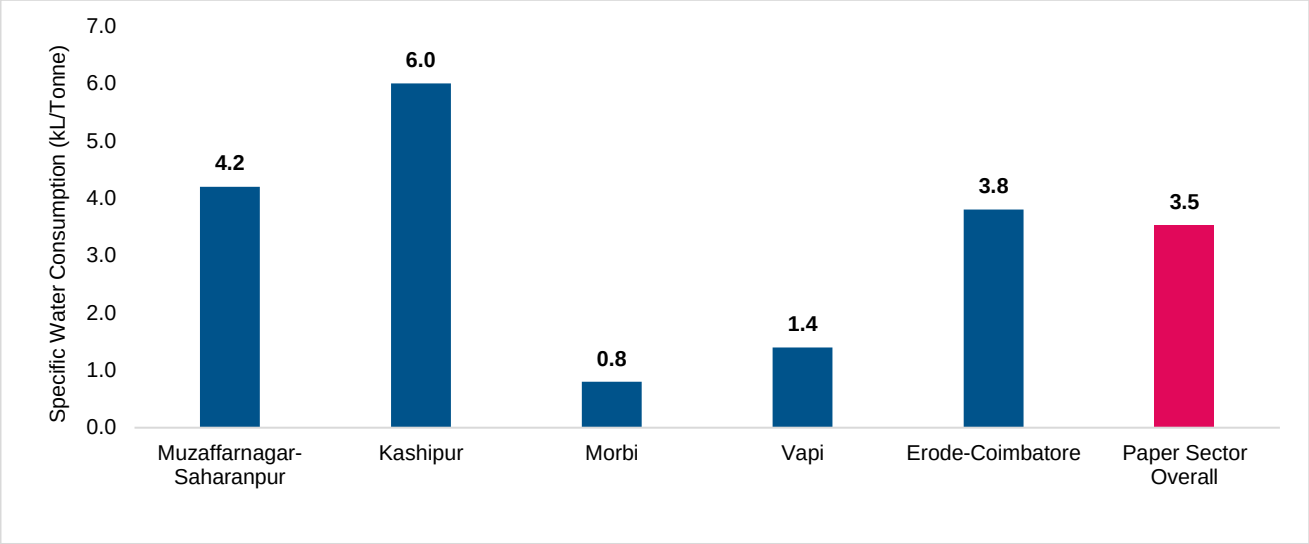


Figure 32: Specific water consumption in selected clusters

3.3 Comparison with International benchmarks

Benchmarking comprises the analysis and reporting of key energy performance Indicators to foster continual energy performance improvements in the industry through comparison with internal and external norms and standards. An energy benchmarking analysis generates two important perspectives; it provides an overview of how well a particular industry sector or sub-sector is doing in managing energy performance. Secondly, it enables company participants in a benchmarking exercise to compare the performance of their own plant(s) with the overall industry indicators. The intention behind the benchmarking study is to facilitate the knowledge transfer and enable performance comparison with peers, identifying the aspects of their performance that were good, bad, or indifferent

Figure 33: Benchmarking Benefits

Considering the growing rate and energy intensity of the industrial sector, there is a need for reducing the energy consumption of the paper industry in accordance with national energy efficiency targets.

Benchmarking priorities are dependent on four key areas. The first is to improve the energy efficiency to define the baseline of the key KPIs for the paper sector. The second is to compare the energy performance for different countries. The next step is to identify the gaps and areas for improvement, leading to the development of improvement programs with a view of a successful adoption.

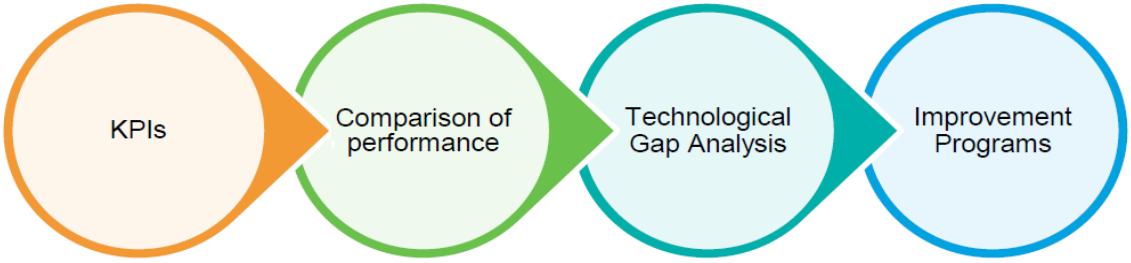


Figure 34: Benchmarking Priorities

The domestic benchmarks presented in the subsequent sections were prepared by both primary and secondary research modes while the international benchmarks were based purely on secondary research. The benchmarking as a tool act as a guide for manufacturing plants to focus on reducing the manufacturing cost and improving efficiency towards maximum limits for sustaining the benefits amid volatile market, increase in raw material and energy cost, demand for the highest quality, and competition from international market players. Figure 35 shows the benchmarking cycle:

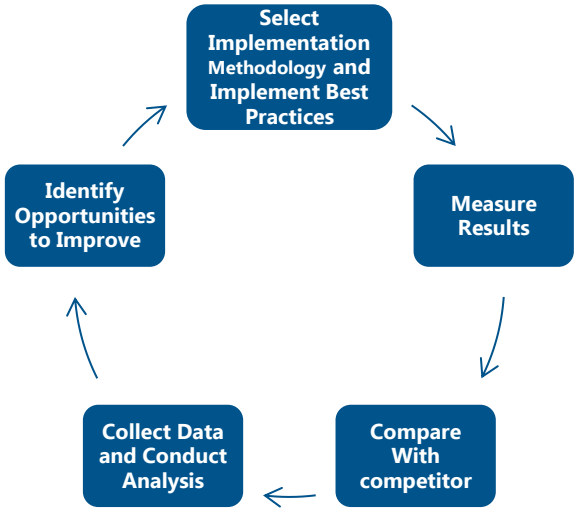


Figure 35: Benchmarking cycle

3.3.1 Non-Energy International Benchmarking

Global Paper Production by type of paper: The total global paper production is approximately 420 million tonnes. The share of packaging paper & board is highest 256 million tonnes with 61%, followed by graphic paper 116 million tonnes which are around 28%. The graphic paper includes printing & writing papers and

newsprint. The remaining 48 million tonnes which are around 11% is contributed by other paper & board category[11].

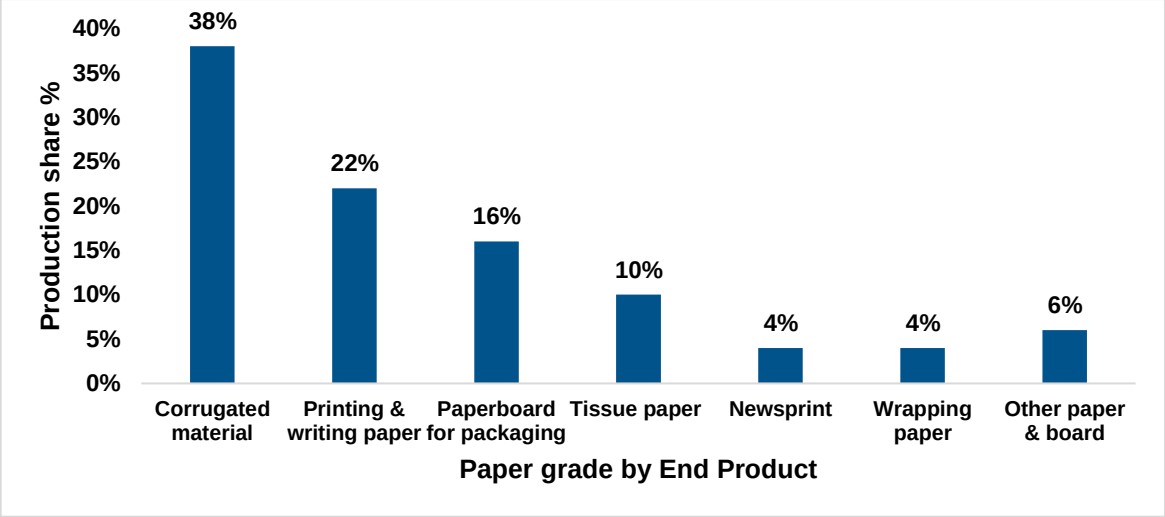


Figure 36: Production share (Global) based on the type of paper[12]

Figure 36 shows global production share based on end product with the further breakup of paper grades i.e., kraft & packaging (includes corrugated material, paperboard for packaging, wrapping paper, other paper & board) newsprint, writing & printing, and special (tissue paper). There has been increased demand for paper used in packaging materials but demand for newsprint has decreased due to the shift to digital media and paperless communication across most developed economies.

The world's five largest paper producing countries are China, the United States, Japan, Germany, and India (these five countries account for more than half of the world's total paper production, around 59%), while India accounts for a small but growing share of the global market (Figure 37).

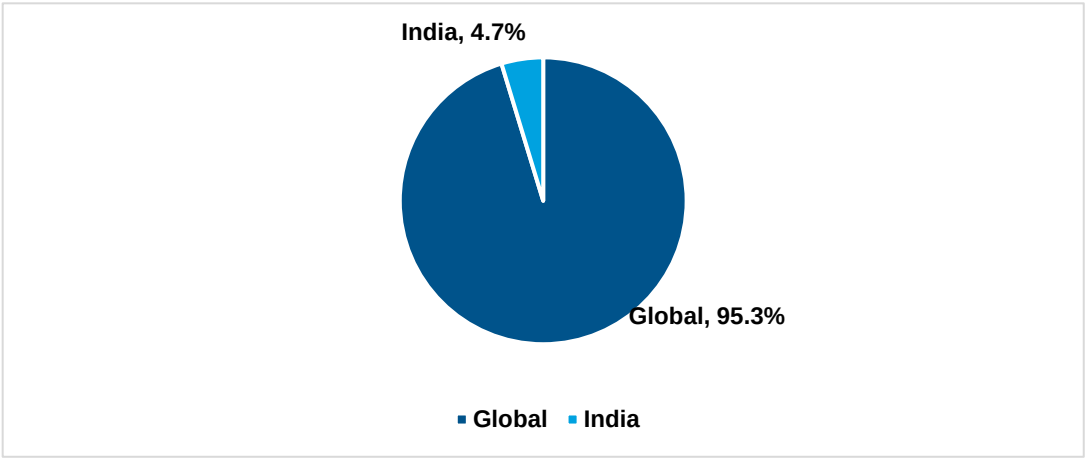


Figure 37: India's share of the Global market

Paper production by country: The Indian Paper & Paperboard industry is one of the oldest organized manufacturing sectors in India and the first paper mill was started in the year 1812 in Serampore, West Bengal. The industry accounts for approximately 4.7% of the world's production of paper. Figure 38 shows the paper and cardboard production volumes of the top 10 countries in the world. India's production is approximately 19,360 thousand tonnes.

[11] Statista 2019- Link

[12] Statista June 2021

.While paper production in the United States has been declining, production in China has increased significantly in the past decade. The global paper and pulp mills industry has contracted slightly over the past five years, primarily due to the shift to digital media and paperless communication across most developed economies. However, demand in emerging markets has partially offset the decline by driving increased demand for paper used in packaging materials.

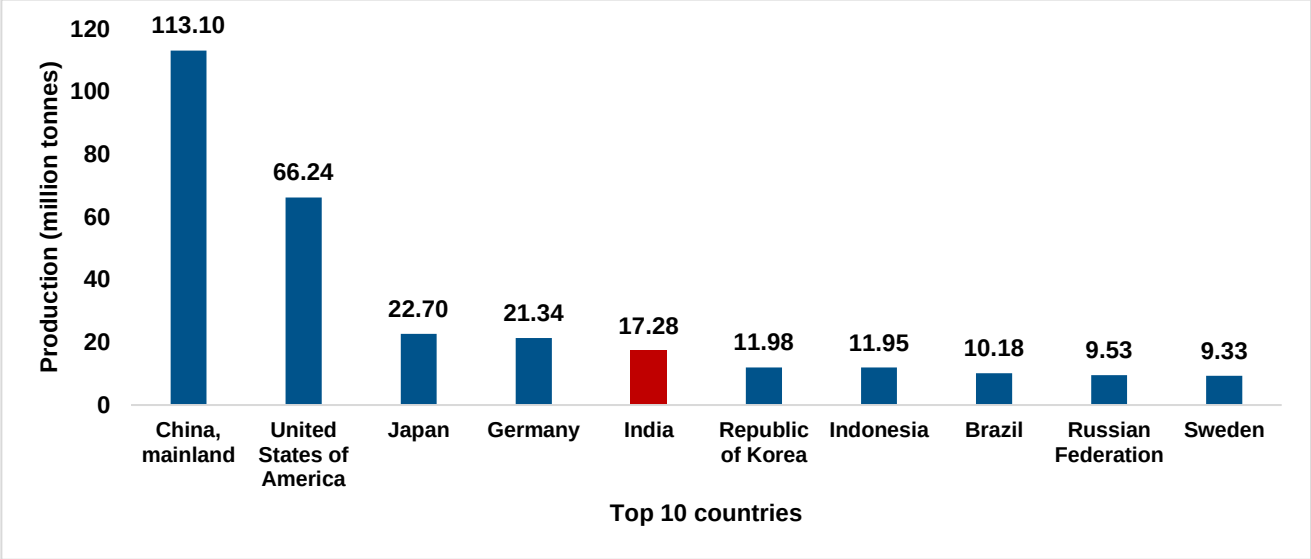


Figure 38: Top 10 countries - Paper & Paperboard production

Per-Capita Paper Consumption: The per capita consumption of paper is a benchmark of a country's social status and yardstick of its economic development. The leading economies of the world use over 150 kgs of paper per person. In India, the per capita consumption is about 15.75 kgs, which is lower than that of the rest of Asia which stands at 17 kgs and much lower when compared to the World average which stands at 57 kgs (Figure 39). This illustrates that there is tremendous headroom for the growth of the paper sector in India when compared with the Asian as well as the world average.

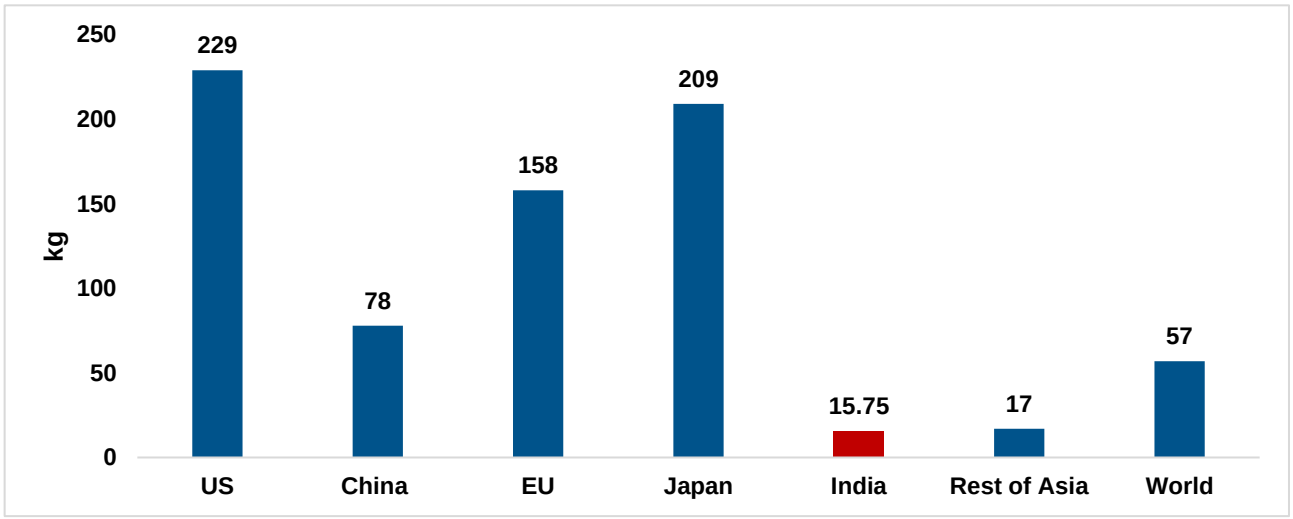


Figure 39: Per capita consumption of paper worldwide by region

Production by raw materials: The raw material which is widely used in papermaking is pulp. Based on their source medium, the pulp is categorized as Wood-based, Agro-based, and RCF based. As shown in Figure

40, the Agro-based share % is higher in India (8.6%) and China (8.2%) when compared to the world average as these are developing countries and being an agricultural economy.

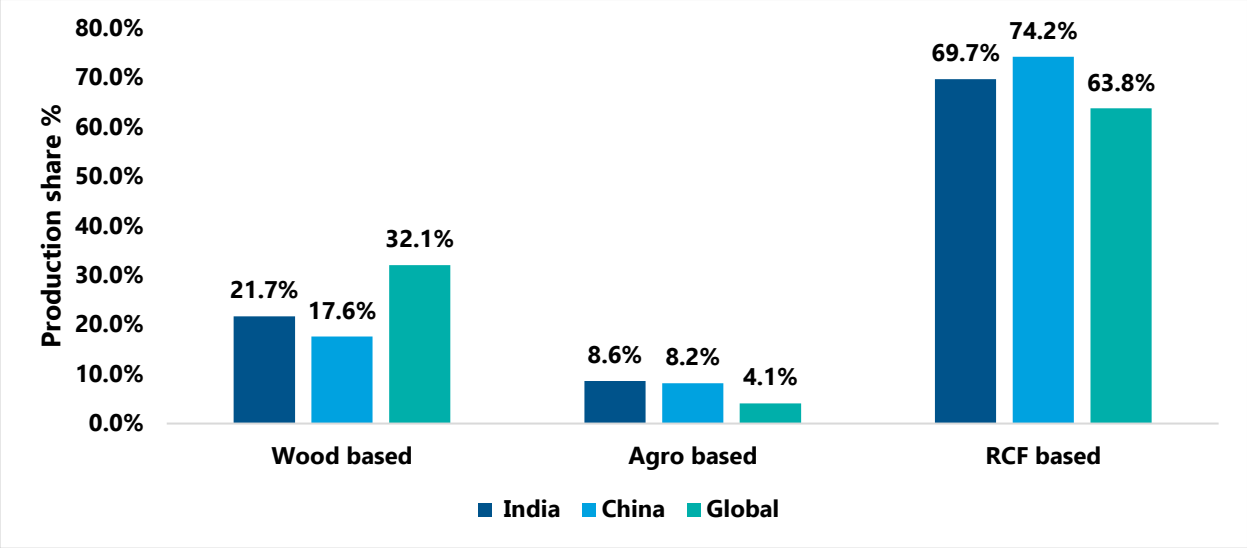


Figure 40: Production share (India & Global) based on raw materials[13]

Paper production by type of paper in India, China, and Globally: The paper industry is classified into four segments, Printing & Writing (P&W), Packaging Paper & Board, Specialty Papers & Others, and Newsprint. The chart depicts the variation of consumption across the segments globally and in India.

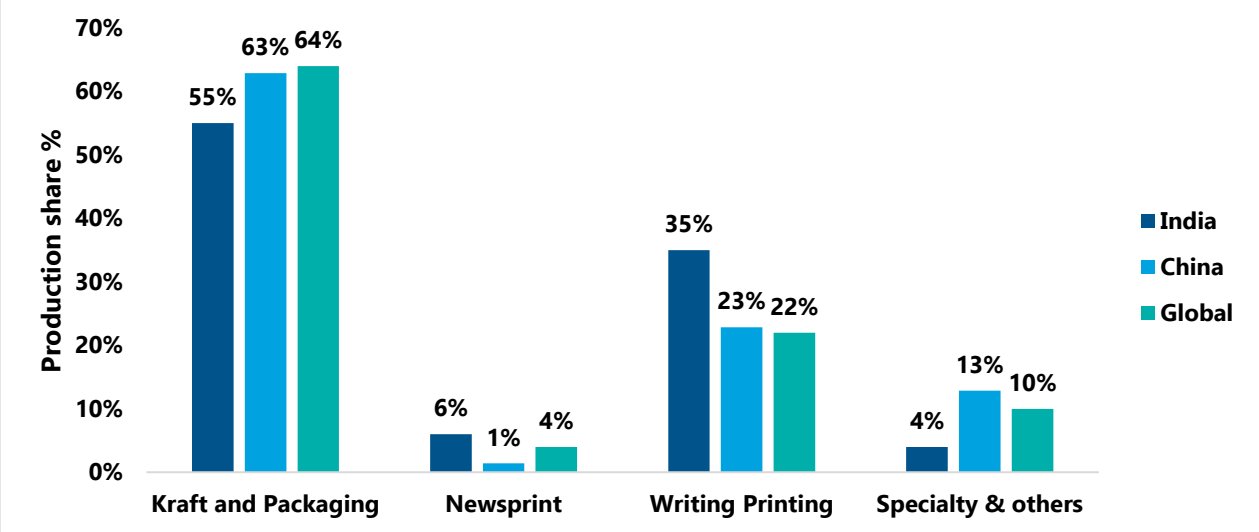


Figure 41: Production share (India vs Global) Based on End Product[14]

As depicted in Figure 41, India's share of kraft and packaging (55%) and specialty papers (4%) variety of paper grade is quite low when compared to China and globally. The share of newsprint (6%) and writing & printing (35%) is lower as the developed countries have transitioned towards digital media & communication indicating there is a potential for India to make the transition too, thereby reducing energy intensity. Also, with an increase in kraft & packaging share, India would be able to reduce its energy consumption further.

[13] Statista March 2016 & Environmentalpaper.org

[14] CPPRI Statistical Cell & Statista

3.3.2 Energy International Benchmarking

A typical paper mill usually produces several types of pulp & paper and uses various wood species and different mixes of raw material. Although the specific energy consumption of different product types can be known, the total annual consumption usually fluctuates depending on the distribution of production. There are also differences in the types of production and the sub-processes involved. The plants are also categorized into stand-alone and integrated pulp and paper mills. Collectively, these factors make benchmarking between different plants a challenge. Further, the impact of different energy efficiency measures on product quality (e.g., tensile strength, freeness, opacity) creates an additional challenge. Meaningful benchmarking is often possible for mills working with certain types of pulp and paper, using the same type of production, and involving comparable sub-processes.

Indian MSME vs International MSME vs Large Industries (PAT)

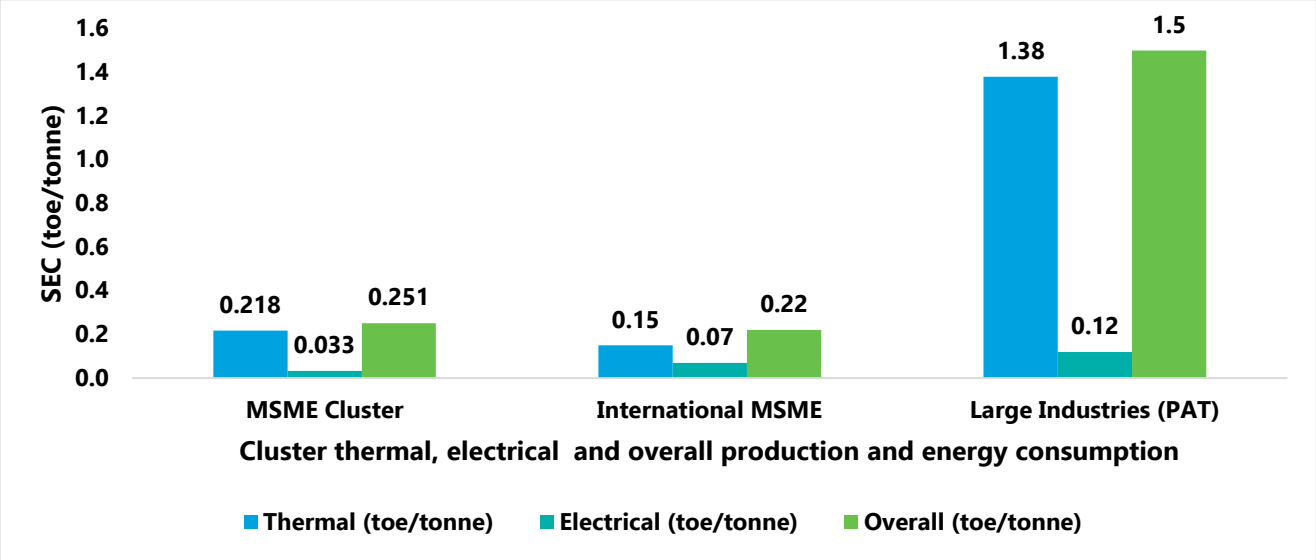


Figure 42: Specific energy consumption data India MSME, International MSME and Large Industries (PAT)[15]

The cluster total production is 6.28 MTPA. The electrical energy consumption (toe/tonne) is 0.033 (Figure 42) and thermal energy consumption (toe/tonne) is 0.218. The overall total energy consumption (toe/tonne) is 0.251. The electrical energy consumption (toe/tonne) of international MSME reference plant (Sweden) is 0.07 and thermal energy consumption (toe/tonne) is 0.15. The overall total energy consumption (toe/tonne) is 0.22. So, there is ample scope for reducing thermal energy consumption for Indian MSMEs but there is a deviation in electrical energy consumption due to the following reasons:

- Overall energy use is dictated by the grade of paper manufactured. The quality of paper (GSM, wet tensile strength for sanitary, tissue paper) produced in Europe is higher compared to India as they pass through more stringent standard test methods
- Another major factor is the source of pulp. It may come from an integrated virgin pulp mill, wastepaper recycling operation, and even maybe buying pulp from a market pulp mill. Use of recycled fibre for producing various paper grades.
- Introduction of technologies in the past 5 years must have reduced European mills electrical energy consumption now

Use of recycled fibre for paper production

[15] IEA-ETSAP 2015 and Swedish Forest Industries and GIZ/BEE/CII – PAT 2018

Many countries have legislation in place which stipulate the use of a mandated amount of recycled fiber in papermaking. Figure 43 gives out the percent of recycled fiber used for the production of various varieties of paper. It can be seen that nearly 70% of Newsprint being made the world over is from recycled fiber. About 55% of Paperboard, wrapping, and packaging paper produced is based on wastepaper. Indian paper mills have a larger share of recycled fibre in the production of various paper grades when compared with other mills globally.

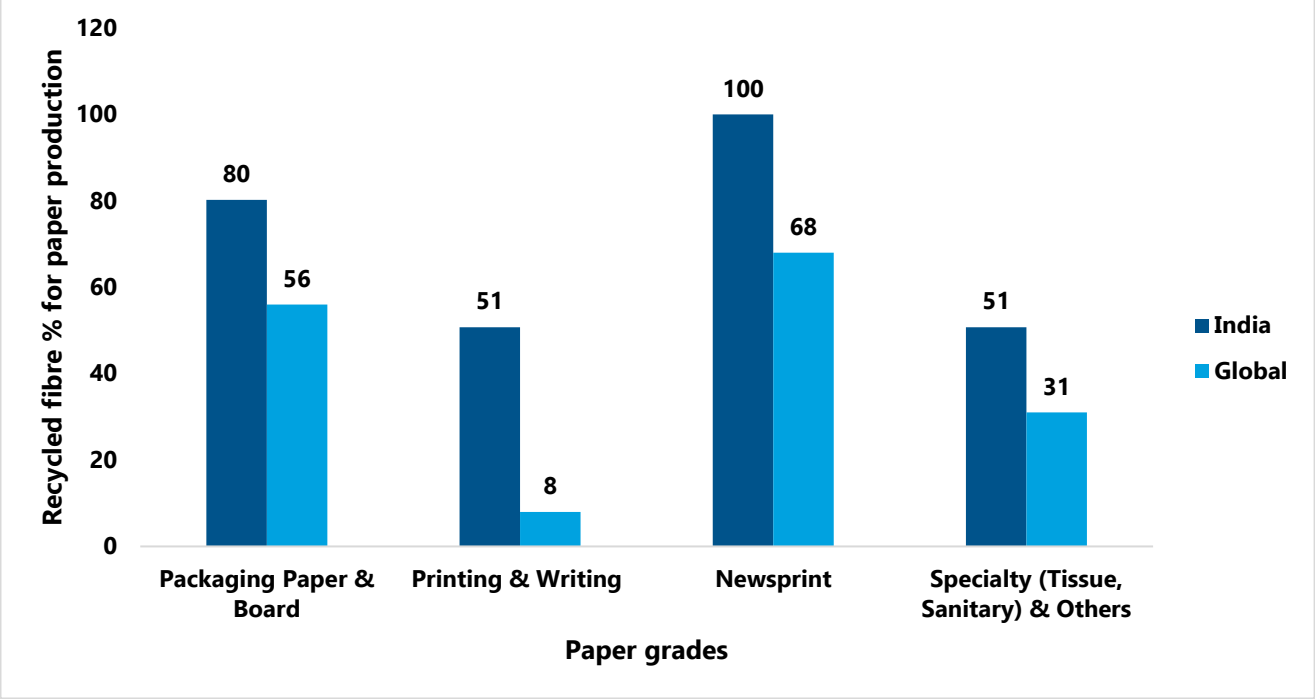


Figure 43: Use of recycled fiber for paper production India vs Global[16]

However, increasing use of wastepaper is liable to translate into supply issues and wastepaper prices may increase in the future. But this has also resulted in achieving lower electrical specific energy consumption (SEC) for Indian MSME paper plants.

Table 12: Comparison between India & European paper mills

Details	Units	Europe	India
		Values	Values
Number of mills	Nos.	894	861*
Total Capacity	MTPA	101	27.15
Production	MTPA	85.2	19.36
Capacity utilization	%	84.4	71.3
Biomass	%	62.2	

*500 mills are currently operating

The typical European paper mill is 5-10 times larger than Indian paper mills for a particular type of paper produced. As can be seen from above table 12, the Indian paper plants have lower capacity utilisation at 71.3% as compared to European mills at 84.4%. This unutilized capacity is primarily due to acute fiber shortage in the country. Another reason for low-capacity utilization has been the ever-increasing input

[16] CPPRI & Environmentalpaper.org

costs particularly for energy inputs (both coal and non-coal). Thus, there is an opportunity to promote recycling, as recycled production requires considerably less energy. Using a higher share of bioenergy and adopting waste heat recovery technologies will also be important.

Water consumption: Average water usage in RCF paper mills is 1-6 m3/ton mostly producing kraft & packaging paper. Water consumption generally increases when paper grade produced is newsprint and writing & printing and is around 5-20 m3/ton. This is quite high when compared to 10-15 m3/ton for similar paper mills in the USA and 5-8 m3/ton for similar mills in EU (European Union) countries.

Recent water usage guidelines by CPCB (Central Pollution Control Board) for paper mills which is freshwater consumption norms to be achieved by March 2017 is 15 m^3/ton for wastepaper-based mills making bleached paper grades and 10 m^3/ton for unbleached paper grades.

The process and technology in wastepaper mills are identical all over the world. So, there are great opportunities for water usage reduction in Indian paper mills. Every drop of water that comes into the paper mill has to go out either as effluent or be evaporated into the atmosphere. Less than 10% of water is evaporated.

Following measures can be implemented to reduce water consumption in paper plants:

- ETPs must be upgraded to tertiary-level treatment. Depending on the requirement, tertiary treated water may have to be treated using RO.
- The cost of treatment up to tertiary treatment including RO treatment may increase the production cost only by 4-6 % for RCF based industries and must be enforced.
- Shifting towards zero liquid discharge is feasible and must be implemented by all plants. Improvements in technology and following best practices in water management can lead to a substantial reduction in water consumption and lower the cost of attaining a zero-discharge system.

Paper recycling

Paper recovery is defined as the total weight of paper recovered as a proportion of the total weight of paper and paperboard consumption. Most printing and writing grades are made with the chemical pulp, which Table 13 showed requires 4.4 short tons of fresh trees to make one short ton of pulp. Its production also results in the greatest negative environmental impacts of all the paper grades across almost all indicators.

Table 13: Volume of required material for different types of pulp

Type of Pulp	Volume of Required Material
Virgin Chemical (Kraft)	4.4 tons of fresh trees
Virgin Mechanical (Groundwood)	2.2 tons of fresh trees
Recycled	1.4 tons of recovered paper

Therefore, including high levels of recycled fiber in printing and writing papers is essential as the foundation for minimizing paper production's footprint.

Canada, Europe, Japan, and the United States have reached high recovery rates (Figure 44). These countries continue to improve recovery rates by taking actions such as investing and expanding wastepaper collection systems and developing community awareness programmes to improve recycling habits.

The recovery rate of wastepaper in India is quite low (~30%) due to the lack of an effective collection mechanism**.** With issues like the availability of quality raw material at competitive prices, the players depend on the imports of pulp, wastepaper, and even pulpwood to meet their raw material needs and often have to pay a premium for availing them thereby impacting profitability and capacity addition. To alleviate this significant challenge, the Government of India could frame a policy to allow access to degraded forest

land for paper mills to raise pulpwood plantations for increasing pulp availability and reduce import dependence; further, the government can ensure collection mechanism be strengthened to increase usage of wastepaper which can be achieved by creating awareness programs and through policy measures. In India, the industry can also find opportunities for job creation as cooperatives for recycling and waste collectors play an increasingly important and legitimate role in the recycling industry.

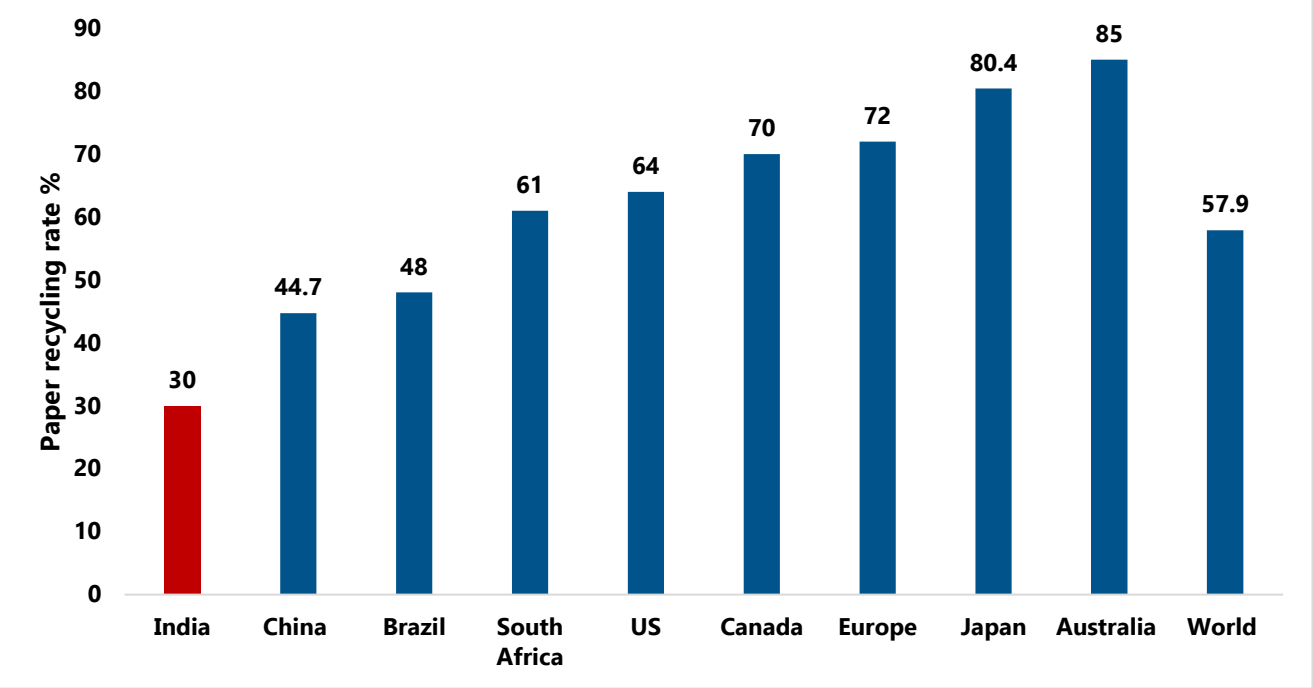


Figure 44: Paper recycling rate India vs Global[17]

In addition to the government policies on this activity, wastepaper recovery is mostly affected by the degree of urbanization in a country and the mixture of different types of paper and paperboard consumed. For example, newsprint, printing and writing paper, and some types of packaging paper are generally recovered more easily than other types of paper (such as household and sanitary paper)

[17] International Council of Forest and Paper Associations (ICFPA)

4. Energy Efficiency Potential in Paper Sector

4.1 Energy Saving potential

The project team has conducted energy audits in 10 plants in all the 5 clusters and based on the energy audits the following Figure 45 presents the EE potential of the different clusters:

The highest energy savings potential is in Muzaffarnagar-Saharanpur and Morbi lusters with 0.1 million TOE (26%).

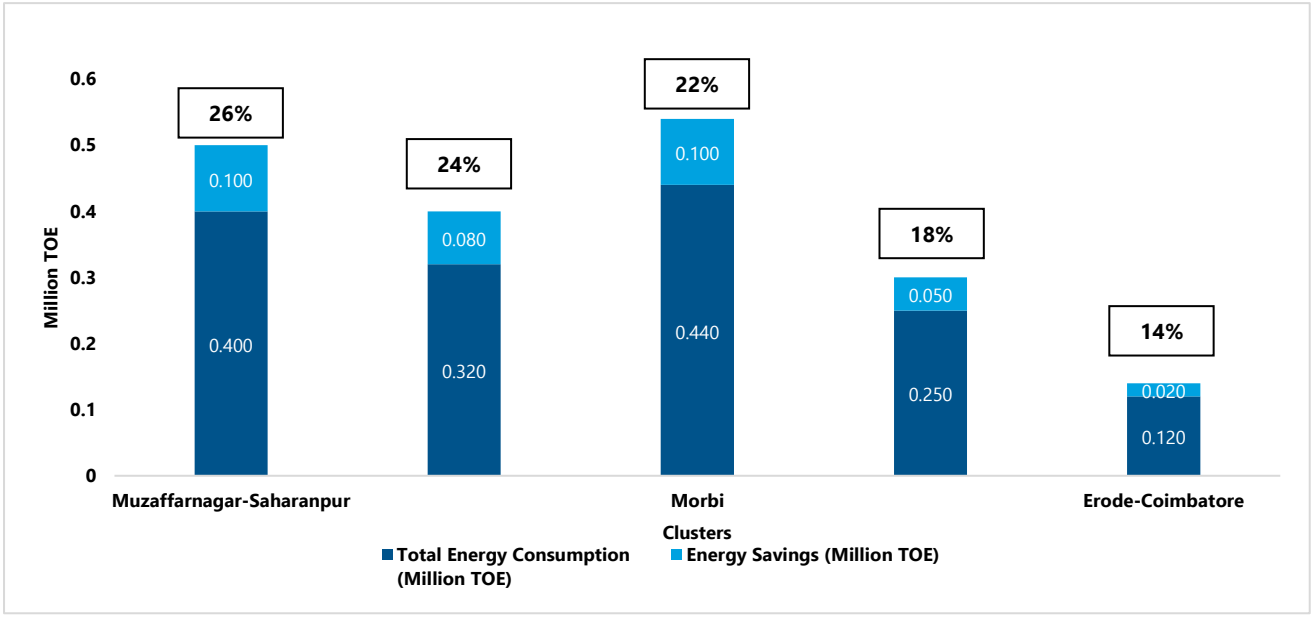


Figure 45: Energy saving potential in selected clusters

4.2 GHG Saving potential

Based on the detailed assessment of the model units in the clusters, the GHG emission savings potential of the different clusters are envisaged which is shown in Figure 46 below:

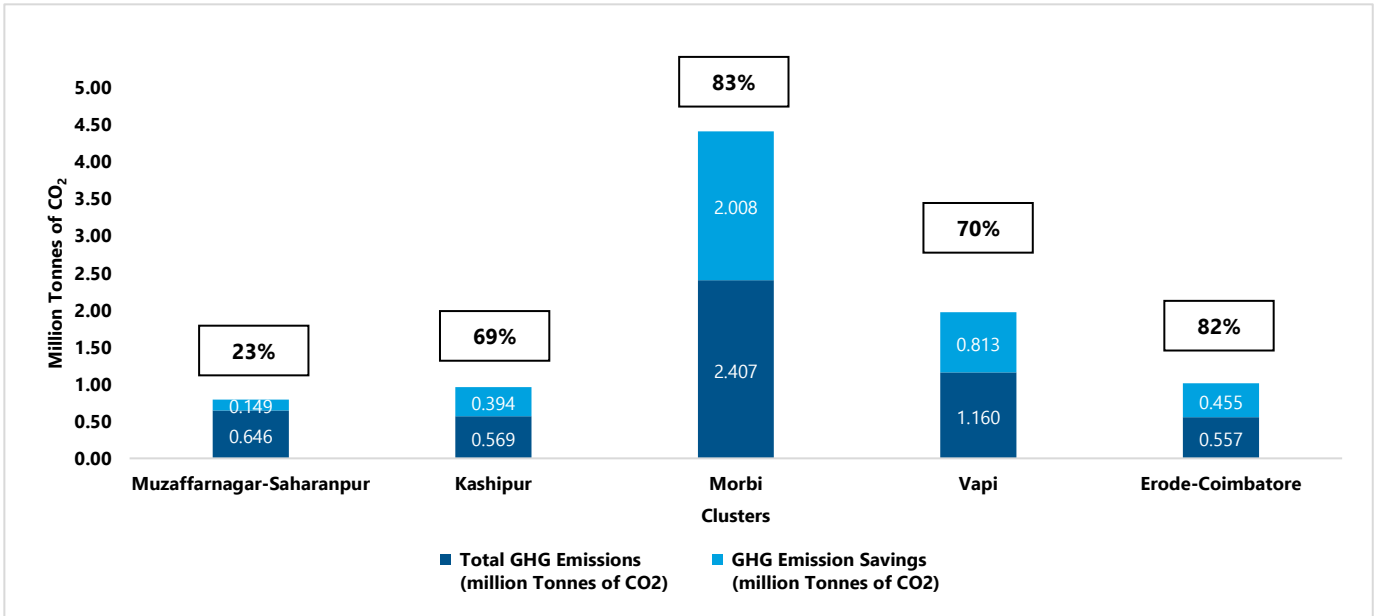


Figure 46: GHG emission saving potential in selected clusters

The Morbi cluster is having the highest GHG emission savings potential with 83% since most of the units consume coal as a primary fuel, whereas Muzaffarnagar-Saharanpur is having the lowest GHG emission savings potential as the cluster is already consuming biofuel in large quantities.

4.3 Water Saving potential

Based on the detailed assessment of the model units in the clusters, the water emission savings potential of the different clusters is envisaged which is shown in Figure 47 below:

The water-saving potential of Kashipur and Muzaffarnagar Saharanpur is lower than that of Morbi and Kashipur due to the following reasons:

1. All the mills in Morbi and Vapi are using recycled fiber-based raw material in comparison to Kashipur and Muzaffarnagar Saharanpur where some mills are using Agro-based raw material also. The agro-based mill has a significantly larger water demand than compared to RCF based paper mill.
2. The water norms at Gujarat and Tamil Nadu are stricter as compared to states like Uttar Pradesh hence the paper mills at Gujarat and Erode-Coimbatore are judicious towards their water consumption.
3. Most of the paper mills in Morbi, Vapi, and Erode-Coimbatore clusters have water monitoring systems to monitor their daily water consumption.

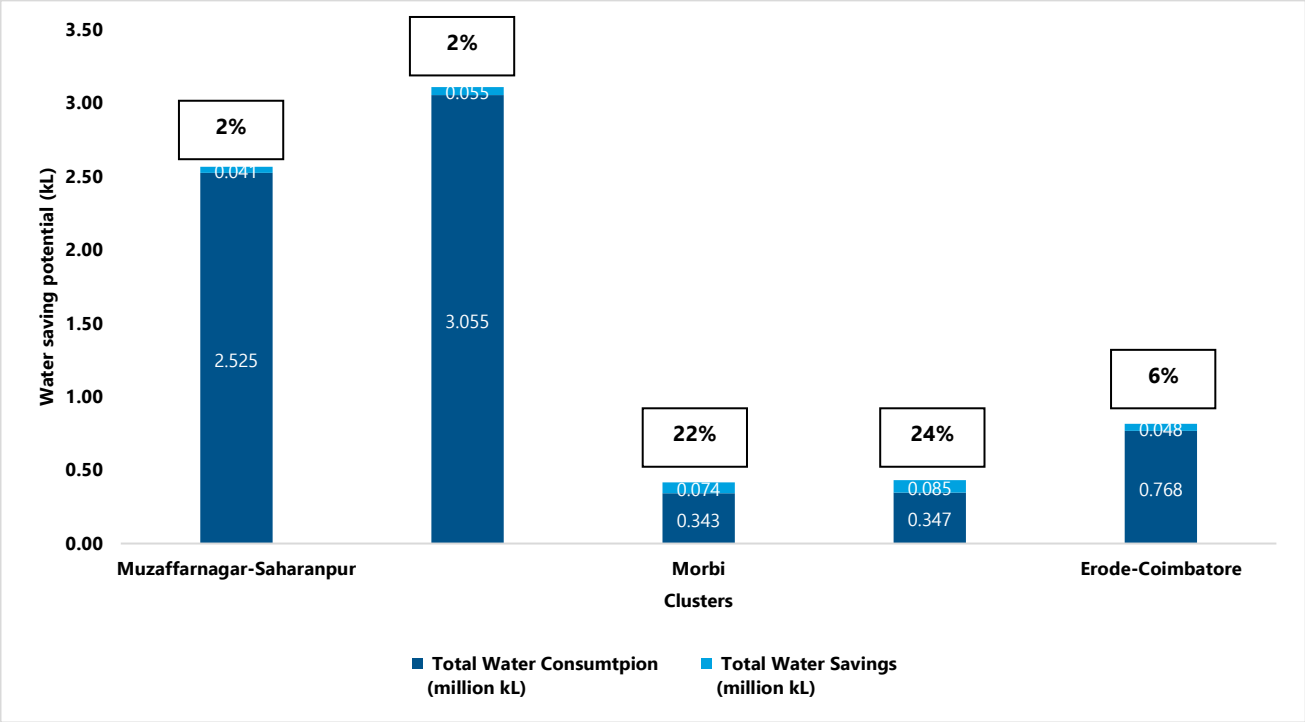


Figure 47: Water saving potential in selected clusters

4.4 Estimation of Investment potential

The paper industry is very energy-intensive in nature. It was observed by the energy audit team that most of the technologies that are employed by the MSMEs are outdated in nature and hence there remains a significant energy efficiency potential. In turn, significant investment potential exists in all the paper MSME clusters. The investment potential observed for all the clusters are shown in figure 48 below:

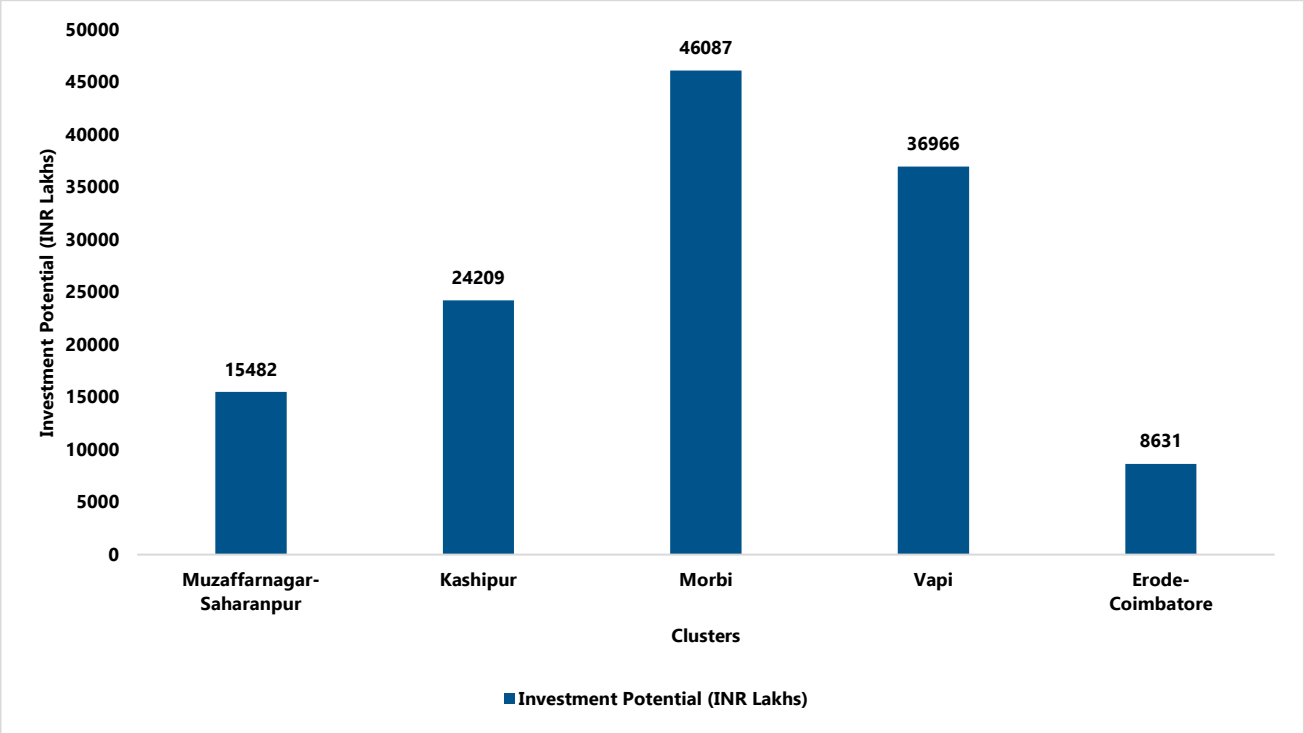


Figure 48: Investment potential in selected clusters

The calculated investment potential depends on the number of mills in the cluster. As Morbi has the most no. of mills, hence, the Morbi has the highest investment potential among all the clusters. The total investment potential is estimated to be 2095 INR Crores.

4.5 Market Potential for Energy Efficient Technologies and Interventions

Table 14 shows market potential including energy-saving opportunities, investment potential, GHG emission reduction potential for each energy-efficient technology. This section also covers a brief description of each technology intervention and its key benefits.

Table 14: Market potential for energy-efficient technologies

Sr. No.	Energy Conservation Opportunities	Saving Potential	Payback (Years)	Sectoral Energy saving (toe/year)	Sectoral Investment in INR Lakhs	GHG Emission reduction TCO2
1	Installation of Oxygen Analyzer and controlling the excess air in the boiler	Overall = 5-15%	<1	41,032	951	34,447
2	Overhauling of Existing Air Preheater in Boiler section	Thermal = 5%	1-2	30,511	1,640	NA
3	Replacing the present pumps with proper head pumps.	Electrical = 15%	<1	4,992	2,418	47,970
4	Freshwater saving by Rainwater Harvesting	Freshwater Saving = 1%-21%	<1	NA	456	NA
5	Installation of VFD Controlled Vacuum System Automation	Electrical = 20%	0.5-3	20,902	12,292	152,911

Sr. No.	Energy Conservation Opportunities	Saving Potential	Payback (Years)	Sectoral Energy saving (toe/year)	Sectoral Investment in INR Lakhs	GHG Emission reduction TCO2
6	Installation of Dryer Insulation in paper machine section	Thermal = 1%	1-2	6,607	1,793	NA
7	Installation of Energy Monitoring System (EMS) to optimize the power consumption	Electrical = 3%	<1	4,488	1,240	29,856
8	Use of DO (Dissolved Oxygen) sensor and optimization of ETP Blowers	Electrical = 20%	0.5-2	647	994	3,872
9	Installation of VFD in air compressor	Electrical =5%-10%	1	64	56	225.6
10	Installation of Cascade Condensate Recovery System for energy savings and improving condensate recovery	Thermal = 5%	1-3	18,346	20	NA
11	Dew Point Sensor with VFD in Air Blower of Paper machine Section	Electrical = 20%	0.5-2	368	152	520
12	Insulation of Boiler Surface	Thermal = 1%	<1	2072	109	NA
13	Installation of proper sized motor in the Plant	Electrical = 2%-3%	<1	2,861	1,849	18,096
14	Installation of energy efficient lighting in place of T8 Lamps and Incandescent Bulb	Electrical = 0.2%	<1	40	21	300
15	Installation of Hi-Consistency Pulper in place of low-Consistency Pulper	Electrical = 15%	2-4	5,075	13860	36,309
16	Replacement of IE 2 motors with IE 3 motors	Electrical = 3%	1-3	4,410	6,076	22,236
17	Replacement of present agitators with energy efficient agitators	Electrical = 15%	1-2	2,430	3,500	14,400
18	Replacement of the SR Boxes with closed box system along with pressure-based VFD controlling at Chest Pump	Electrical = 20%	1-2	24	20	208
19	Replacing Vacuum Pumps and Installing Vacuum Blowers	Electrical = 20%	2-4	8,120	15,437	49,933
20	Insulation of condensate drums	Thermal = 1%	1-2	232	13.6	NA
21	Installation of Microturbines at Paper Mill	Electrical = 5-10%	1-2	17,776	4,026	169,730

Sr. No.	Energy Conservation Opportunities	Saving Potential	Payback (Years)	Sectoral Energy saving (toe/year)	Sectoral Investment in INR Lakhs	GHG Emission reduction TCO2
22	Installation of Solar PV panel	Electrical =3%-10%	3-6	13,978	29,417	133,308
23	Installation of VFD in De-inking recirculation pumps in place of Throttling	Electrical = 10%	1-2	224	215.2	2,128
24	Installation of Pocket ventilation system in the dryer of a paper machine.	Thermal = 8%	1-3	296,400	25,680	NA
25	Installation of Thermocompressor on dryer section of paper machine	Thermal = 5%-10%	0.5-2	53,244	312	NA
26	Replacing the roll press with shoe press in paper machine	Thermal = 15%	1-2	142,613	68,267	NA
27	Installation of Economizer in Boiler section	Thermal = 2-5%	1-2	14,629	3,120	NA
28	Installation of soot blower system in the boiler WHR system	Thermal = 5%	1-3	779	264	NA
29	Reduction of GHG emissions by shifting towards biomass from coal	-	>5	-		6,800,000
30	Installation of Screw Press in Place of Potcher for Pulp Washing	Electrical = 10%	1-2	112	104	62
31	Installation of Pressurized Headbox in paper machine	Electrical = 3%; Thermal = 3%	3-5	3,280	1,800	1,328

4.6 Prioritization of interventions

The project study examined the impact of different energy-efficient technologies. A novel approach was developed using various factors to evaluate the prioritization of technology and allow plant managers to make better-informed decisions, leading to financially and environmentally successful energy-efficient technology project implementations.

The factors considered for prioritization of the intervention are -

a) Performance improvement,
b) Environment improvement,
c) Reliability,
d) Investment,
e) Technical risk.

Table 15: Prioritization of interventions

Prioritization of interventions	
Performance improvement (Energy) criteria (a)	High = significant gain in energy savings, or quality of product produced (Electrical = 10%+; Thermal = 10%+) Medium = moderate gain in energy savings (Electrical = 3-10%; Thermal = 5-10%) Low = marginal gain in energy savings (Electrical < 3%; Thermal < 5%)
Resource-saving potential criteria (b)	High = multiple and significant environmental benefits, Medium = some environmental benefits, Low = little or no environmental benefit Apart from energy, water savings; Promotion of 3R, circular economy
Circular economy (c)	6 REs: Reduce, Reuse, Repair, Remanufacture, Recycle, and Recover Circular economy potential High; Medium and Low based on 6REs concept
Replicability (d)	High - Widely applicable Medium - Applicable to many industries Low - Applicable to few industries or unique process
Investment (e)	High - Implementation cost >20 Lakhs Medium - Implementation cost <20 Lakhs and >5 lakhs Low - Implementation cost < 5 lakhs
Payback (f)	High - Payback > 3 years Medium - Payback < 3 years and > 1 year Low - Payback < 1 year
Technology Priority Score Score (a+b+c+d+e+f)	Technology Priority Score **High score: 12 to 15** **Medium score: 10 to 12** **Low score: Less than 10**

High Technology Priority Score technologies should be implemented on a priority basis for reaping maximum benefits and improving overall plant performance. As a second priority, Medium Technology Priority Score technologies should be implemented, and Low Technology Priority Score technologies require feasibility study and can be implemented in the long term. The push from the government along with adequate policy support and subsidy schemes for Low Technology Priority Score technologies can motivate the paper unit for adoption and scaling up of these technologies at a national level.

Table 16: Prioritization of intervention

Sr. No.	Energy Conservation Opportunities	Performance improvement (Energy)	Resource-saving potential	Circular economy	Repli-cability	Inves-tment	Pay-back	Technology Priority Score)
1	Installation of Oxygen Analyzer and controlling the excess air in boiler	2	2	2	3	3	3	15
2	Overhauling of Existing Air Preheater in Boiler section	1	2	3	3	3	3	15
3	Replacing the present pumps with proper head pumps.	3	1	2	3	3	3	15

Sr. No.	Energy Conservation Opportunities	Performance improvement (Energy)	Resource-saving potential	Circular economy	Repli-cability	Inves-tment	Pay-back	Technology Priority Score)
4	Freshwater saving by Rainwater Harvesting	1	1	3	3	3	3	14
5	Installation of VFD Controlled Vacuum System Automation	3	1	1	3	2	3	13
6	Installation of Dryer Insulation in paper machine section	1	1	3	3	3	2	13
7	Installation of Energy Monitoring System (EMS) to optimize the power consumption	1	1	2	3	3	3	13
8	Use of DO (Dissolved Oxygen) sensor and optimization of ETP Blowers	3	1	1	3	3	2	13
9	Installation of VFD in air compressor	2	1	1	3	3	3	13
10	Installation of Cascade Condensate Recovery System for energy savings and improving condensate recovery	1	2	3	2	2	2	12
11	Dew Point Sensor with VFD in Air Blower of Paper machine Section	3	1	1	2	3	2	12
12	Insulation of Boiler Surface	1	1	3	1	3	3	12
13	Installation of proper sized motor in the Plant	1	1	2	3	2	3	12
14	Installation of energy efficient lighting in place of T8 Lamps and Incandescent Bulb	1	1	1	3	3	3	12
15	Installation of Hi-Consistency Pulper in place of low-Consistency Pulper	3	1	2	3	1	1	11
16	Replacement of IE 2 motors with IE 3 motors	1	1	1	3	3	2	11
17	Replacement of present agitators with energy efficient agitators	3	1	1	2	2	2	11
18	Replacement the SR Boxes with closed box system along with pressure based VFD controlling at Chest Pump	3	1	1	1	3	2	11

Sr. No.	Energy Conservation Opportunities	Performance improvement (Energy)	Resource-saving potential	Circular economy	Repli-cability	Inves-tment	Pay-back	Technology Priority Score)
19	Replacing Vacuum Pumps and Installing Vacuum Blowers	3	1	2	2	1	2	11
20	Insulation of condensate drums	1	1	3	1	3	2	11
21	Installation of Microturbines at Paper Mill	2	1	3	2	1	2	11
22	Installation of Solar PV panel	2	3	1	3	1	1	11
23	Installation of VFD in De-inking recirculation pumps in place of Throttling	2	1	1	2	2	2	10
24	Installation of Pocket ventilation system in the dryer of a paper machine.	2	1	1	3	1	2	10
25	Installation of Thermocompressor on dryer section of paper machine	2	1	2	2	1	2	10
26	Replacing the roll press with shoe press in paper machine	3	1	2	1	1	1	9
27	Installation of Economizer in Boiler section	1	1	1	1	2	2	8
28	Installation of soot blower system in the boiler WHR system	1	1	1	1	3	2	9
29	Reduction of GHG emissions by shifting towards biomass from coal	0	3	2	2	1	1	9
30	Installation of Screw Press in Place of Potcher for Pulp Washing	2	1	1	1	2	2	9
31	Installation of Pressurized Headbox in paper machine	1	1	1	1	1	1	6

Note: The score is considered as such H = 3; M = 2, and L = 1. The score is reversed such that H = 1 and L = 3 for Investment & Payback

High Technology Priority Score: 12 to 15
Medium Technology Priority Score: 10 to 12
Low Technology Priority Score: Less than 10

5. Recommendation and Implementation Plan

5.1 Background

Governments around the world are studying, developing, and implementing numerous policies to reduce energy use and GHG emissions. While the primary goal of these measures is to meet international commitments on climate change, most also seek to improve economic efficiency and competitiveness, energy security, and environmental performance.

The micro, small and medium enterprises (MSME) sector is one of the most significant sectors in the Indian economy. The sector contributes to 6% of GDP, accounts for 33% of exports. MSMEs are often termed as the growth engine of the Indian economy. It is no surprise that a large component of the government Rs 20 lakh crore (20 trillion) stimulus package is earmarked for the MSME sector. SME development cuts across sectors involve multiple stakeholders and necessitate concerted actions by the public and private sectors. Therefore, SME development should be mainstreamed into the national development framework.

Despite several existing regulations and policy frameworks on the Paper sector in India (Energy Conservation Act 2001, PAT scheme for large industries, Import policy, The Environment (Protection) Act, 1986; EIA Notification 2006), it was found that there are many challenges in promoting energy efficiency in the sector. Low penetration of energy-efficient (EE) technologies among SME units can be attributed to limited awareness, lack of access to improved EE technologies and services, limited availability of skilled operators to operate and maintain the latest machinery and adopt best operating practices such as the replacement of centrifugal screen with pressure screen in stock preparation, modification of pulp mill washers in order to avoid the usage of vacuum pumps, Installation of energy-efficient agitators, avoiding the operation of silo level control pump in paper machine area, Installation of VFDs, rainwater harvesting and energy monitoring of different sections of the plant.

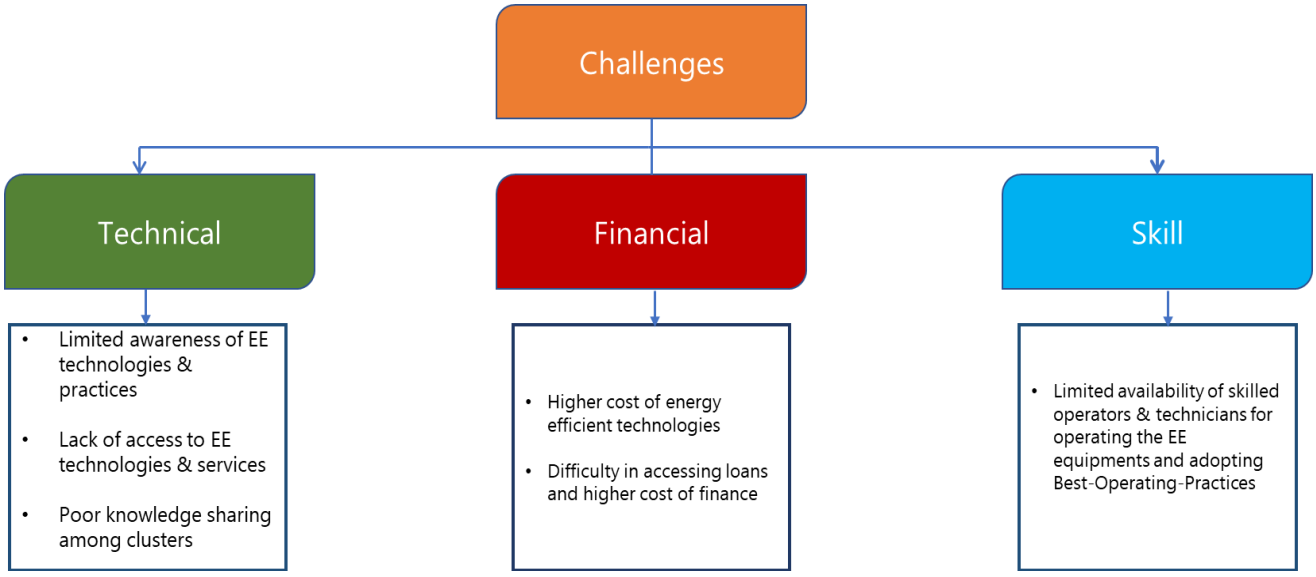


Figure 49: Challenges in Paper Sector

There is a need to address these barriers through a series of policy instruments along with their implementation plan and timeline which would scale up the energy efficiency of the Paper sector. These "Integrated Policy Package" are categorized into – Regulatory, Informatory, Financial, Market based, and

Institutional framework-based policy instruments. The timeline for each of the measures is categorized into –

Short term - Within 3 years
Medium term – 3 to 5 years
Long term – More than 5 years

Table 17: Integrated Policy Package

Mechanism	Policy instrument	Timeline
Regulatory	1. Promotion of uptake in Energy Management System (EnMS) standards	1. Short Term
	2. Widening of the PAT scheme to include the Paper units	2. Medium Term
	3. Increase in biofuel usage in clusters	3. Short Term
	4. Plastic waste to energy boiler for paper mills (Coprocessing)	4. Medium Term
	5. Promotion of Paper recycling	5. Medium Term
	6. Use of Microturbines in clusters (Cogeneration)	6. Short Term
	7. Promotion of electrification of boilers	7. Long Term
	8. Setting up Solar Park in clusters	8. Long Term
Informatory	9. Formation of cluster development centers	9. Medium Term
Financial	10. Soft loans for EE technologies	10. Short Term
	11. Adoption of energy-efficient technology through cluster-level ESCOs	11. Medium Term
Market-based	12. Emission trading scheme	12. Long Term
	13. Carbon pricing	13. Long Term
Institutional framework	14. Increase the participation of State Designated Agencies (SDA)	14. Short Term
	15. Enhance the role of MSME associations in promoting energy efficiency	15. Short Term
	16. Introduce Paper curriculum in Engineering colleges (B.Tech, M.Tech)	16. Short Term

The ideal policy package for industrial energy efficiency integrated the five mechanisms:

- **Regulatory:** creates a strong push for EE technologies
- **Informatory:** promotes benchmarking and information sharing
- **Financial:** creates a market for EE technologies
- **Market-based instruments** promote energy efficiency based on the supply and demand among the units
- **Institutional framework:** creates an organizational structure for deeper penetration and handhold the SME units to uptake energy efficiency.

At present, the manufacturing sector is facing financial challenges due to the Covid-19 economic crisis. With economic stimulus packages focusing on immediate efforts to deliver jobs, incentives will play a more significant role in economic stimulus packages. Positive drivers could aim at supporting training/capacity building and the rollout of energy management systems and rely on bulk procurement. Policymakers have the opportunity to place conditions on grants and funding, which could include implementation of EE technologies, benchmarking, and facility upgrades/ process improvements.

An integrated policy package consisting of a mix of information/technical assistance, financial incentive, and regulations is proposed to improve the energy efficiency of the SME Paper industry. The policies, regulations, frameworks, and other instruments collated and analyzed in this research form the basis of some preliminary recommendations for enabling a conducive policy environment and empowering SMEs to report on their sustainability impacts. After collating the results of the workshop with various stakeholders such as BEE, SDA, MSME-DI, Paper Associations and plant professionals, interviews and discussions with paper sector experts and consultants and desk research carried out for this study, policy packages that foster a conducive environment for SME energy efficiency uptakes were identified.

The proposed policy package consists of a group of policies as shown in Figure 50 below:

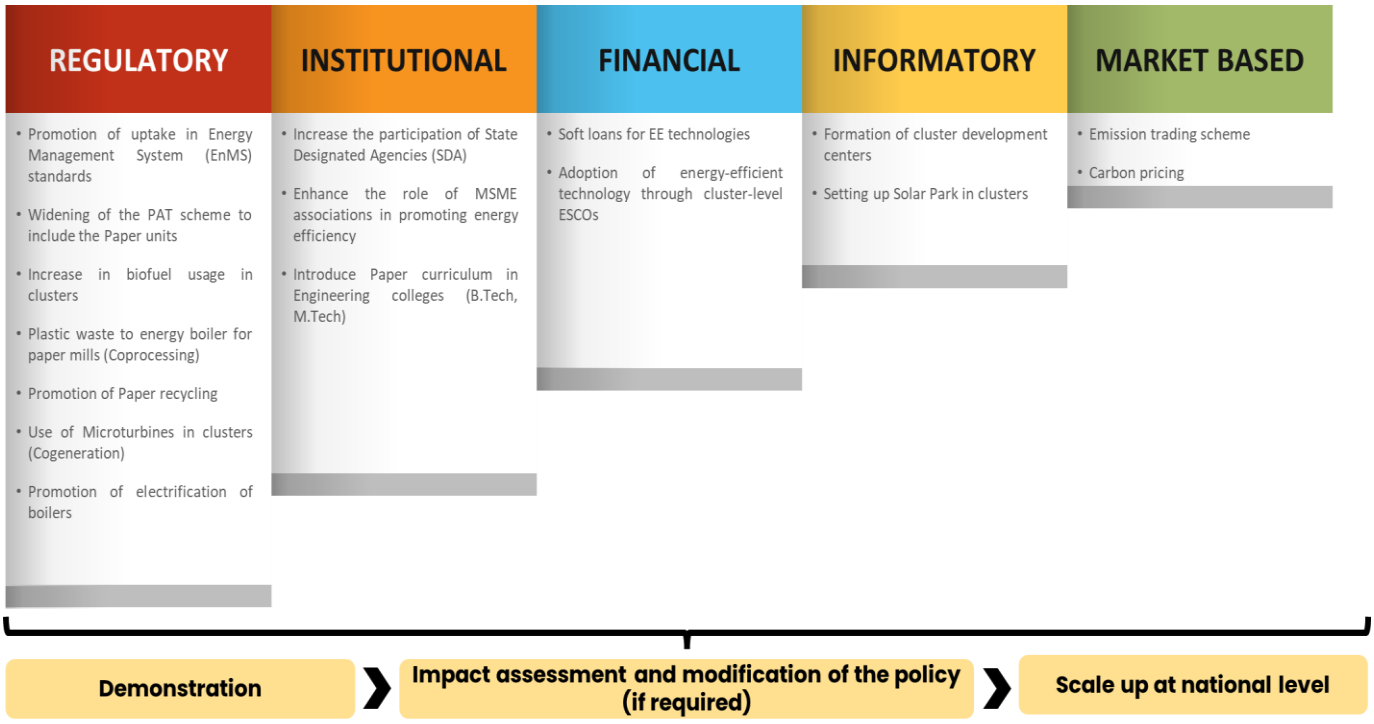


Figure 50: Integrated Policy Package

5.2 Policy recommendations along with Implementation Road map to enhance the energy efficiency

The implementation road map to enhance energy efficiency is divided into short term, medium-term and long term.

Synopsis of stakeholders' responsibilities of the suggested policy recommendations

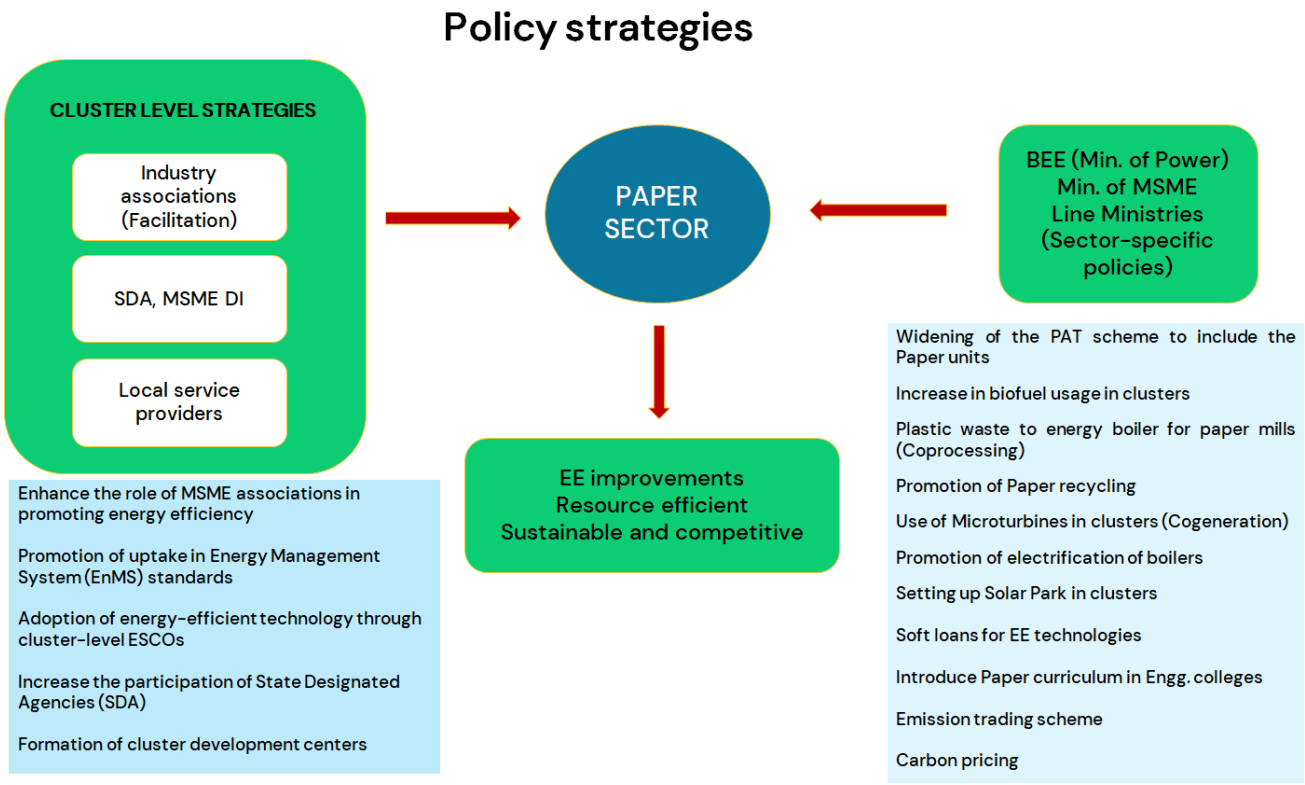


Figure 51: Policy Strategies

5.2.1 Synopsis of stakeholders' responsibilities of the suggested policy recommendations

Sector Specific Policies

The policies mentioned below in table 18 is specifically tailored for the Paper MSME sector

Table 18: Sector Specific Policies

Policy	Stakeholders Involved	
Increase in biofuel usage in clusters	**BEE**	To introduce a carbon pricing policy
	Cluster Association	Assist carbon pricing policy at the regional level
	State government/SDA	Provide awareness among SMEs member units
Use of Microturbines in clusters (Cogeneration)	**BEE**	Program for the implementation of Microturbine.
	Cluster Association	Actively promote the uptake of microturbine

Policy	Stakeholders Involved	
	Technical providers/ consultants	To provide service for the implementation of the technology
Policy to promote electrification of boilers in paper units	BEE	Develop a scheme to help transition from high emission fossil-fired boilers to the electric boiler.
	Manufacturers	To provide service for the implementation of the technology
	Cluster Associations	Encourage member units to adopt electric boilers
Plastic waste to energy boiler for paper mills (Coprocessing)	BEE	Develop a scheme to install boilers capable of converting plastic waste to energy
	Manufacturers	To provide service for the implementation of the technology
	Cluster Associations	To encourage member units to adopt plastic waste to energy boilers.
Promotion of Paper recycling	BEE	Develop a scheme to promote paper recycling
	Cluster Associations	To encourage member units to adopt recycling practices.
Wider adoption of Paper curriculum in Engineering colleges	MoHRD/AICTE	To provide certification benefits to the diploma paper courses
	Engineering colleges	To start courses B. Tech, M. Tech, PhD. in paper technology
	Central/State government	To regulate engineering colleges and provide financial aid programs in the promotion of starting paper technology-specific courses.

Sector Neutral Policies

The policies mentioned below in table 19 is specifically tailored for the Paper MSME sector

Table 19: Sector neutral policy recommendation

Policy	Stakeholders Involved	
Increase the participation of State Designated Agencies (SDA)	**BEE**	To actively include SDA in all the cluster-related programs for its better outcomes.
	State Level Govt. bodies	To actively participate in all the cluster programs of BEE.
Enhance the role of MSME associations in promoting energy efficiency	**BEE**	To develop an organizational framework to monitor the activities
	State Level Govt. bodies	To actively engage the associations
Promotion of uptake in Energy Management System (EnMS) standards	**BEE**	Program for the implementation of EnMS system
	State Level Govt. bodies	Actively promote the uptake of the EnMS system
	Technical consultants	Provide services for the implementation of EnMS
	Technology Providers	Create awareness on their EE offerings
Widening of the PAT scheme to include the Paper units	**BEE**	Inclusion of Paper units under the PAT scheme
	State Level Govt. bodies	To create awareness of the PAT scheme
	Technical consultants	Services for implementation of the PAT scheme

Policy	Stakeholders Involved	
Soft loans for EE technologies	**BEE**	To develop schemes for accessing soft loans for EE technologies by SME plants
	Cluster Associations	Provide awareness among SMEs member units
	Financial Institutions	Provide the collateral-free loan to the SME paper plants
Formation of cluster development centers	**BEE**	To develop cluster development centers
	SDA	Awareness of the cluster development program
	Cluster Associations	Identify the key facilities required by the cluster
	Technical Consultants	Implementation of common facility center
	Technology providers	Create awareness on their EE offerings
Emission Trading Scheme	**BEE**	To launch a national cap-and-trade program
	State Government / SDA	Enforce & implement emission trading schemes
	Cluster Associations	To provide awareness among SMEs member units

Policy	Stakeholders Involved	
	Technology Providers	Create awareness on their EE offerings
Adoption of energy-efficient technology through cluster-level ESCOs	Manufacturers	Supply of Energy Efficient equipment
	Financial Institutions	Collateral free loan/soft loan to the ECSOs
	Cluster associations	Provide awareness among SMEs member units
	Technical consultants	Recommend EE technology and provide (M&V)
	ESCOs	EE tech. at no upfront cost from the SMEs

Policy	Stakeholders Involved	
Carbon pricing (Polluters pay principle)	BEE	To introduce a carbon pricing policy
	Manufacturer	To assist the central government in implementing carbon pricing policy at the regional level.
	Cluster Associations	Provide awareness among SMEs member units
Setting up Solar Park in clusters	BEE	To develop a scheme to set up solar parks in paper clusters
	Manufacturer	Participate in cluster level programs to create awareness on their products offering
	Cluster Associations	To encourage member units for solar adoption and assist in developing pilot.

5.2.2 Implementation Roadmap for the Sustainability of the Paper MSME sector

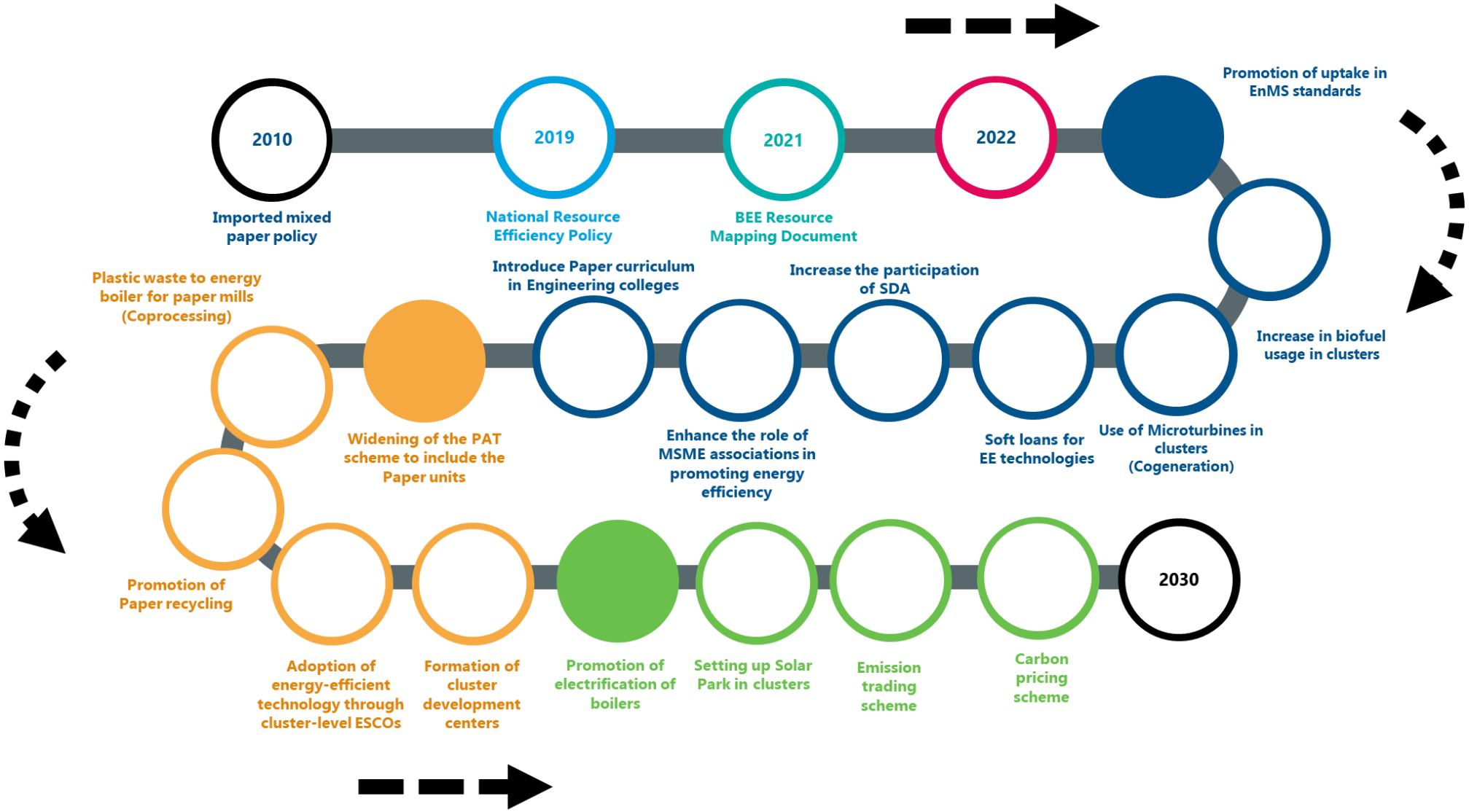


Figure 52: Implementation Roadmap for the Sustainability of the Paper MSME sector

5.3 Detailed Policy Description

5.3.1 Increase the participation of State Designated Agencies (SDA)

At present almost all the SME programs are directly driven through BEE at the center, with little involvement of State Designation Agencies (SDA's). More than 400 SME clusters are manufacturing energy-intensive products in India. Some of the clusters are located in very remote areas. Given the diversity and geographic spread of MSMEs, it is cumbersome for BEE to manage all programs simultaneously. For effective implementation of these programs' active participation from SDAs is imperative.

Key Benefits:

- Easy to manage cluster programs.
- Due to the local presence of SDAs, the cluster programs will leverage more trust from the association and units and will be more impactful.
- Increased participation of stakeholders

Action points

An operating model to be developed while formulating the cluster programs to larger participation from SDAs.

Roles and responsibilities of the stakeholders

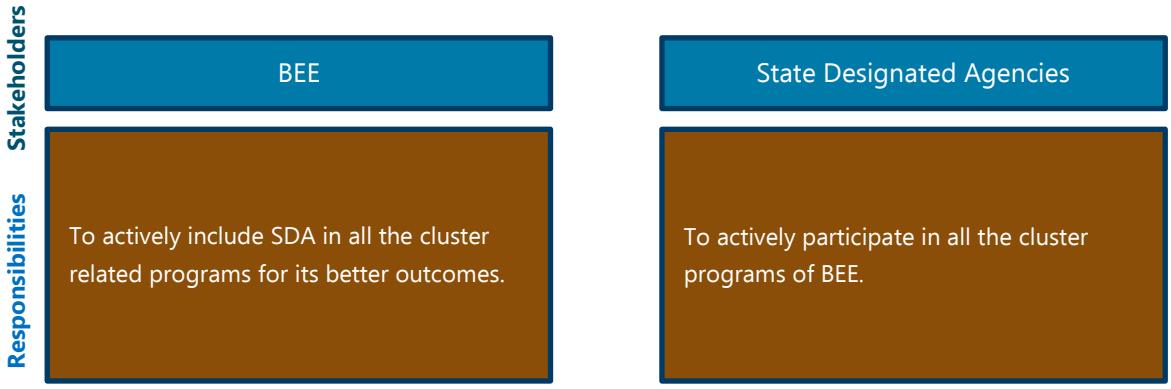


Figure 53: Increase the participation of State Designated Agencies (SDA)

5.3.2 Enhance the role of MSME associations in promoting energy efficiency

Under the present schemes/programs, MSME associations do not come under direct contact with SDA's or BEE, but through the hired consultants. As per our experience, MSME associations tend to enjoy the greater trust of the member enterprises, on basis of which it is easier to change behavioral patterns and perceptions to drive energy efficiency measures. MSME Associations can locally drive certain activities which can reap immediate benefits.

Key Benefits:

- The role of MSME associations can be leveraged to scale up energy-efficient technologies (aggregation model).
- Quick communication and easy reach out to MSME units.
- Accelerate the promotion of Energy Efficiency.

Action points

An institutional framework to be developed so that key MSME associations become members under the certain scheme and are in direct contact on regular basis with SDAs.

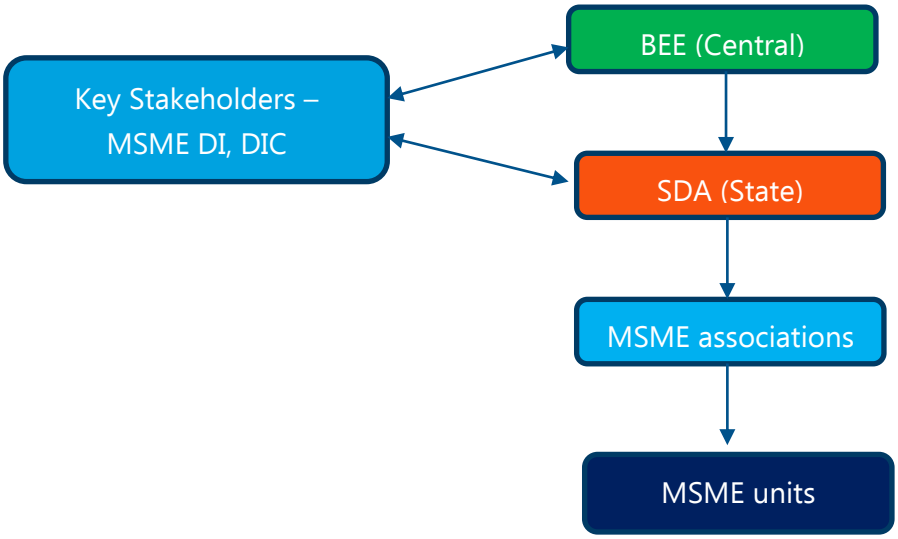


Figure 54: Action Points – Enhance the role of MSME associations in promoting energy

Roles and responsibilities of the Stakeholders

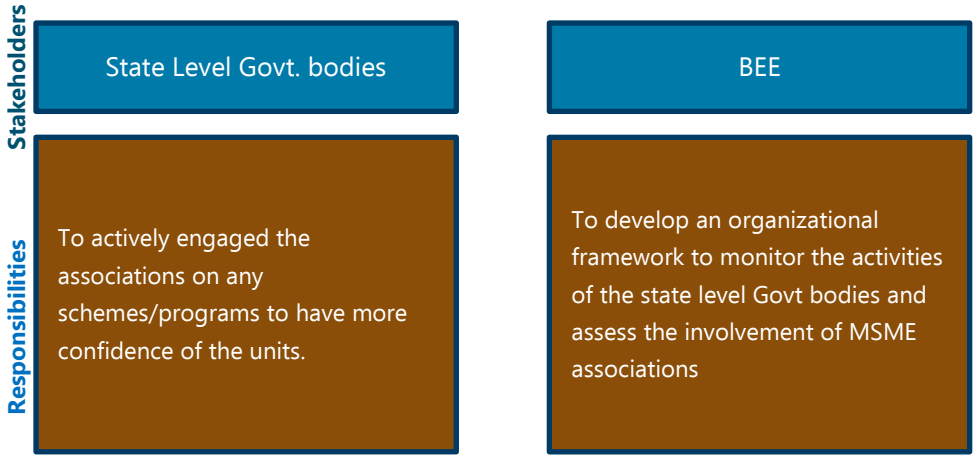


Figure 55: Enhance the role of MSME associations in promoting energy efficiency

5.3.3 Promotion of uptake in Energy Management System (EnMS) standards

The ISO Energy Management Systems aims to help organizations continually reduce their energy use, and therefore their energy costs and their greenhouse gas emissions. It will help the units in integrating energy performance into daily management practices and business systems, leading to a lasting change in organizational culture. During our field visit, we have seen that the SME units do not monitor the KPI of the process and lack consistent data on energy and operations.

Implementation of EnMS will require the units to assess baseline energy use, actively monitor, control, and manage energy use and costs, reduce emissions and continue to improve energy use/product output over time.

Key Benefits:

- Develop a policy for more efficient use of Energy.
- Fixed Targets and Objectives in line with the policy.
- Use data to make informed decisions about energy use.
- Measure the results to identify areas of energy efficiency improvements.
- Energy monitoring will help in benchmarking different processes.
- Ease out the monitoring and verification process for the EE projects.
- Review the policy's effectiveness and results of improvements.
- Continually improve Energy Management practices

Action points

The Bureau of Energy Efficiency should develop a program to support SME units in implementing EnMS in the pilot SME units.

Roles and responsibilities of the Stakeholders

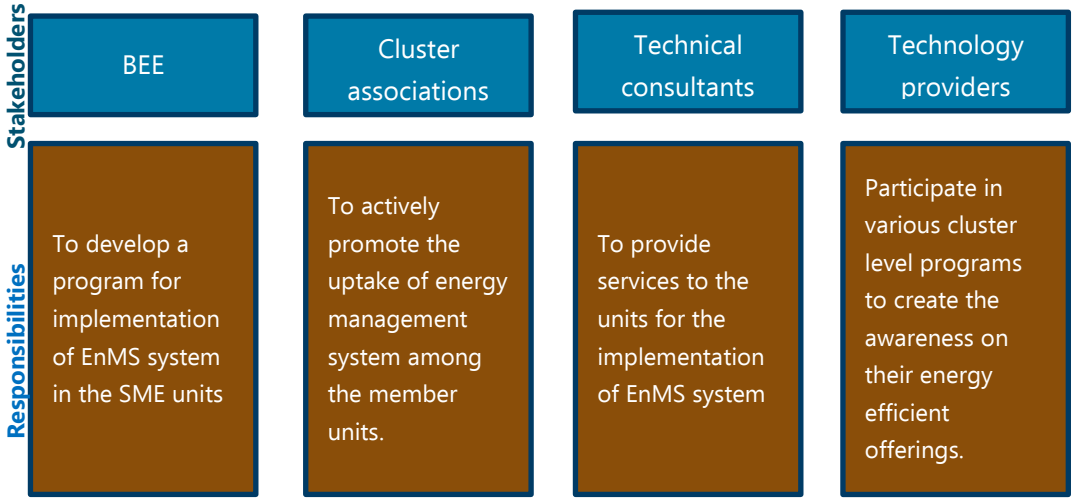


Figure 56: Promotion of uptake in (EnMS) standards

5.3.4 Widening of the PAT scheme to include the Paper units

The PAT scheme has been highly successful in promoting energy efficiency among the larger industries. The scheme may be expanded to cover the medium-sized Paper plants, say above the 5,000 toe threshold. In order to make it attractive for medium-sized units, the scheme for them could initially be voluntary and implemented in cooperation with the cluster level industry associations.

The initial phases of the scheme can target modest energy savings (say around 2%). Future phases can target a slightly higher rate of efficiency improvement (say 4-5%). The scheme can be strengthened by linking it with concessional loans for the EE technologies program. Investments made by SMEs on energy-efficient equipment under the PAT scheme will qualify for a loan on priority.

Key Benefits:

- SMEs are nudged to move beyond "Business As Usual".
- Encourages innovation and compliance.
- Adoption of EE technologies and BOPs to reduce energy consumption.

Action points

The Bureau of Energy Efficiency should develop a voluntary program to include the Paper units under the PAT scheme.

Roles and responsibilities of the Stakeholders

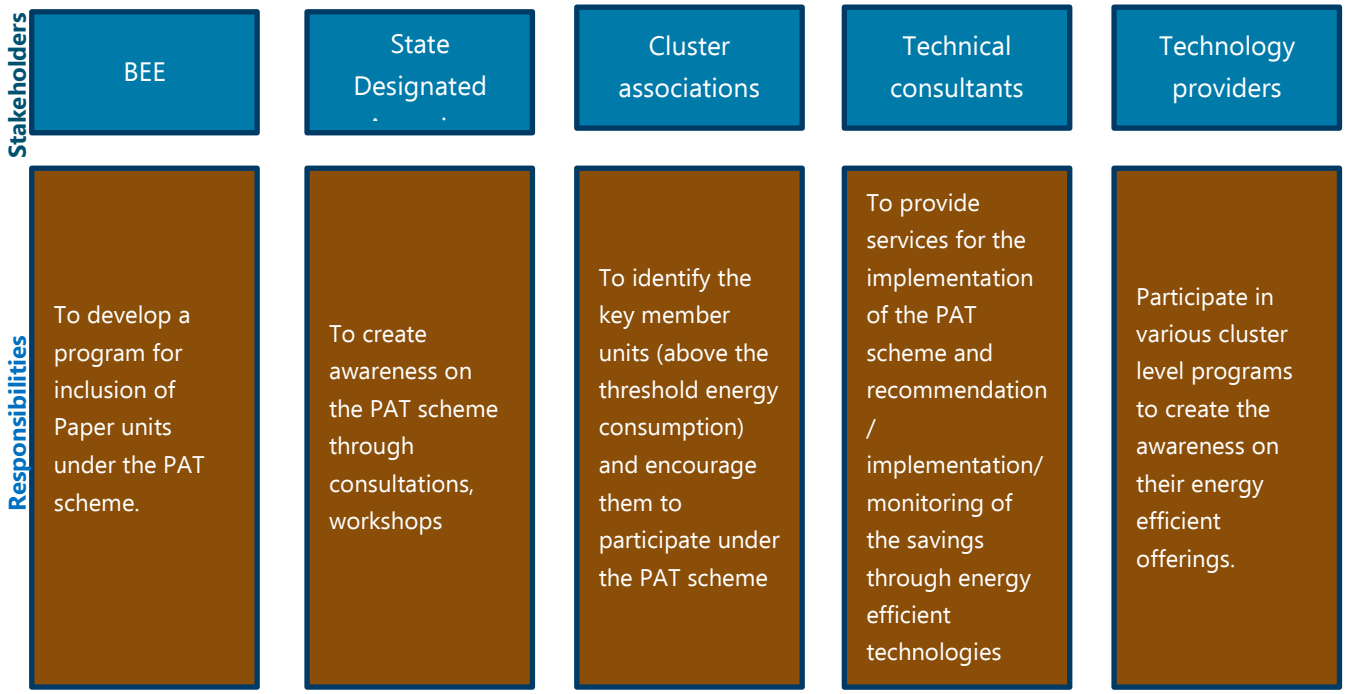


Figure 57: Widening of the PAT scheme to include the Paper units

5.3.5 Adoption of energy-efficient technology through cluster-level ESCOs

Our detailed energy assessment of the units has identified various energy-efficient (EE) technologies to reduce energy consumption. Low penetration of EE technologies in SMEs can be directly attributed to lack of technical support at a local level on one hand and absence of institutional mechanisms and financing models on the other. Large financial institutions and original equipment manufacturers (OEMs) find it difficult to provide loans as well as technical assistance for EE equipment to SMEs due to higher transaction costs and risk-return profiles.

The EE technologies with higher replication potential like – EE IE3 motors, pumps, and compressors can be routed through cluster-level ESCOs. The proposed instrument will aim at removing these barriers by creating 'mini-ESCOs' of local service contractors who already work with SMEs at the cluster level. Local service providers are particularly sensitive to maintaining good customer relations and hence complex performance contracts are not necessarily needed to cover contingencies if actual energy savings is less than the guaranteed level.

Key Benefits:

1. Replicates the commercially proven technologies
2. Reduce the financial burden of the units in implementing the EE technologies
3. Reduces the cost of EE equipment through bulk procurement
4. Promotes high energy savings

Action points

To propagate the concept and identify the cluster level ESCO

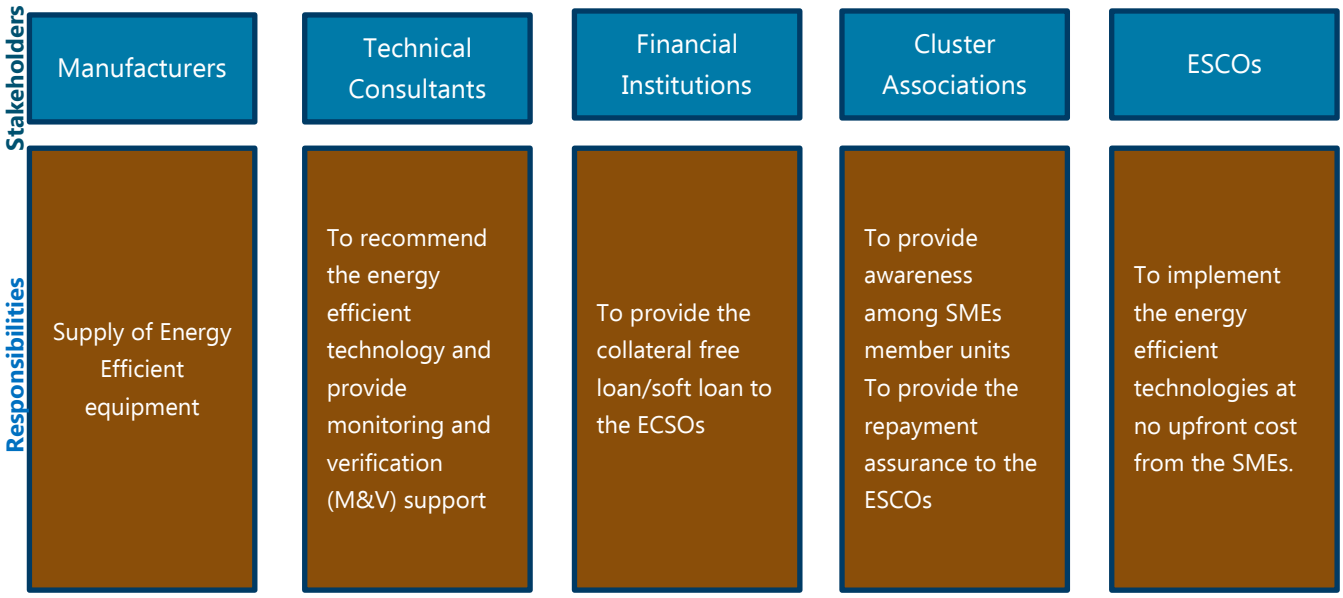


Figure 58: Adoption of energy-efficient technology through cluster-level ESCOs

5.3.6 Soft loans for EE technologies

Indian MSME sector consumes almost half of the total energy consumption by the industrial sector. Many MSMEs are highly energy inefficient due to obsolete technology/processes. During the study, it was found that the potential for enhancing energy efficiency in MSME paper plants is around 10- 25%. BEE should introduce schemes for financing Energy Efficiency (EE) in paper clusters.

Financial Assistance to MSMEs through Special Credit lines (Loan with lower interest rate): It can be established by a public entity (government or donor organization) and enable financing of EE projects by a private organization. The scheme will provide funds to local financial institutions at a low-interest rate, the public entity can encourage the institution to lend at a lower interest rate to parties interested in developing EE projects. A similar scheme has already been installed by China and Thailand.

Bilateral agencies like JICA, KfW, AFD, and ADB have been supporting concessional financing of energy-efficient equipment among Indian MSMEs, through SIDBI. Other agencies like GIZ have supported awareness generation and capacity building of bankers on the financing of energy efficiency projects. Multilateral agencies like GEF, through World Bank, and UNIDO are funding projects which support energy audits in selected energy-intensive sub-sectors.

During the COVID time, the credit rating of many units has deteriorated. This is because of the disruption of cash flow in the entire value chain. Credit rating of the units during the COVD period should not be considered while considering a soft loan for the units on the implementation of EE technologies.

Key Benefits:

1. This will promote Energy Efficiency Investments in MSMEs.
2. These lending schemes can reduce energy consumption, enhance energy efficiency, reduce CO2 emissions, and improve the profitability of the Indian MSMEs

Action points

Adequate focus on EE/ cleantech/ renewable energy financing by the banks

Roles and responsibilities of the Stakeholders

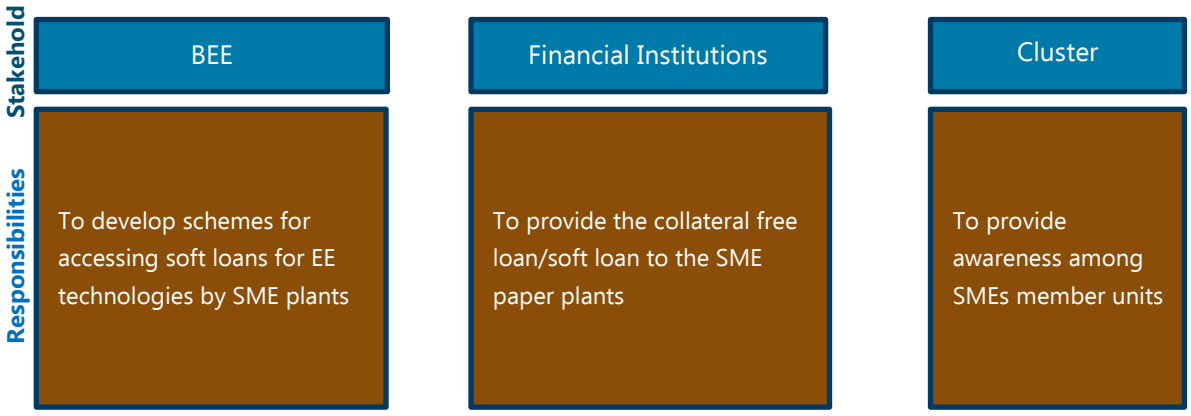


Figure 59: Soft loans for EE technologies

5.3.7 Formation of cluster development centers

BEE can adopt the cluster development approach as a key strategy for enhancing the productivity and competitiveness as well as capacity building of Micro, Small, and Medium Enterprises (MSMEs). This will lead to the creation of infrastructural facilities like skill development centers, testing facilities, energy management centers (EMC) which cannot be undertaken by individual units

Key Benefits:

- To support the sustainability and growth of MSMEs by addressing common issues such as improvement of technology, skills & quality, market access, etc.
- To build the capacity of MSEs for common supportive action through the formation of self-help groups, consortia, upgradation of associations, etc.
- To create/upgrade infrastructural facilities in the new/existing Industrial Areas/Clusters of MSMEs.
- Promotion of green & sustainable manufacturing technology for the clusters to enable units to switch to sustainable and green production processes and products.

Action points

Bureau of Energy Efficiency should develop cluster development centers like skill development, testing facilities for Paper units.

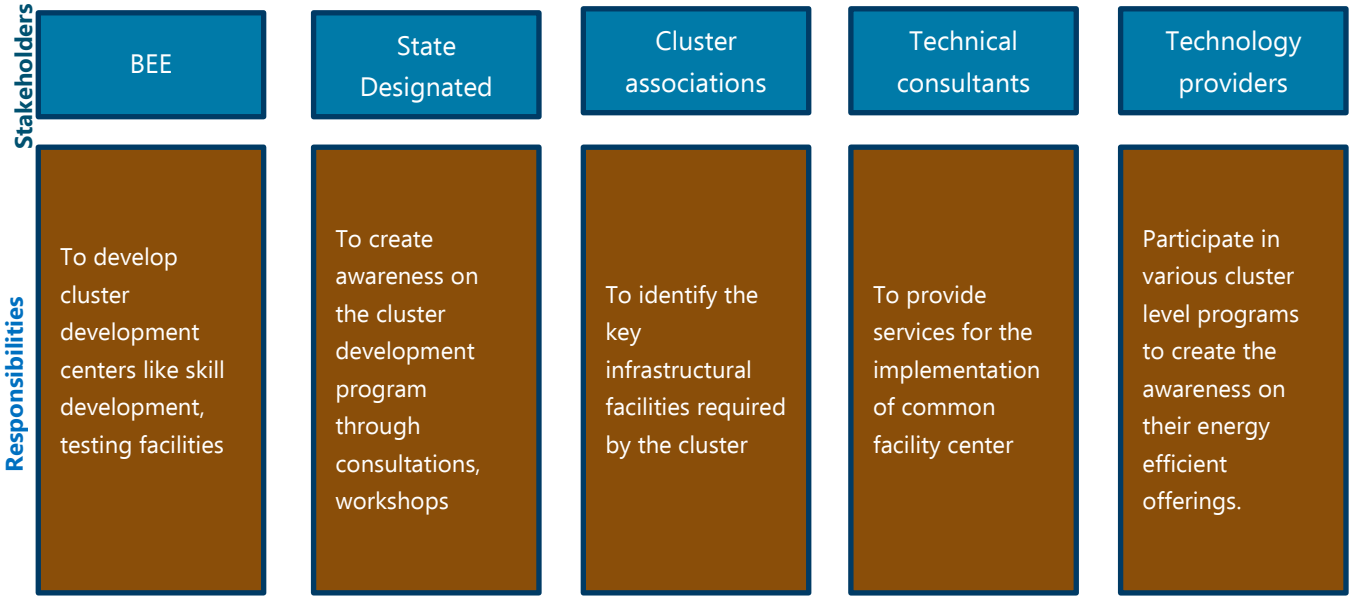


Figure 60: Formation of cluster development centers

5.3.8 Emission Trading Scheme

The first emissions trading scheme internationally was in 1995 which was successful in terms of addressing acid rain in California and reducing air pollution significantly. Compliance costs were less than half of those predicted by the US Environmental Protection Agency, and many times lower than those predicted by industry. The other examples are European Union Emission Trading Scheme (ETS), China ETS, and Korea ETS. It is estimated that there are at least 45 schemes across the world that put a price on carbon. The current carbon market is valued at USD 277 Bn. The design of trading programs is critical to its success, as it will end up determining the transaction costs as well as the uncertainty and risk inherent in the trading system.

There should be a cap set for maximum emissions by industry, and surplus entities (achievers) can trade with non-achievers. This will push industries for cleaner and more energy-efficient technologies and the adoption of renewable energy. It can be initially started as a voluntary program and could be mandated with higher caps and trading. The Gujarat government has already implemented a cap-and-trade program, although it is a pilot project and specifically targets particulate matter (PM) pollutants in Surat's industrial belt but can be considered by other state governments.

Key Benefits:

1. This scheme is efficient in reducing GHG emissions
2. Departure from the traditional command and control approach to environmental regulation.

Action points

Adequate focus on EE/ cleantech/ renewable energy financing by the banks

Roles and responsibilities of the Stakeholders

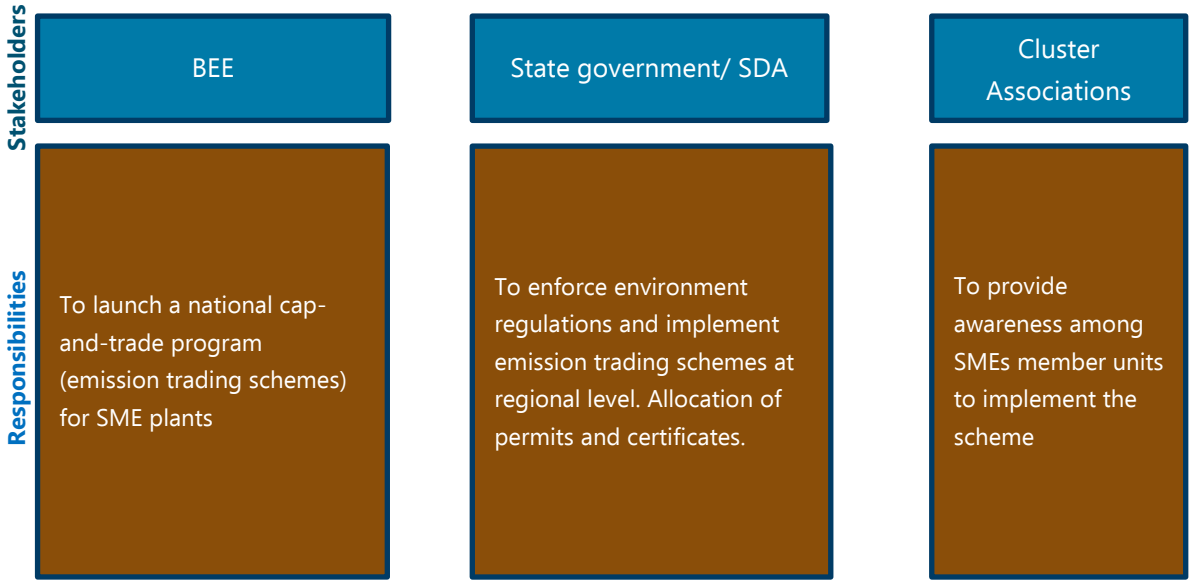


Figure 61: Emission Trading Scheme

5.3.9 Carbon pricing (Polluters pay principle)

The emissions produced by industries are a negative externality for the environment and the economy since their true social cost is not reflected by the market price of carbon-intensive goods and services. Thus, instituting a price that reflects the true cost of these emissions seems like an intuitive solution to address these climate change issues. This will drive the industry to push for alternative energy sources, cleaner fuel & renewables. As policy makes industries pay an external cost for carbon emissions, it will help in raising revenues that can be spent on EE initiatives.

India does not have an explicit carbon price and BEE can introduce this mechanism. However, It will be important to address issues such as additional tax might suffocate industries in an already competitive market, administrative costs in measuring pollution, and collecting tax should be considered during designing carbon pricing mechanism.

Example: Sweden's economy grew by 60 percent since the introduction of the Swedish carbon tax in 1991, while its carbon emissions decreased by 25 percent

Key Benefits:

1. Carbon pricing can promote cost-effective abatement, deliver powerful innovation incentives
2. Avoid fiscal problems by adding to the government revenues which can be spent on EE initiatives

Action points

BEE can introduce a carbon pricing policy in the medium to long term. In the short term, India should focus on phasing out fossil-fuel subsidies and improving the efficiency of existing policies that place an implicit price on carbon.

Roles and responsibilities of the Stakeholders

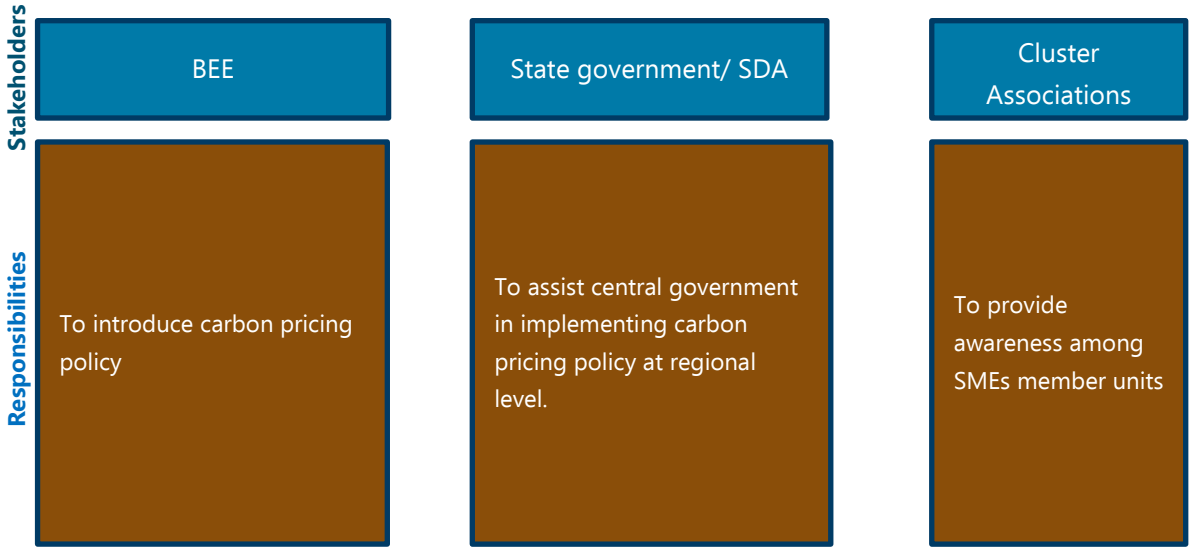


Figure 62: Carbon pricing (Polluters pay principle)

5.3.10 Increase in biofuel usage in clusters

The paper sector is one of the few sectors that can become not only carbon neutral but also carbon negative. Policy to promote the use of biofuels in paper units is one such tool. Biomass can replace fossil fuels in the production of process heat in boilers and lime kilns (large plants). This would make the sector carbon neutral. Some units in clusters are already using biofuels such as wood, pith, etc.

Biomass with CO_2 Capture and Storage (Bio-CCS) in the future can be used to make the paper sector carbon-negative. This would be achievable once CCS technology is available at a commercial scale. This policy is already part of EU prospects for the decarbonizing paper industry.

During the study, it was found that except Kashipur all clusters were using mix share of fossil fuels with Morbi using almost 100% coal as a source of thermal energy.

	Percentage share of biofuel	Percentage share of fossil fuel
Muzaffarnagar	61%	39%
Kashipur	100%	-
Morbi	-	100%
Vapi	4%	96%
Erode-Coimbatore	55%	45%

Key Benefits:

- Encourages innovation and promotes decarbonizing the paper industry
- Adoption of biofuels will reduce the burden on the environment due to GHG emissions
- It Will help in achieving India's emission reduction target
- Potential to make paper sector carbon-negative

Action points

The Bureau of Energy Efficiency should develop a scheme to promote increased usage of biofuel in the Paper cluster. Demand can be further increased by subsidizing biofuel (where cost difference is high with coal) and penalizing fossil fuel usage, thereby making biofuel more attractive as a fuel.

Roles and responsibilities of the Stakeholders

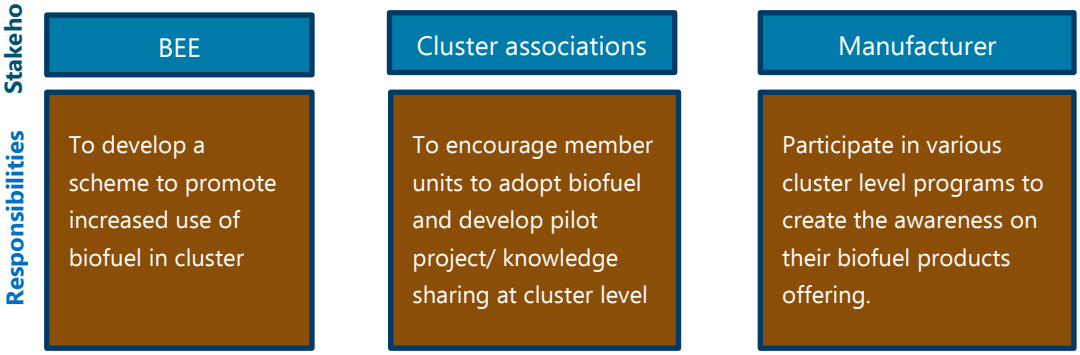


Figure 63: Increase in biofuel usage in clusters

5.3.11 Use of Microturbines in clusters (Cogeneration)

Cogeneration systems produce electricity and thermal energy sequentially from the same fuel source at 10-30% fuel savings. Cogeneration is useful in the pulp and paper, chemicals, food, petroleum refining, textile, and fertilizer industries for which energy costs are large fractions of production costs and process heat is required.

All paper industries have an in-house boiler to meet process heat requirements. The boiler generates steam at a pressure of 9-10 bar and the process requirement is at 3 bar. This means steam at a higher pressure is converted to low-pressure steam using the PRV system and sent to process. Thus, making a case for the installation of Microturbine. Plant use pressure-reducing valves (PRVs) to drop the steam pressure to the desired level. While PRVs effectively reduce steam pressure, they also waste valuable energy. Microturbines enable the plant to capture this waste energy by placing it in parallel with an existing PRV. This allows on-site generation of electricity and also reduces steam pressure to the required level, saving money and increasing overall system efficiency.

Table 20: Total No. of Turbine in shortlisted industries in selected clusters

Cluster	No. of Industries shortlisted	Total No. of Turbine in shortlisted industries Cluster
Muzaffarnagar	10	7
Vapi	10	3
Kashipur	10	1
Morbi	10	1
Erode-Coimbatore	10	1
Total	50	13
		26%

During the study, it was found that only 26% of industries have microturbines installed. Thus, there is a good potential to install microturbines and save energy.

Key Benefits:

- A small number of moving parts, compact size
- Good efficiencies in cogeneration, lower electricity costs
- Strengthens energy security by utilizing waste energy

Action points

The Bureau of Energy Efficiency should develop a program to support SME units in implementing cogeneration in all the units.

Roles and responsibilities of the Stakeholders

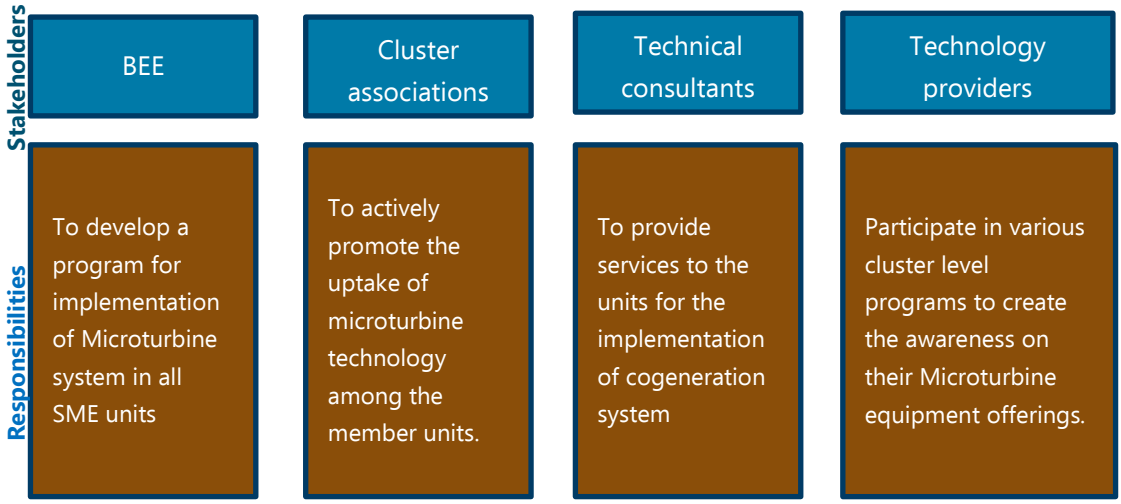


Figure 64: Use of Microturbines in clusters (Cogeneration)

5.3.12 Policy to promote electrification of boilers in paper units

Several processes in paper manufacturing need steam such as pulping, bleaching, starch preparation, drying (paper machine), etc. This process heat is currently supplied by steam generated by firing fossil fuel in boilers. For a typical paper plant, process heat at 170 ^{0}C is needed at lower pressure of about 3 bar whereas the boiler generates steam at a pressure of 8 bar to 10 bar (max.). Processes in the paper industry need low-temperature heat.

This process heat can easily be supplied by electric boilers as they can produce heat up to 400 ^{0}C. Electric boilers also have higher efficiency (99.5%) as compared to conventional boilers (< 80%). By using electric boilers, we can switch from GHG emitting fuel sources to clean energy. This policy is already part of EU prospects for the decarbonizing paper industry.

Key Benefits:

- Electric boilers are compact, economical, and produce no emissions.
- Promote transitioning from high emission fossil-fired boilers
- Electric boilers have several advantages compared to conventional boilers, including superior safety, ease of installation, faster start-up, shut downtime, and quiet operation
- Electric boilers do not have a high minimum operating level to make them immediately available.

Action points

The Bureau of Energy Efficiency should develop a program to support SME units in implementing the electrification of boilers.

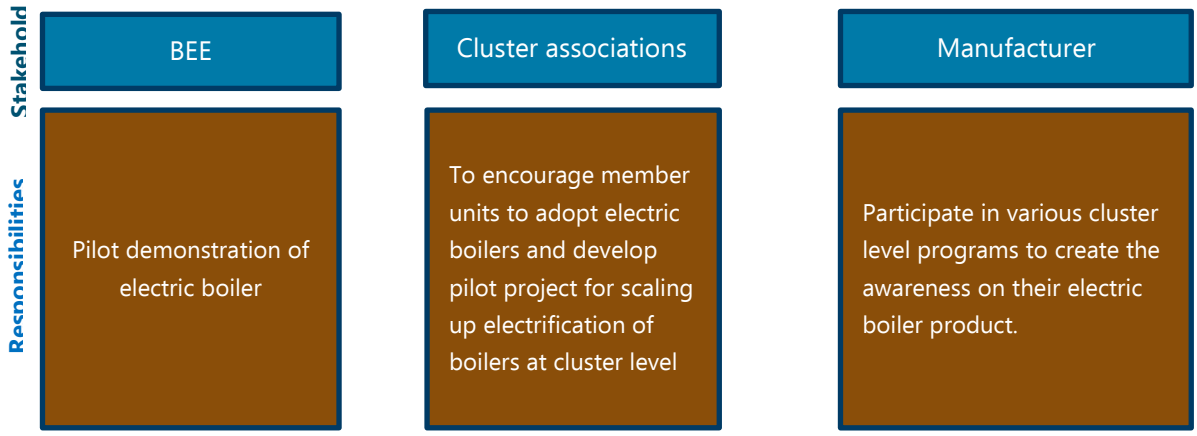


Figure 65: Policy to promote electrification of boilers in paper units

5.3.13 Plastic waste to energy boiler for paper mills (Coprocessing)

While the recycled paper-based industries are considered eco-friendly in terms of their resource consumption for generating paper, they generate lots of plastic waste. When magazines and high-end glossy publications are sent to the pulping machine, the plastic-coated on the front page is separated from the paper. Typically, plastic is around 1-2 per cent of the total paper that goes into the pulping machine. Around 400 MT of plastic waste is used to get generated in the Vapi industrial area itself.
Traditionally, this waste was collected and stored at a place outside the town. Its disposal, therefore, was a big issue, and most industries either used to dump it into landfills developed for the disposal of the industrial hazardous waste or would make heaps of it at a location outside town, in remote locations, where it would be stored for months. Such heaps would catch fire and would burn for days, generating toxic fumes in addition to greenhouse gases.

While the co-processing of plastic waste in cement industries is considered as a viable option due to numerous advantages but considering the availability of cement plants in a few clusters like Gujarat, etc. and also a requirement of high temperature and residence time in cement kilns, and requirement of huge amounts of energy in clinker-making process in cement plants is not possible at the national level.
Paper Mills waste plastics should be mitigated using emerging techniques and methodologies depending upon the type of plastics, associated impurities, wetness, etc. As waste plastic does not have defined properties/characteristics, a suitable technology such as waste to energy boiler can be adopted. Every 1000MW of power generated by Waste to energy boiler plant cuts carbon emissions by 1 million tons.

Key Benefits:

- Waste-to-Energy generates power with less environmental impact than almost any other source of electricity.
- Reduce the volume of waste in an environmentally friendly manner.
- Generate valuable energy.
- Emissions from landfilling can be avoided.
- Promotion to the concept of circular economy

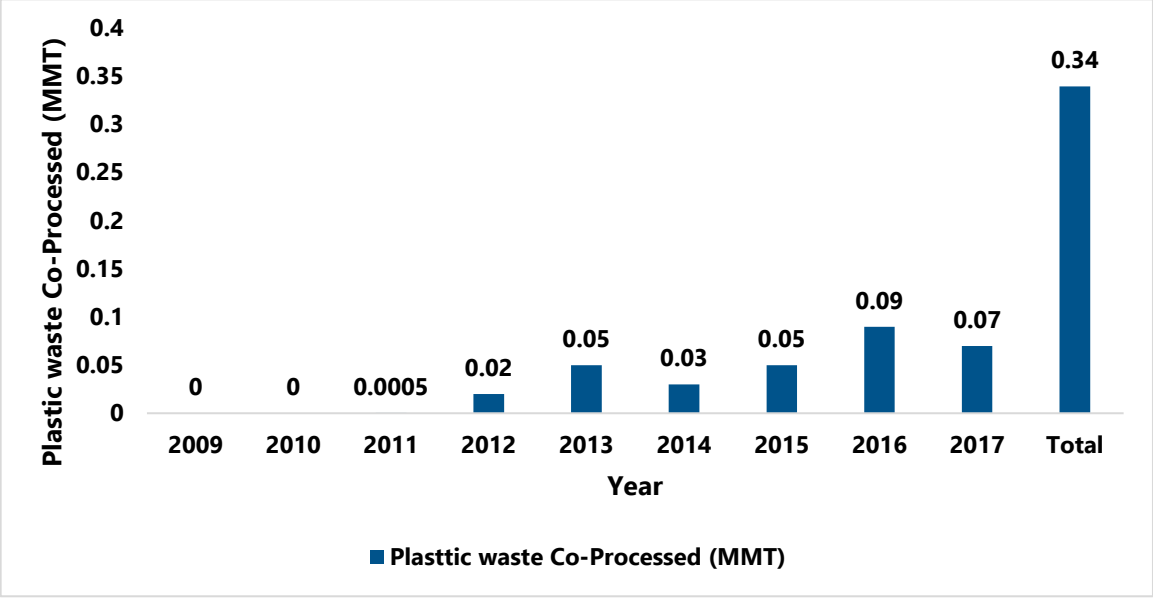


Figure 66: Plastic waste co-processed (MMT) in India

Action points

The Bureau of Energy Efficiency should develop a program to support SME units in promoting coprocessing in paper plants.

Roles and responsibilities of the Stakeholders

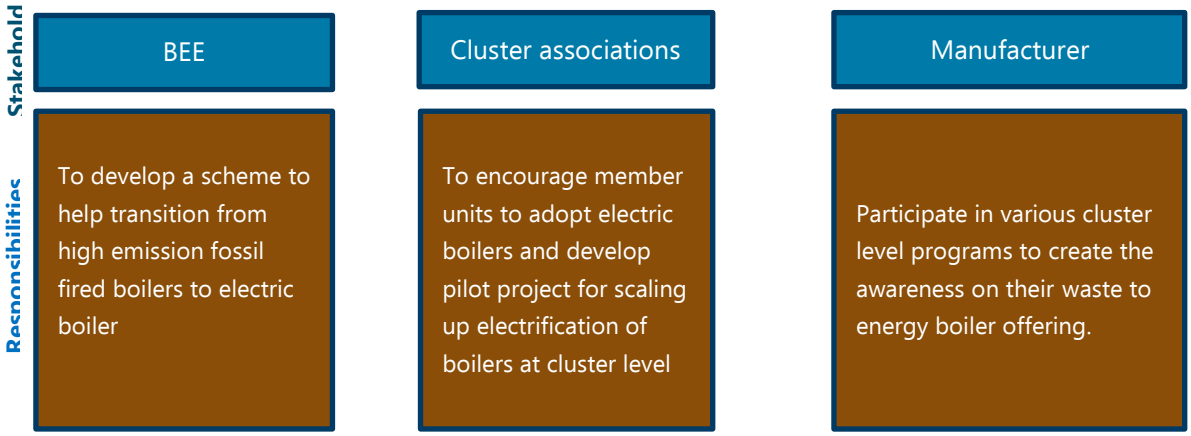


Figure 67: Plastic waste to energy boiler for paper mills (Coprocessing)

5.3.14Promotion of Paper recycling

Canada, Europe, Japan, and the United States have reached high recovery rates (Figure 68). These countries continue to improve recovery rates by taking actions such as investing and expanding wastepaper collection systems and developing community awareness programs to improve recycling habits.

The recovery rate of wastepaper in India is quite low (~30%) due to the lack of an effective collection mechanism**.** With issues like the availability of quality raw material at competitive prices, the players depend on the imports of pulp, wastepaper, and even pulpwood to meet their raw material needs and often have to pay a premium for availing them thereby impacting profitability and capacity addition. To alleviate this significant challenge, BEE could frame a policy to allow access to degraded forest land for paper mills to raise pulpwood plantations for increasing pulp availability and reduce import dependence; further, the

government can ensure collection mechanism be strengthened to increase usage of wastepaper which can be achieved by creating awareness programs and through policy measures. In India, the industry can also find opportunities for job creation as cooperatives for recycling and waste collectors play an increasingly important and legitimate role in the recycling industry.

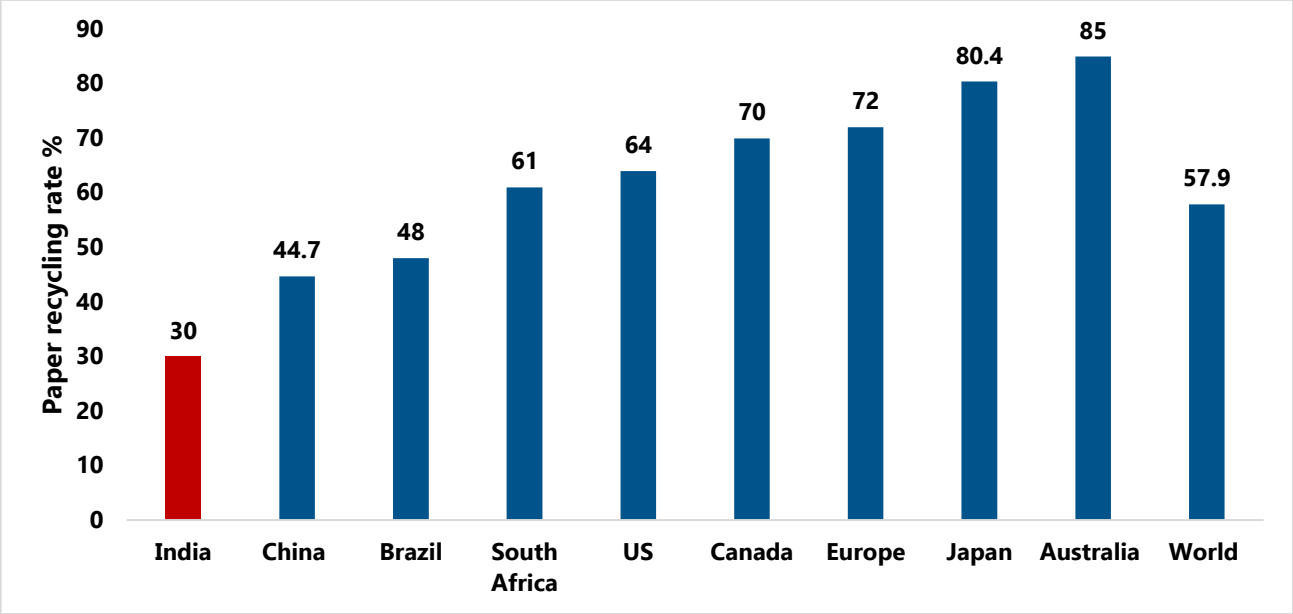


Figure 68: Paper recycling rate India vs Global

Key Benefits:

- Reduce the volume of waste in an environmentally friendly manner.
- Promotion to the concept of circular economy

Action points

The Bureau of Energy Efficiency should develop a program to support SME units in promoting recycling in paper plants.

Roles and responsibilities of the Stakeholders

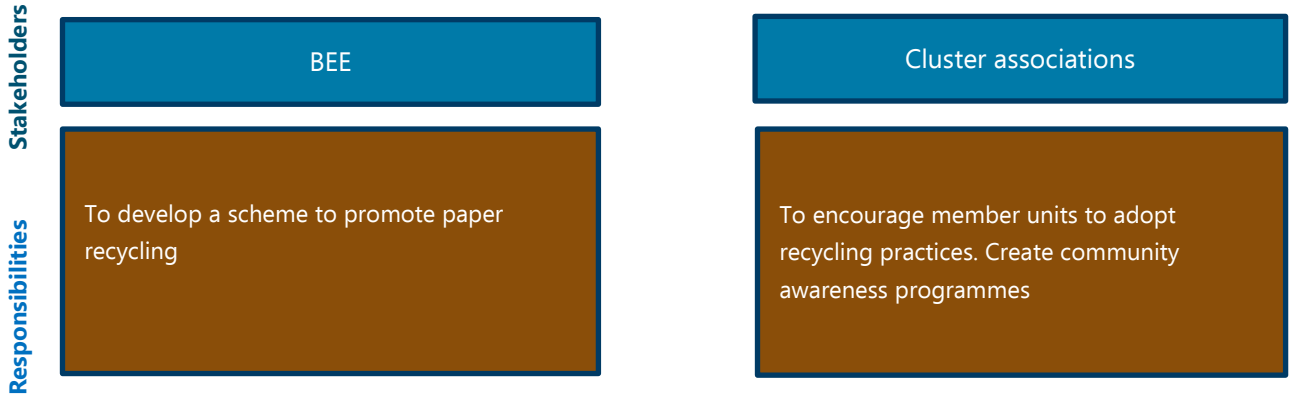


Figure 69: Promotion of paper recycling

5.3.15 Setting up Solar Park in clusters

The solar park gives clean, cheap, and reliable sources of energy, and can play a major role in reducing India's MSME Paper plant carbon footprint, promoting high-end technical investments, and empowering local communities. BEE may come up with a new scheme for setting up a solar park for the MSME sector. Such schemes will encourage significant solar adoption, which will reduce the cost of production and increase profitability. It will further help in the replacement of polluting diesel gen-sets usage in the MSME enterprises. MoMSME, Government of India schemes such as Micro and Small Enterprises Cluster Development Programme (MSE-CDP), as well as newly introduced 'Atmanirbhar Bharat Abhiyan', may facilitate credit-linked capital subsidy facilities for inclusion of setting up solar PV park in the MSME cluster. Multipronged strategies may be needed through a multi-stakeholder collaboration including policymakers, consultants, paper association, paper plants, suppliers, bankers, research institutions, for arranging resources for successful piloting and then scaling up of solar PV parks in MSME clusters.

Key Benefits:

- Reduction of MSME Paper plant carbon footprint
- Meeting Renewable Purchase Obligation (RPO) mandates

Action points

The Bureau of Energy Efficiency should develop a program for setting up solar parks in paper clusters.

Roles and responsibilities of the Stakeholders

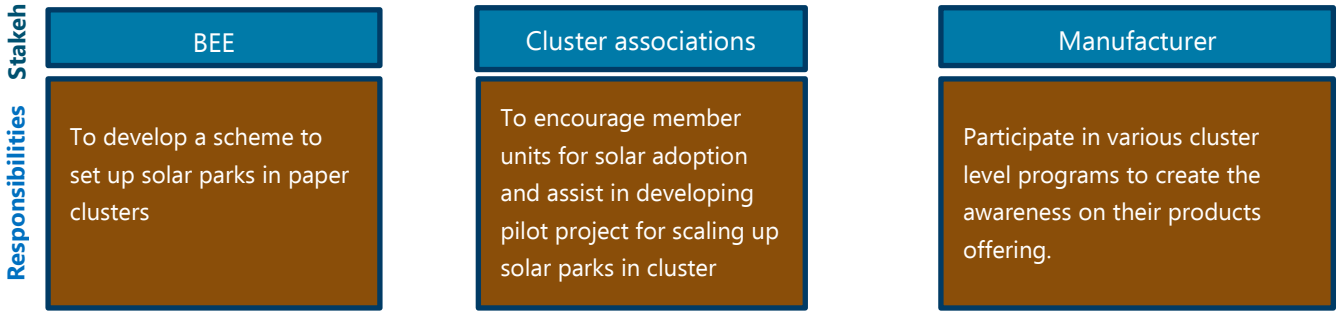


Figure 70: Setting up Solar Park in clusters

5.3.16 Wider adoption of Paper curriculum in Engineering colleges (B.Tech, M.Tech)

At present only a few colleges/ universities run engineering courses on Pulp and Paper Technology. The paper industry is in a transition from conventional technology to the use of new and advanced technologies for paper production. Therefore, It is necessary to equip the students with the essential knowledge and skills to take up the paper sector challenges and provide solutions to the problems towards achieving sustainable paper production

Key Benefits:

- Create employment opportunities in plants, Industry Trade Association, technology provider, and others.

Action points

The Bureau of Energy Efficiency should

- Launch courses on Pulp and Paper Technology
- To initiate paper curriculum in engineering colleges

Roles and responsibilities of the Stakeholders

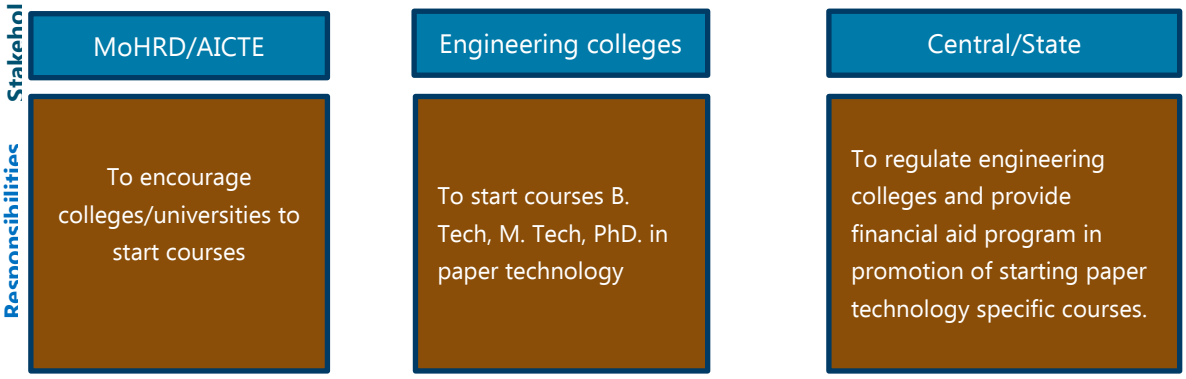


Figure 71: Wider adoption of Paper curriculum in Engineering colleges (BTech, MTech)

5.4 Sector Way-Forward

Due to continuous efforts of the Bureau of Energy Efficiency (BEE), SDAs, Paper associations, and other stakeholders, MSME paper plants in India have started to shift from a traditional strictly cost and quality approach to energy efficiency, zero waste, and reduced carbon emissions. Further, for bringing more competitiveness and making this sector more energy-efficient, it is essential to understand the consumption of energy and its flow within the facility along with the classification of energy usage and its relationship to processes and production outputs in the present scenario. Thus, it is envisaged that the energy scenario of MSMEs will cover energy usage patterns, detailed analysis of current and future (estimated) energy, production, and energy intensity as per different paper grades produced in RCF based paper mills. The following scenarios are considered: Pessimistic Scenario (PES), Business-As-Usual (BAU), Global Benchmarking (GBS), and Sustainable Scenario (SS).

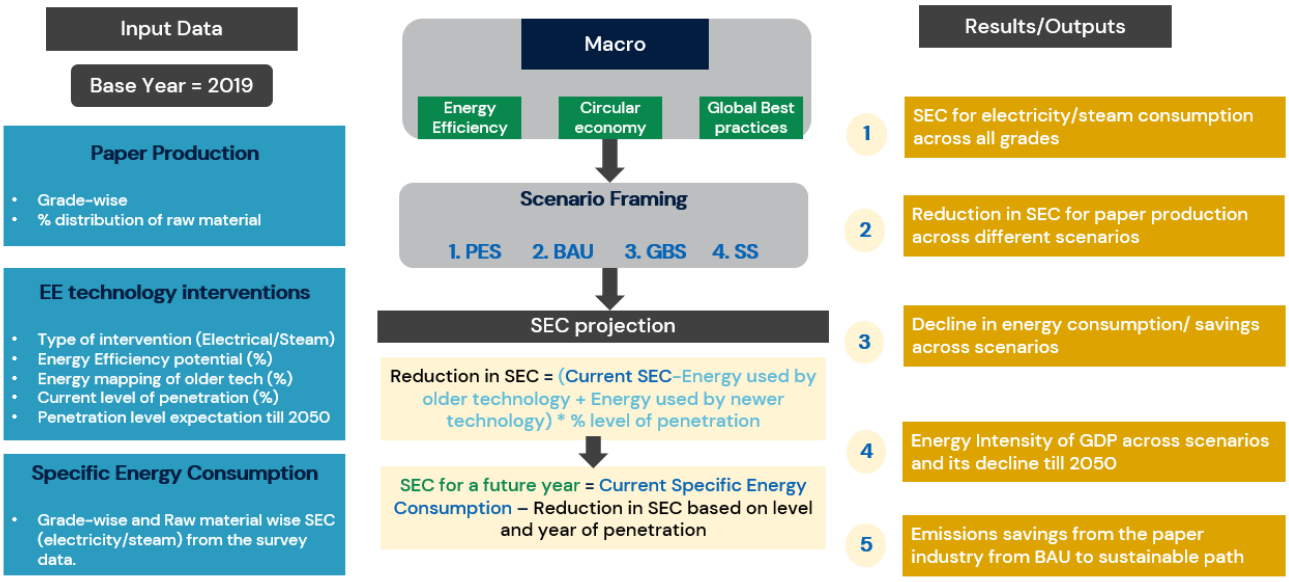


Figure 72: Scenario Analysis Methodology

The assumed penetration level of the energy-efficient technologies for different years for the scenarios considered: Pessimistic Scenario (PES), Business-As-Usual (BAU), Global Benchmarking (GBS), and Sustainable Scenario (SS) is provided in Annexure E7.

5.5 Scenario Analysis

5.5.1 Production Scenario

Pulp and paper have adapted to the changes that have occurred in recent years and are continuing to thrive. The pulp and paper industry has been thriving and will continue to do so in 2030 and further. The industry must continually innovate to meet the changing demands. The production of Paper in India is expected to grow at a CAGR of 5.5% during the forecast period of 2021-2026. It is expected that the total production of paper MSME will increase from 11.5 million tonnes in 2019 to 119 million tonnes in 2050 (Figure 73).

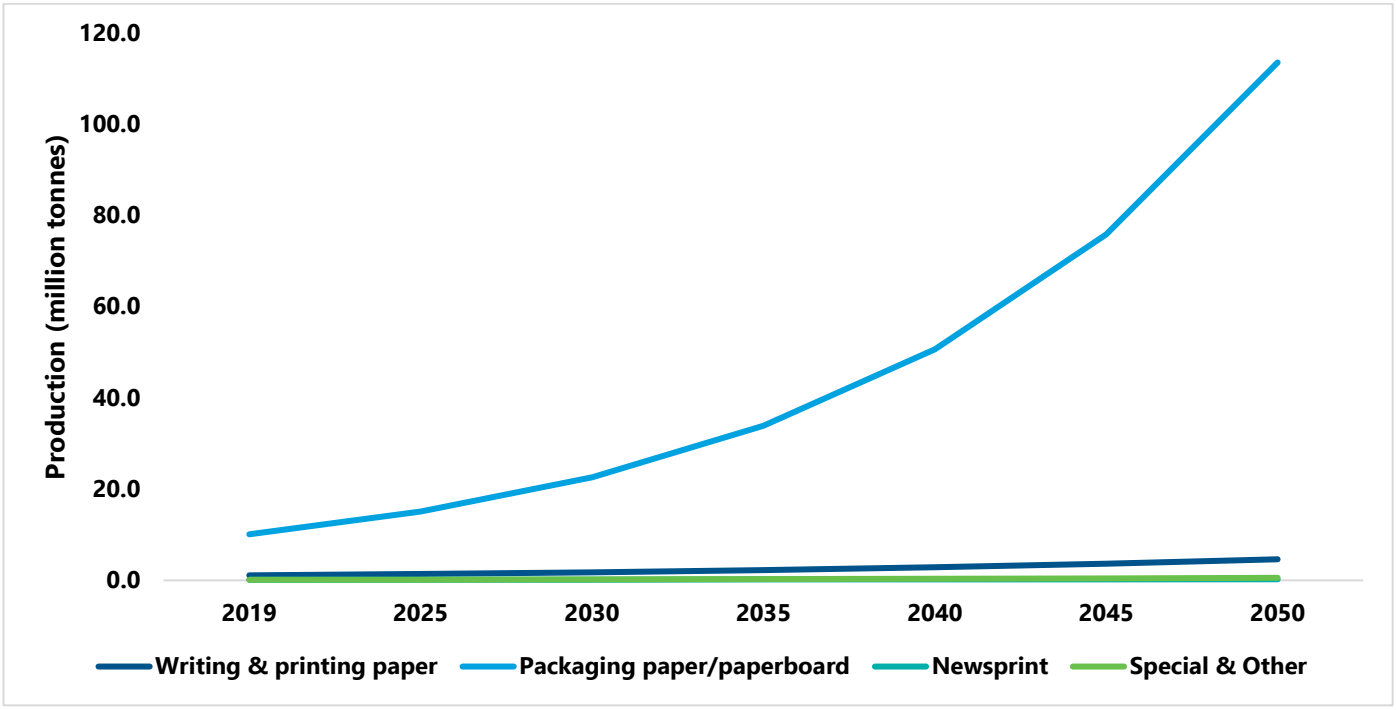


Figure 73: Paper production scenario (by type of paper product)

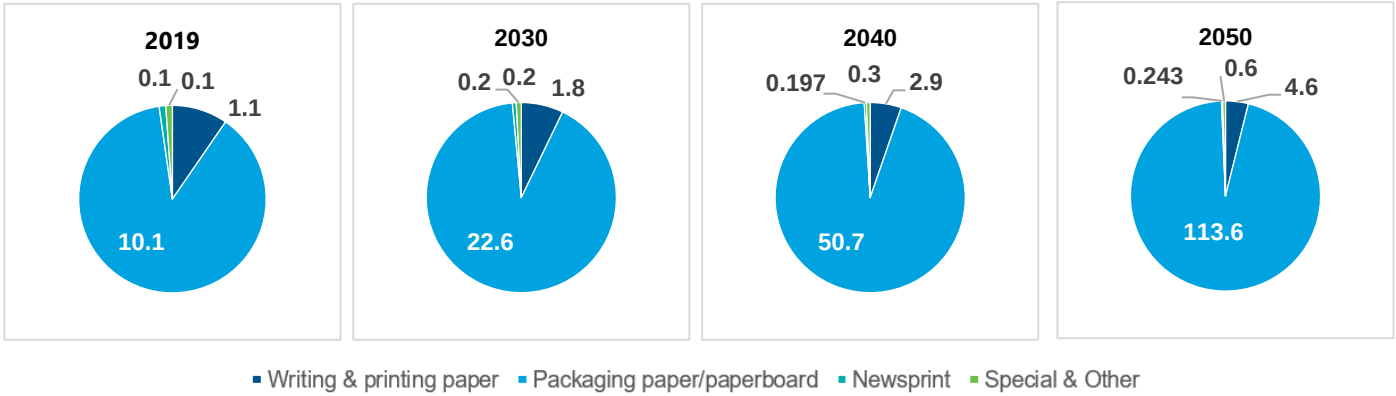


Figure 74: Production scenario (2019 to 2050)

The above Figure 74 shows a growing share of packaging and paperboard in the overall paper mix as per various paper grades from 2019 to 2050.

5.5.2 Energy Scenario

The estimated total energy consumption, electricity consumption, and steam consumption from 2019 to 2050 as per different scenarios are given in Figures 75, 76, and 77.

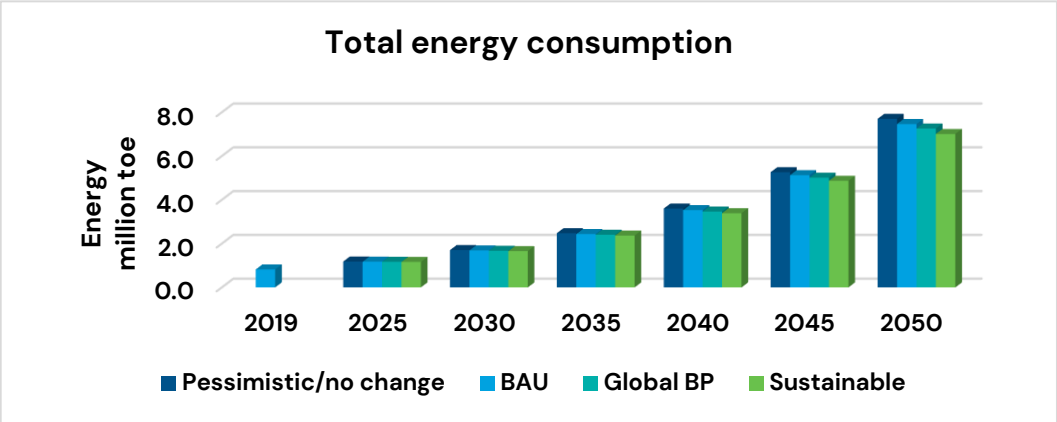


Figure 75: Total energy consumption scenario (2019 to 2050)

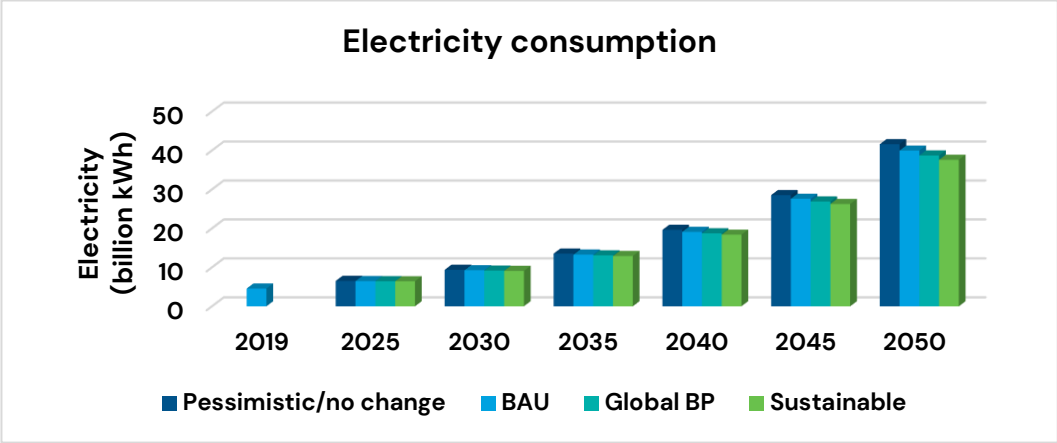


Figure 76: Total electricity consumption scenario (2019 to 2050)

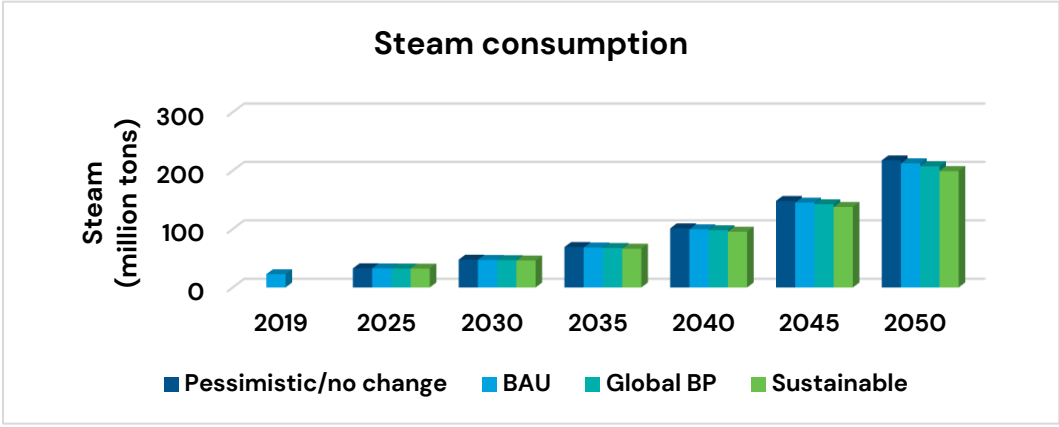


Figure 77: Total steam consumption scenario (2019 to 2050)

It is expected that the total energy consumption of paper MSME will increase from 0.8 million tonnes in 2019 to 7.70 million tonnes in 2050 (Pessimistic scenario), whereas 7.0 million tonnes in 2050 (Sustainable scenario).

The estimated specific electrical energy consumption and specific steam consumption from 2019 to 2050 as per different paper grades are given in Figure 75 to Figure 77.

Packaging Paper/Paperboard

It is expected that specific steam energy consumption of paper MSME will decrease from 1.83 tonnes of steam/tonne in 2019 to 1.77 tonnes of steam/tonne in 2050 (Pessimistic scenario), whereas 1.62 tonnes of steam/tonne in 2050 (Sustainable scenario). Similarly, specific electrical energy consumption will decrease from 349 kWh/tonne in 2019 to 334 kWh/tonne in 2050 (Pessimistic scenario), whereas 300 kWh/tonne in 2050 (Sustainable scenario).

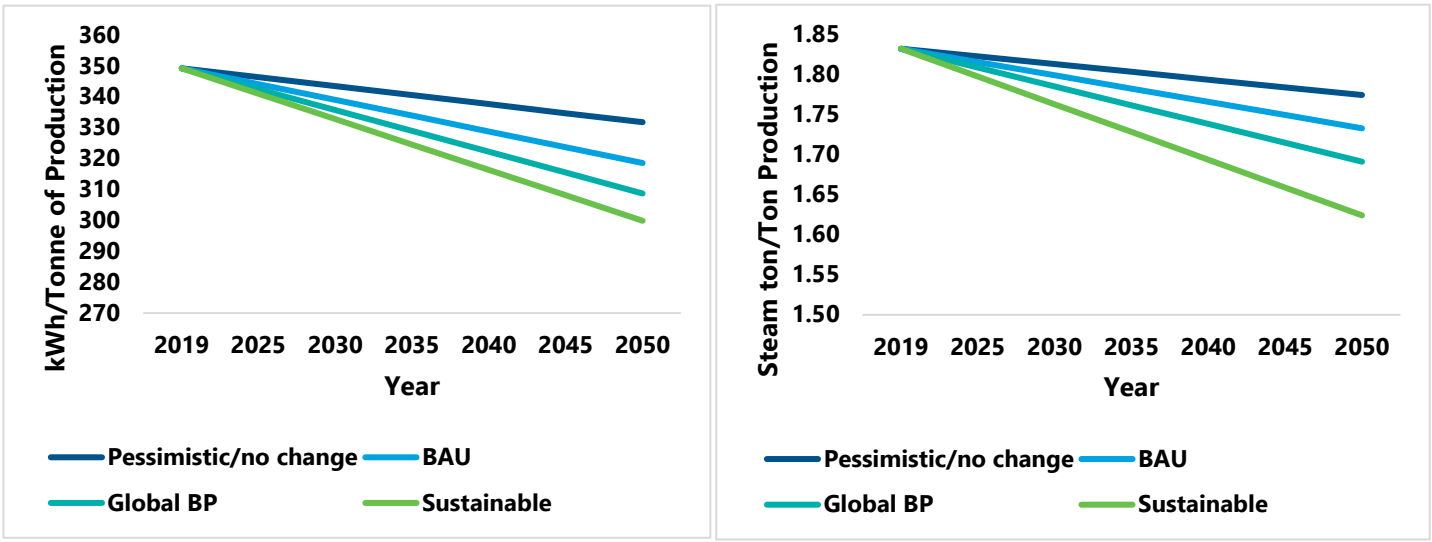


Figure 78: Packaging Paper/Paperboard - Specific Energy Consumption Scenario

Writing & Printing Paper

It is estimated that the specific steam energy consumption of MSME paper will decrease from 3.10 tonnes of steam/tonne in 2019 to 3.0 tonnes of steam/tonne in 2050 (Pessimistic scenario), whereas 2.80 tonnes of steam/tonne in 2050 (Sustainable scenario). Similarly, specific electrical energy consumption will decrease from 787 kWh/tonne in 2019 to 753 kWh/tonne in 2050 (Pessimistic scenario), whereas 675 kWh/tonne in 2050 (Sustainable scenario).

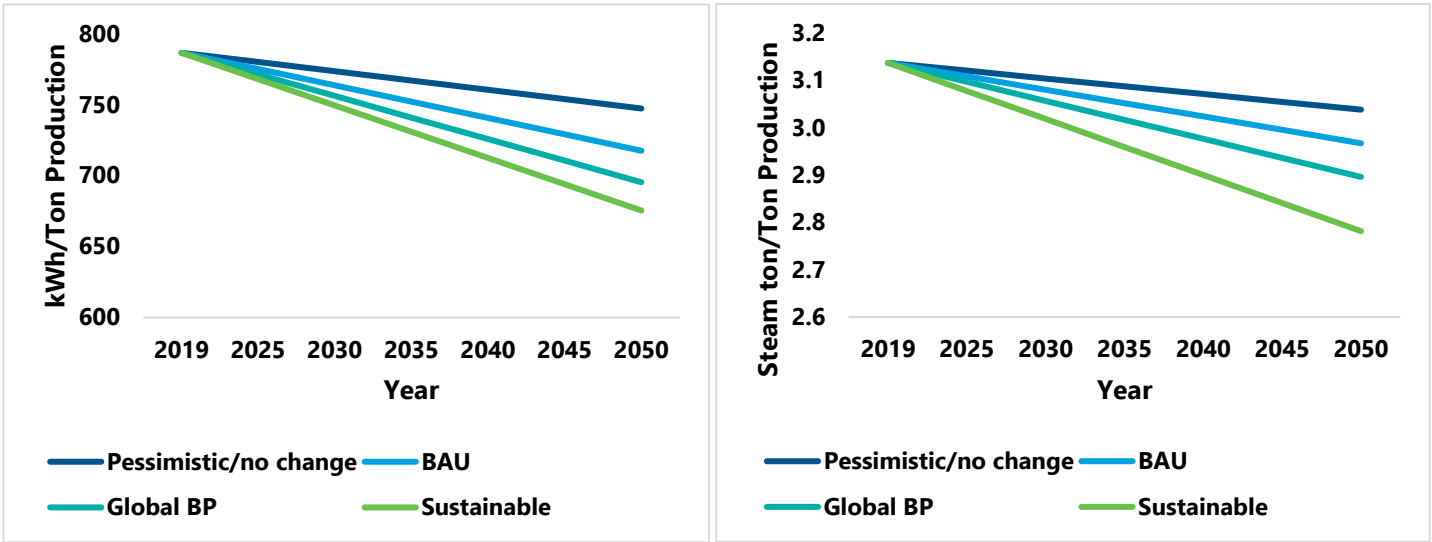


Figure 79: Writing & Printing Paper - Specific Energy Consumption Scenario

Newsprint Paper

It is estimated that the specific steam energy consumption of MSME paper will decrease from 2.30 tonnes of steam/tonne in 2019 to 2.2 tonnes of steam/tonne in 2050 (Pessimistic scenario), whereas 2.0 tonnes of steam/tonne in 2050 (Sustainable scenario). Similarly, specific electrical energy consumption will decrease from 617 kWh/tonne in 2019 to 591 kWh/tonne in 2050 (Pessimistic scenario), whereas 530 kWh/tonne in 2050 (Sustainable scenario).

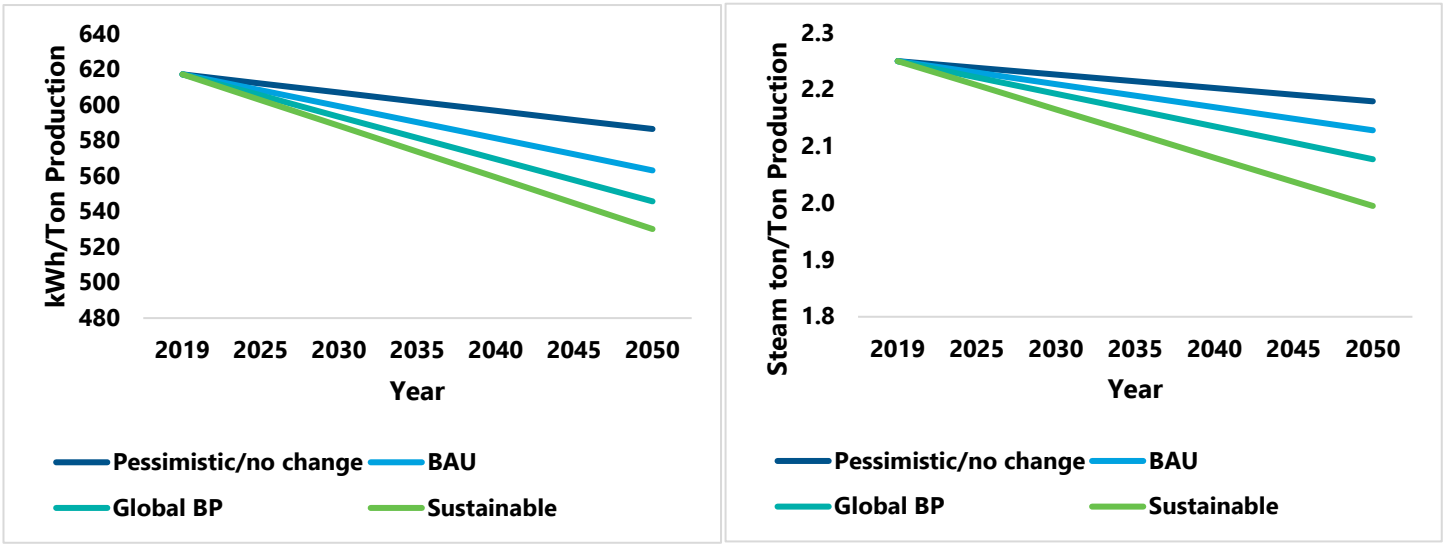


Figure 80: Newsprint Paper - Specific Energy Consumption Scenario

Special and Other Paper

It is estimated that the specific steam energy consumption of MSME paper will decrease from 2.90 tonnes of steam/tonne in 2019 to 2.8 tonnes of steam/tonne in 2050 (Pessimistic scenario), whereas 2.60 tonnes of steam/tonne in 2050 (Sustainable scenario). Similarly, specific electrical energy consumption will decrease from 659 kWh/tonne in 2019 to 631 kWh/tonne in 2050 (Pessimistic scenario), whereas 566 kWh/tonne in 2050 (Sustainable scenario).

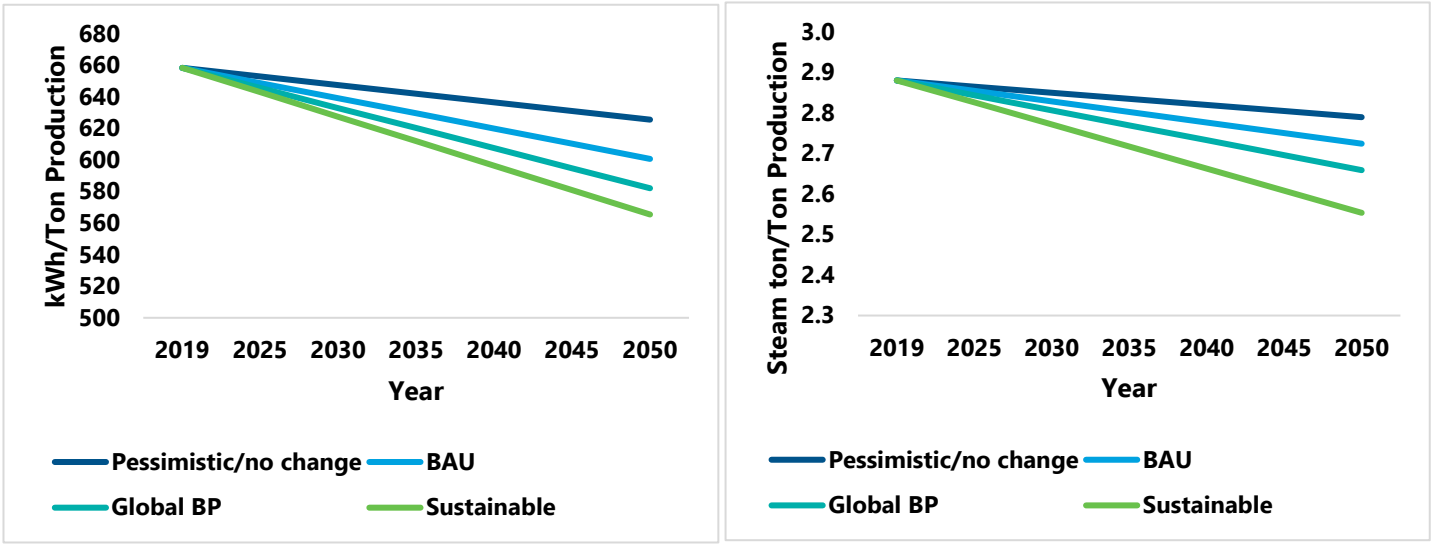


Figure 81: Special & Other Paper - Specific Energy Consumption Scenario

5.5.3 Emission Saving Scenario

The estimated emission savings due to technology interventions from 2019 to 2050 in different scenarios as per the different levels of penetration are given in Figures 82 & 83.

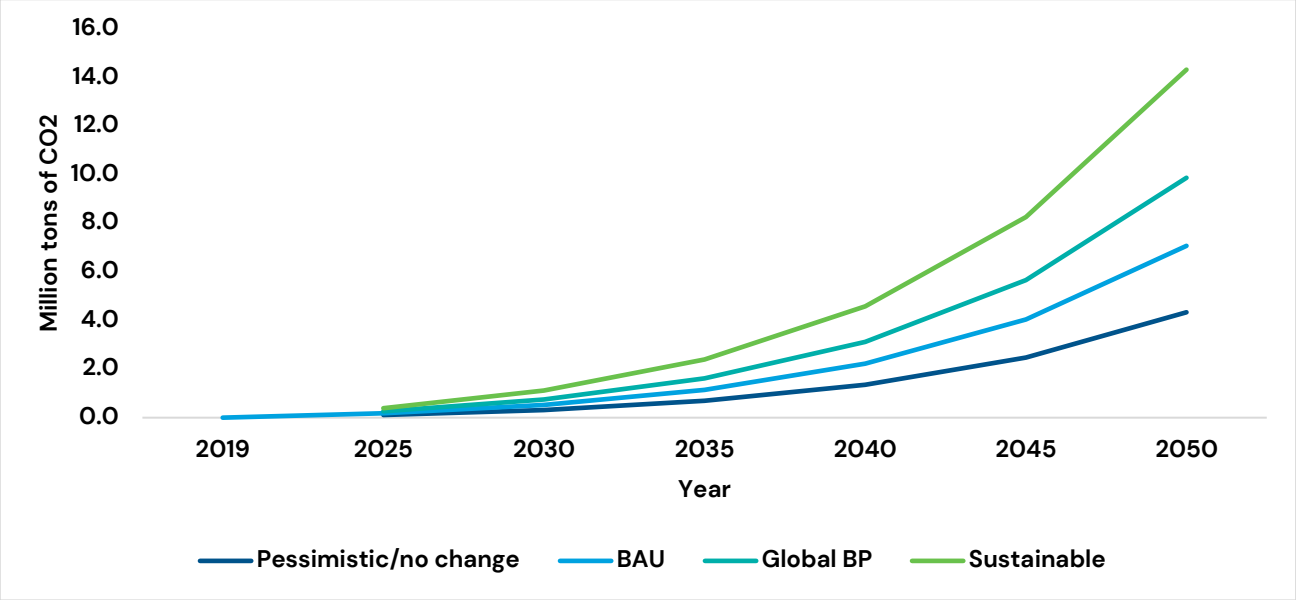


Figure 82: Emissions saved due to tech interventions Scenario

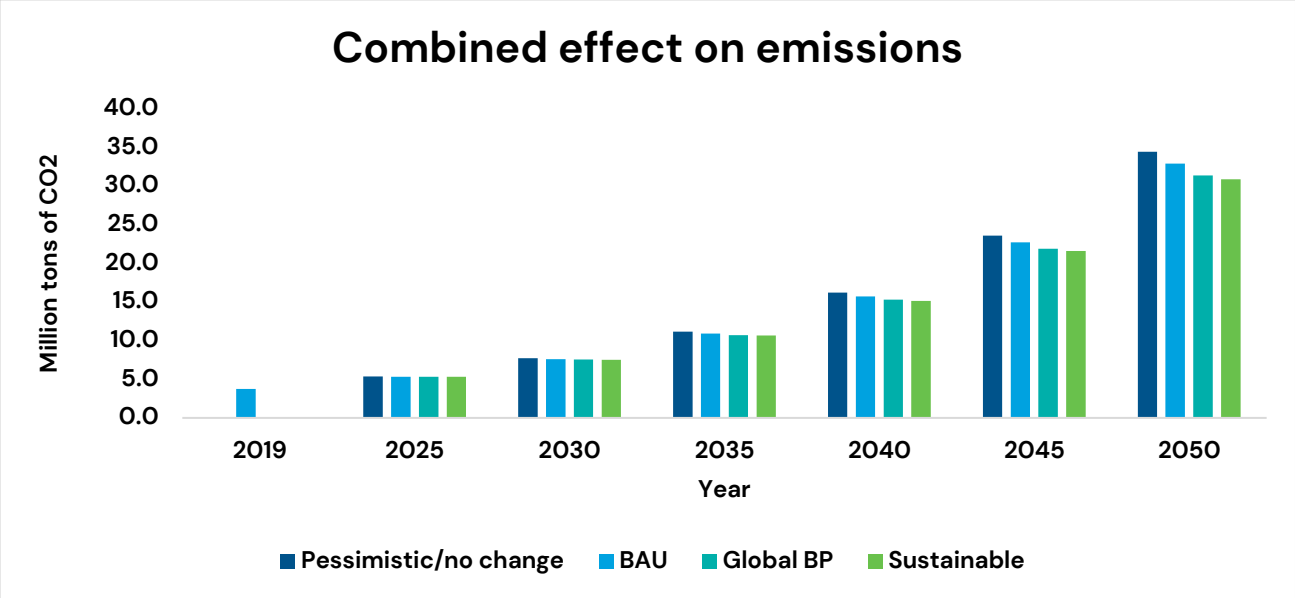


Figure 83: Combined effect on the emissions scenario

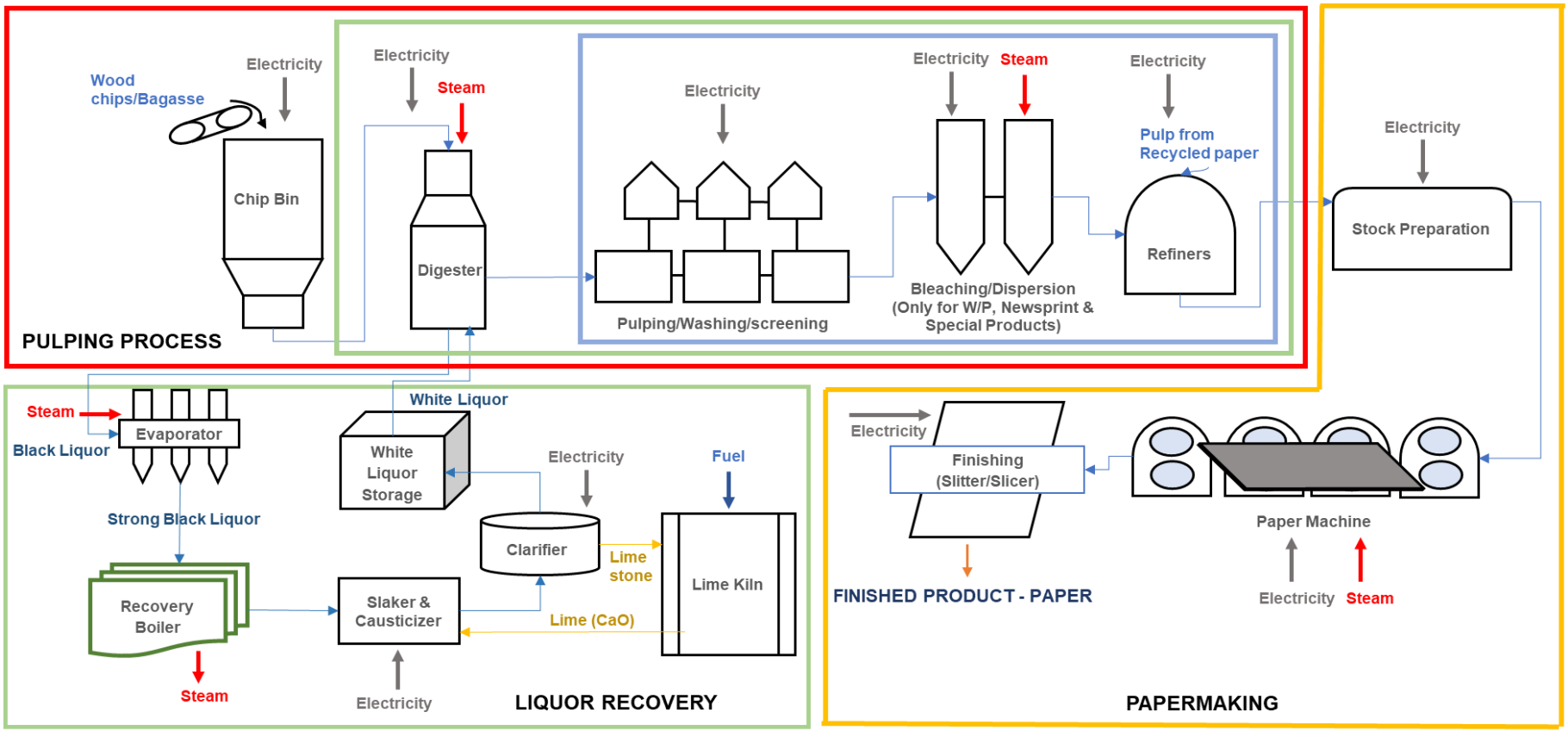
It is estimated that the emissions saved of MSME paper will be around 4.6 million tonnes of CO_2 in 2050 (Pessimistic scenario), whereas it will be around 14.3 million tonnes of CO_2 in 2050 (Sustainable scenario).

Annexure A – Production process and technology adopted

A1 – Type of production processes in Paper Sector

:

The clusters have mills that use multiple types of raw materials to produce kraft and packaging paper, writing/printing paper, Newsprint, and special paper. Overall, in MSMEs in the paper sector, around 88% of the paper production is of kraft and packaging paper, 10% of the paper production is of writing/printing, 1% is accounted for newsprint, and 1% for special grade paper.



Wood Based Mill

Figure 84: Process Mapping

hine (Common for all type of mill)

A1.1 Paper Making Processes

The following sections give a brief description of the papermaking process and technology.

1. Pulping

Chip bin

The chip bin is for allowing buffer storage and pre steaming of the raw material. For the white liquor to impregnate fast and evenly, the air is usually removed (about one-third of a chip's volume is air) by pre-steaming the wood chips in the chip bin before cooking, which is a very common process in the pulp industry today. Modern systems in the industry tend to have an atmospheric pre-steaming step in the chip bin, at the beginning of the process. The chip bin performs the following function:

- Pretreatment of the raw material by steam at an elevated temperature for a certain time
- Moisture increases of the raw material
- Reduction of natural wood resins

Digestor

The wood chips are heated in a solution of Sodium Hydroxide (NaOH) and Sodium Sulphide (Na_2S) in a pressure cooker (digester), during which time a lot of the lignin is removed from the wood. The pressure is then released suddenly, causing the chips to fly apart into fibers. The black liquor from the digester is sent to the evaporator for liquor recovery.

Pulper

The function of the pulper is to gently slush the recycled paper raw material into a pumpable pulp, suitable for processing in stock preparation whilst facilitating the efficient removal of contaminants from the pulp. The pulper is used in RCF based mill to pull out the recycled paper.

Washing

The pulp is washed with water to wash out the cooking chemicals and lignin from the fiber so that they will not interfere with later process steps.

Screening

After separation of the black liquor from the fiber in the washing section the pulp contains coarser fibers, foreign matter, and dirt like pieces of bark, digester brick, cement, etc. Hence this unwanted and troublesome matter should be removed to produce first quality pulp. Pulp screening equipment is applied in this regard.

Bleaching

Bleaching is done in two stages. First, the pulp is treated with NaOH in the presence of Oxygen (O_2). The NaOH removes hydrogen ions from the lignin and then the O_2 breaks down the polymer. The pulp is then treated with Chlorine Dioxide (ClO_2), a mixture of NaOH, O_2, and peroxide, and finally with ClO_2 again to remove the remaining lignin. In the case of a plant producing brown sack paper or linerboard for boxes and packaging, the pulp does not always need to be bleached to high brightness.

Refining

A refiner is a refining aggregate with rotating and stationary cutters, the variable positioning of these rotors and stators in relation to each other determines whether the fibers are being cut (free stock refining) or fibrillated (wet refining). Fibrillating is fine bleeding of the fiber ends, resulting in a close-knit connection between the individual fibers. In the final paper this, in turn, results in greater strength.

Deinking

In Deinking/Floatation process ink is eliminated from the wastepaper pulp by adding chemicals like surfactants. The ink is a hydrophobic component, so it is attracted by the surfactants. After adding the surfactants, the air introduces into the recovered pulp. Then the ink particles that are detached from the fiber will float and mix with the foam on the water surface. This foam is then removed from the vat (pulper).

Dispersion

The principal task of the disperser is to ensure good optical characteristics. Dispersion is used to reduce ink particle size, disperse hot melts, and release remaining ink from fibers by applying energy. Both refiner type and kneader type dispersion systems are used. Consistency is around 30% and temperature is under or above 100° C depending on pressure conditions. A disperser can also be utilized to mix bleaching chemicals, or separate chemical mixers can be used.

2. Papermaking

Stock Preparation

The refined pulp is then taken to the mixing chest where paper-making chemicals like Rosin, alum, Deformer, starch, and dye are mixed. The chemical mixed pulp is then pumped to the machine chest. Stock preparation is performed after the papermill receives the pulp from the pulp mill, either in wet or dry form. The cellulose fibers comprising the pulp must be in a water suspension both for loading and to control the fiber bonding as the paper web forms.

Headbox

The Headbox is equipment that discharges a uniform jet of paper-making stock onto the moving wire. The functions of Headbox are to:

- Spread stock evenly across the width of the machine.
- Level out cross currents and consistency variations.
- Level out machine direction velocity gradients.
- Create controlled turbulence to eliminate fiber flocking.
- Discharge evenly from the slice opening; impinge on the
- forming fabric at the correct location and angle.

Wire Section

In the Wire section, paper is formed on an end-less fabric wire running in a loop across foils and various dewatering elements. It is moving, fine mesh, woven wire cloth, or plastic fabric upon which the pulp slurry is deposited, forming the web. The wire forms a continuous belt that picks up fiber at the breast roll from the headbox, runs over the table rolls, foils, suction boxes, and then over a couch roll, where the web of fibers leaves the fourdrinier table. The wire, however, continues around the couch roll, under the machine, to the breast roll where more fiber is received. A wire might make several hundred thousand trips in its life.

Press Section

After Wire Section, the paper web is pressed by multiple rollers in the Press Section. In the Press Section, the paper web is conveyed by the felt; drive to the rolls also transmit through these felts. The task of the paper machine press section is to remove water, primarily through wet pressing. Wet pressing increases sheet dryness in order to ensure adequate paper machine drying capacity and to improve web runnability at the beginning of the dryer section.

Dryer Section

After Press Section, the paper web passes through a number of drying cylinders. The cylinders are driven by fabric wires. The classical drying section consists of two tiers of drying cylinders. The cylinders are cast in normal grey iron and coded for a steam pressure of 250-750 kPa depending on the type of paper being made. Steam is introduced in the dryer cylinder and the heat of steam is used to dry the paper running on the dryer roller.

Calendar Section

After Drying Section, paper is pressed in the Calendar section, by calendar rolls. The concept of pressing in the Calendar Section is different than pressing paper webs in the Press Section. Pressing in the Calendar Section provides an ironing effect in the paper. The calendar rolls may be heated or unheated depending on the design.

Pope Reel Section

After Calendar Section, paper winding takes place in the Pope Reel Section. Pope reel shell is made of cast iron. Primary arms swivel empty reel spool over pope reel into threading position for reel spool changes and then into transfer position on reel spool track. Secondary arms press spool against pope reel with controlled linear force and pushes the full reel spool into final position. Full reel spool brakes in end position using levers and hydraulic shock absorbers.

3. Liquor Recovery

Evaporator

Evaporators have traditionally been used to evaporate black liquor from about 15% dry solids when it leaves digester to 70-85 % dry solids before it is combusted in the recovery boiler. Volatile compounds are released from the black liquor and separated from the condensate when the dry solids percentage is increased, and the condensate is collected for future use.

Recovery Boiler

The inorganic fraction of the black liquor is recovered as sodium compounds, and the concentrated black liquor and combustion air are introduced into the furnace where heat is recovered as steam for electricity production and process heating.

Slaker and Causticizer

Green liquor is sent to the causticizing area for transformation to white liquor for cooking. The process begins with a clarification of the green liquor to remove impurities called dregs.

- Clarified green liquor is then mixed with lime in the slaker to form white liquor.
- The lime (CaO) activates the conversion of sodium carbonate (Na_2CO_3) in the green liquor to form sodium hydroxide (NaOH) for white liquor.
- To allow time for a complete reaction, the white liquor passes to a series of agitated tanks called causticizers.

Clarifier

After the causticizing process, the slurry of white liquor and lime mud is separated in the white liquor clarifier. The resultant white liquor exiting the clarifier is targeted at less than 20 parts per million of suspended solids and is recycled back to the digester.

Lime Kiln

The lime kiln calcines the recovered lime mud into quicklime for use in the lime slaker. A lime kiln is used to convert calcium carbonate CaCO3 into burnt lime CaO. The burned lime reacts with the green liquor and precipitates as CaCO3, thus creating a closed-loop with the re-causticizing.

Storage of the white liquor

The recovered white liquor is stored in the storage tank and can be used in the digester again.

A1.2 Process wise energy (thermal/electrical) distribution

The manufacturing process and technologies involved in all types of paper products are almost similar. Raw materials such as recycled fiber, Agro-based, and wood-based are used for paper production. These raw materials are generally procured locally and are then processed by mechanical/chemical methods as mentioned below:

1. Pulping Process

Pulping is the process where fibers are separated and treated to produce pulp. The wet pulp is then converted into paper at an integrated pulp and paper mill or is dried and transported from the pulp mill to a paper mill. Virgin fibers are derived from pulpwood such as from woodchips or logs. Virgin pulps are used to make high-quality paper. The virgin pulp is generally used in large industries as it is a costly process. Most of the MSMEs make use of recycled fiber which is extracted from the wastepaper.

Process flow indicating mass & energy balance of Pulping is given in figure 85 below.

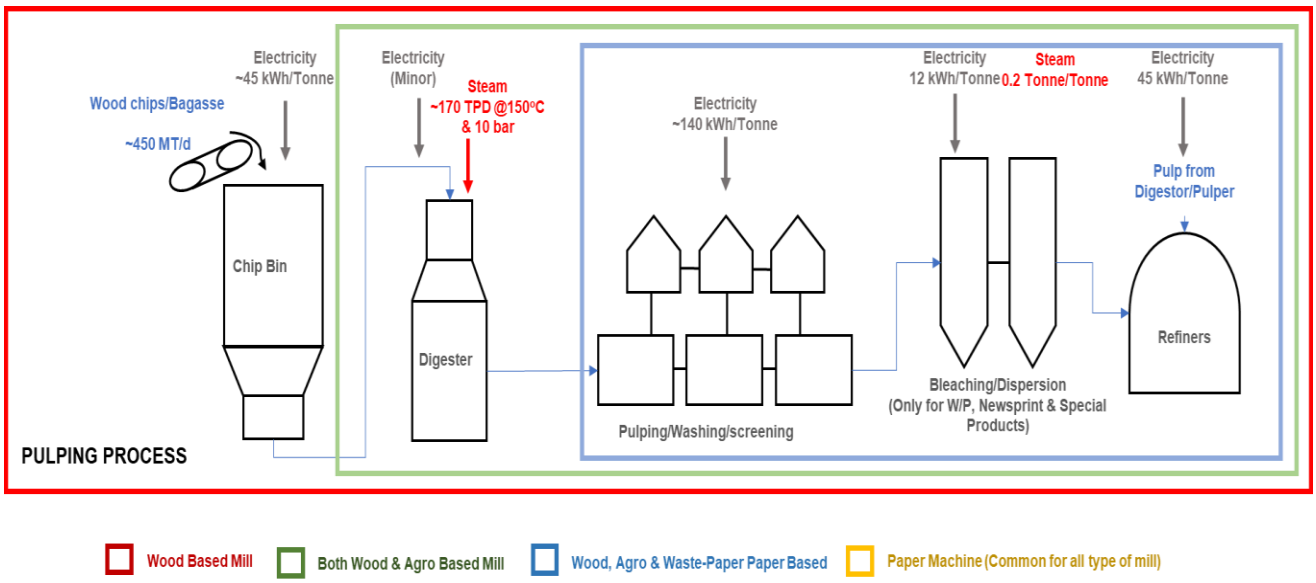


Figure 85: Pulping process

2. Papermaking Process

The papermaking process is the process in which the prepared pulp is converted to paper. In this process, the refined pulp is then taken to the mixing chest where paper-making chemicals like Rosin, alum, Deformer, starch, and dye are mixed. The chemical mixed pulp is then pumped to the machine chest. The final pulp from the chest is pumped to the stock regulating box. The overflow of the SR box is collected in a chest

and regulated stock is taken to the suction of the fan pump. The much-diluted slurry is fed to three-stage Centric leaners. Accept of three-stage centric leaners is taken to the pond of Headbox through a tapered manifold. The head of the stock is maintained to match the speed of the paper machine. Then stock is sprayed equally on the wire table through the slice.

The wire moves in one direction and the fixed elements remove water from the web of paper. The excess water is removed by vacuum which is equally applied through suction boxes. From the wire part, the web is taken to the press part. The web of paper is passed between two moving rolls. When a load is applied, the water from the web is squeezed out and carried by the felts, which are further sucked by vacuum pumps. The dry sheet of paper is then run on the MG section, where the remaining water is evaporated.

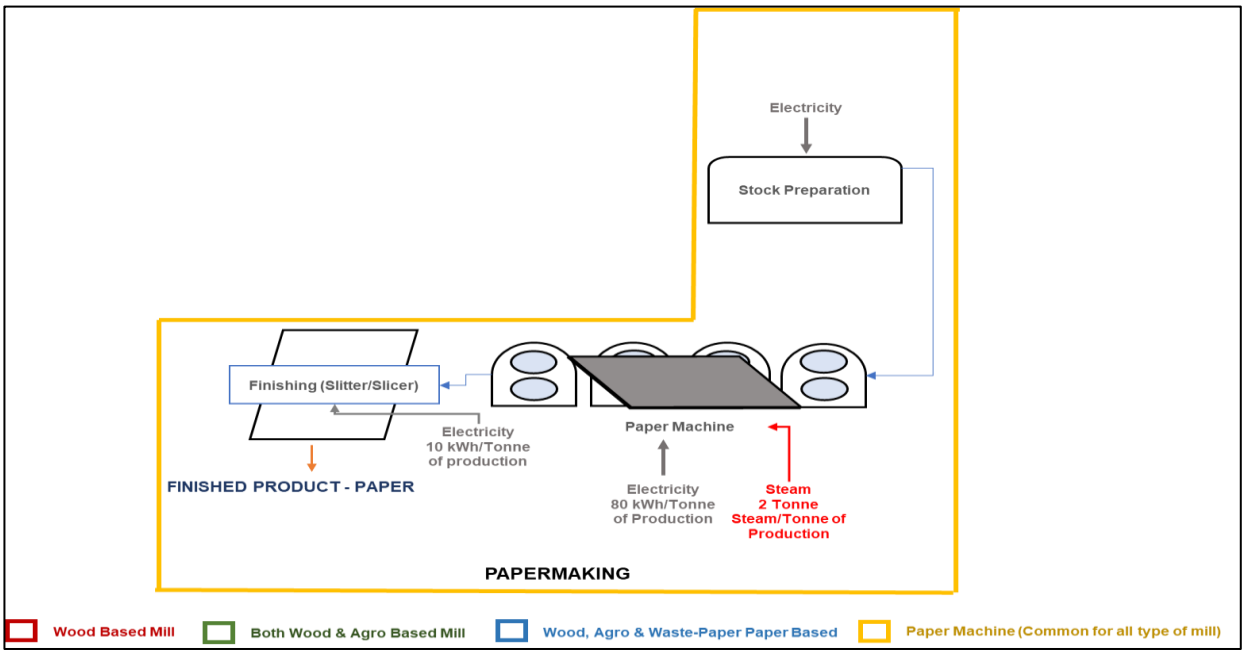


Figure 86: Paper making process

3. Liquor Recovery Process

The liquor recovery process has mainly three steps:

- Minimizing the environmental impact of waste material (black liquor) from the pulping process.
- Recycling pulping chemicals, NaOH and Na_2S; and
- Co-generating steam and power.

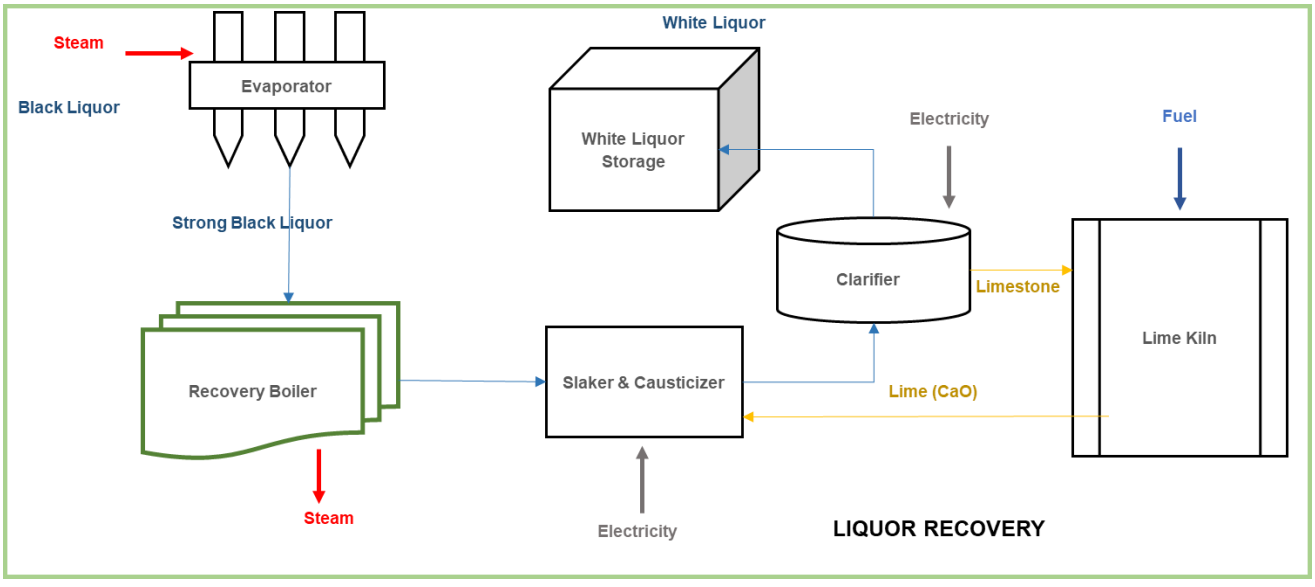


Figure 87: Liquor recovery process

A2 – Technologies used in Paper Sector

There are many technologies and processes that are being used for paper production. The following table shows the list of such technologies/ processes currently being utilized and the most conventional methods/practices adopted by MSME paper units. It also presents the opportunity to change these conventional and inefficient practices to energy-efficient ones.

Table 21: Present technological status

Section	Details	Current practices
Pulping	1. Type of pulper used	Low-Consistency Pulper
	2. Use of motors	IE2 motor
	3. Use of agitator	Old inefficient agitators
	4. Pulp Washing	Potcher
	5. Flow control of pumps	Mostly Throttled
Paper Machine	6. Pocket ventilation system in the dryer of a paper machine.	No
	7. VFD Controlled Vacuum System Automation	No
	8. Use of Thermocompressor	No
	9. Type of press in paper machine	Roll press
	10. Use of equipment for maintaining vacuum	Vacuum Pumps
	11. Is there any condensate recovery system for improving condensate recovery	Few plants
	12. Insulation condition of Condensate drums, Boiler hot surfaces	Poor
Boiler	13. Boiler combustion system	Absence of O_2 sensor, Air ingress, FD & ID fan controlled with damper
	14. Air Preheater performance in the Boiler section	Inefficient & poor performance
	15. Microturbines at Paper Mill	No, PRDs are used.
Electrical System	16. Use of Energy Monitoring System (EMS) to optimize the power consumption	Not Available
ETP	17. Use of DO (Dissolved Oxygen) sensor for optimization of ETP Blowers	Not used
Auxiliary System	18. Type of Pumps used	Higher head pumps
	19. Type of Motors	Higher rated motors
	20. Type of Air Compressors used	Old & inefficient, No flow control using VFD
	21. Type of Lighting System	T8 Lamps and Incandescent Bulb
	22. Use of soot blower system in the boiler WHR system	No
	23. Type of fuel for boiler	GHG emitting fuel
Water Saving	24. Is Rainwater Harvesting practiced	No
Renewable Energy	25. Use of Solar PV panel	Few plants

Annexure B – EE Technology Compendium

B1 – EE Technologies and EE Retrofits (Utilities)

1. Installation of Oxygen Analyzer and controlling the excess air in the boiler

Boiler combustion requires the correct measure of oxygen; too much or too little can cause undesirable effects. Too little air results in carbon monoxide formation, sooting, and even explosion of accumulated soot and other non-combusted suddenly get enough oxygen to rapidly burn. When there is too much air in the combustion process, additional fuel is burned to raise the temperature of this excess air to that of the combustion process. Excess air is a (costly) waste of fuel because it simply absorbs heat that goes up the stack, rather than into the process.

Technology Description

It is recommended to install the O_2 analyzer on the downstream line of flue gas. The O_2 analyzer helps us in maintaining the excess air in range and using VFD control on the FD, ID, and PA fans, which results in considerable power saving.

Figure 88 O2 Analyzer

Advantage/ Key benefits

1. Fuel Savings in the plant.
2. Combustion (boiler) efficiency computation
3. Excess air can be monitored by O_2 measurement at Air Preheater (APH) inlet which also helps optimize ID fan power
4. Accurate flue gas temperature monitoring (in case of air ingress)

Sectoral Investment (INR Lakhs)	951
Percentage of energy savings %	Overall = 5-15%
Approx. Reduction in energy consumption (TOE/year)	41,032
Approx. Reduction in GHG emission (TCO_2)	34,447
Simple Payback Period (Years)	0.1-1

2. Overhauling of Existing Air Preheater in Boiler section

Air preheater effectiveness is the measure of how well the overall thermal conduction is taking place in the air preheater. In most of the paper units, the APH effectiveness was coming out to be around 30% to 35% which is very low and can be improved up to 50% by overhauling the air preheater.

Technology Description

The most common air pre-heaters are tubular preheaters consisting of straight tube bundles which pass through the outlet ducting of the boiler and open at each end outside of the ducting. Overhauling of the air preheater can increase the effectiveness of the air preheater.

Figure 89: Air preheater

Advantage/ Key benefits

1. Increase in APH effectiveness
2. Increase in combustion air temperature can lead to a substantial increase in boiler efficiency thus leading to a reduction in specific fuel consumption.
3. Fuel Savings
4. Arresting air leakages helps in reducing ID fan power

Sectoral Investment (INR Lakhs)	1,640
Percentage of energy savings %	Thermal = 5%
Approx. Reduction in energy consumption (TOE/year)	30,511
Simple Payback Period (Years)	0.1-2

3. Replacing the present pumps with proper head pumps

In many paper industries where audits were performed, the pumps that are being used were having a design head that was much greater than what was required at that place.

Technology Description

Centrifugal pumps can often be oversized because of "rounding up," trying to accommodate gradual increases in pipe surface roughness and flow resistance over time or anticipating future plant capacity expansions. Because of this conservative approach, pumps can have operating points completely different from their design points. The actual pump head is often less than expected, while the flow rate is greater. This can cause cavitation and waste energy as the flow rate typically must be regulated with bypass or throttle control.

A pump may be incorrectly sized for current needs if it operates under throttled conditions, has a high bypass flow rate, or has a flow rate that varies more than 30% from its best efficiency point flow rate. It is recommended to replace the mentioned pumps with proper head pumps. Doing this will lead to an estimated 15% increase in efficiency thereby saving a lot of energy.

Advantage/ Key benefits

1. High efficiency
2. Low power consumption
3. Low noise and easy maintenance (with new models developed)

Figure 90: Existing pump

Sectoral Investment (INR Lakhs)	2,418
Percentage of energy savings %	Electrical = 15%
Approx. Reduction in energy consumption (TOE/year)	4,992
Approx. Reduction in GHG emission (TCO_2)	47,970
Simple Payback Period (Years)	<1

4. Freshwater saving by Rainwater Harvesting

It was observed by the audit team that the industry under consideration has a large roof area and large site area and therefore can harvest large quantities of rainwater.

Technology Description

Rainwater harvesting is the technique of collecting rainwater from the roof catchment and storing it in surface/subsurface reservoirs. As the paper mills are highly reliant on freshwater consumption hence rainwater harvesting could help these industries to save some water and energy.

Figure 91: Freshwater saving by rainwater harvesting

Advantage/ Key benefits

1. Water harvesting is a very simple way to ensure the availability of water in water-stressed areas and seasons.
2. It reduces the consumption of groundwater.
3. In areas where there is excess rainfall, surplus rainwater can be used to recharge groundwater through artificial recharge techniques.

Sectoral Investment (INR Lakhs)	456
Percentage of Freshwater Saving %	Freshwater Saving = 1%-21%
Simple Payback Period (Years)	0.1-1

5. Installation of VFD Controlled Vacuum System Automation

Vacuum System automation can help in identifying and realizing significant energy savings in vacuum systems. The primary cause of efficiency losses in a paper machine vacuum system is control of the vacuum level, as efficiency losses can be high when the pump capacity does not match the requirements of the paper machine.

Technology Description

VFDs manipulate the frequency of their output by rectifying an incoming AC current into DC and then using voltage pulse-width modulation to recreate an AC current and voltage output waveform. It is known that variable speed drives reduce energy consumption, reduce energy costs, increase production and increase the life of electric motors.

It is recommended to use solenoid valves for controlling the vacuum levels at different sections of the paper machine. A considerable amount of energy can be saved by optimizing the vacuum system using automation. It is recommended to adjust the pressure in the paper machine in ascending order, as high-water content requires low vacuum and low water content requires high vacuum.

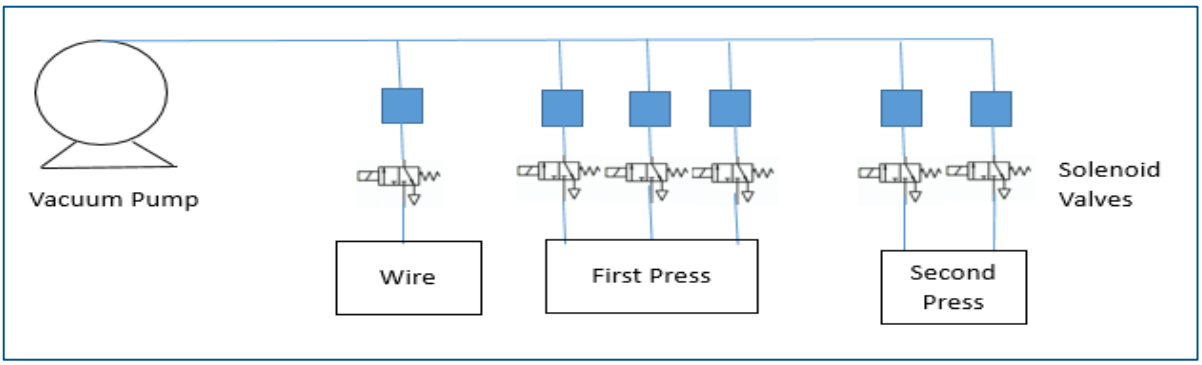


Figure 92: Vacuum Pump Automation

Advantage/ Key benefits

1. Keeps starting current in control:
2. Demands lower power on start:
3. Helps in controlling operating speed and acceleration
4. Limits and adjusts torque
5. Saves energy and cost

Sectoral Investment (INR Lakhs)	12,292
Percentage of energy savings %	Electrical = 20%
Approx. Reduction in energy consumption (TOE/year)	20,902
Approx. Reduction in GHG emission (TCO_2)	152,911
Simple Payback Period (Years)	0.5-3

6. Installation of Dryer Insulation in the paper machine section

During the field visit, heat losses were observed at the side sections of the machine dryers of the paper machines. The audit team observed an average surface temperature of 100 ºC at the dryers.

Technology Description

Insulation is an easy and low-cost method that not only performs on building skin but also on industrial processing equipment such as pipelines, furnaces, heat exchangers, and valves to reduce energy usage and CO2 emission. The audit team recommends the plant management install Resign Bounded Rock Wool insulation over the side sections of the dryers to prevent heat losses to the environment.

Figure 93: Dryer section paper machine

Advantage/ Key benefits

1. Controls surface temperature for personnel protection.
2. Controls and stabilizes process temperatures.
3. Prevents condensation and subsequent corrosion on cold surfaces.
4. Increases fire protection.
5. Controls noise and vibrations

Sectoral Investment (INR Lakhs)	1,793
Percentage of energy savings %	Thermal = 1%
Approx. Reduction in energy consumption (TOE/year)	6,607
Simple Payback Period (Years)	1-2

7. Installation of Energy Management System (EMS) to optimize the power consumption

It has been observed that there is no online Energy Monitoring system present in the plant due to which section-wise energy mapping for the plant is quite difficult.

Technology Description

An energy management system is a system of computer-aided tools used by operators of plants to monitor, control, and optimize the performance of the equipment and systems. In the absence of an energy monitoring system, it becomes difficult to diagnose the actual reason behind hikes in the electricity bill rise in different sections. Moreover, EMS also serves as a platform for accounting for the total investment in production as the profit or loss can be analyzed by co-relating it to the total production achieved. It will help in benchmarking the high energy-consuming sectors and focusing on them for the reduction in energy wastage.

Advantage/ Key benefits

1. Hassle-free and quick installation
2. Reduces operating cost which leads to an increase in productivity and competitiveness
3. Helps in tracking real-time energy consumption feedback as compared to indirect feedback like monthly bills
4. Reduce greenhouse gas emission

Sectoral Investment (INR Lakhs)	1,240
Percentage of energy savings %	Electrical = 3%
Approx. Reduction in energy consumption (TOE/year)	4,488
Approx. Reduction in GHG emission (TCO_2)	29,856
Simple Payback Period (Years)	<1

8. Use of DO (Dissolved Oxygen) sensor and optimization of ETP Blowers

The ETP has aerators that provide dissolved oxygen to the wastewater. The requirement of dissolved oxygen value is 1 mg/liter. In the present situation, the plant operators are checking the DO value daily.

Technology Description

Modern techniques involve either an electrochemical or optical sensor for measuring DO concentration. In an electrochemical, dissolved oxygen diffuses from the sample across an oxygen-permeable membrane and into the sensor. Once inside the sensor, the oxygen undergoes a chemical reduction reaction, which produces an electrical signal. This signal can be read by a dissolved oxygen instrument. An optical DO sensor consists of a semi-permeable membrane, sensing element, light-emitting diode (LED), and photodetector

The Audit team recommends installing VFDs on the aerators and controlling the speed according to the DO value required. There is a possibility of energy saving. In the winter season, the DO value increase, and the aerators speed can be optimized for power saving. We expect 20 % energy savings from the power consumption.

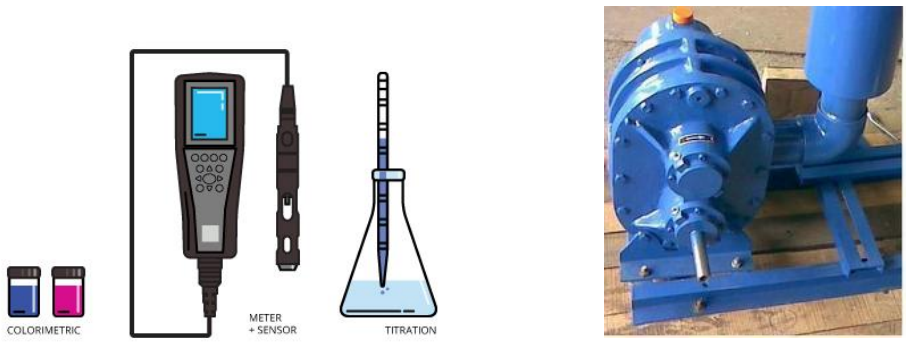


Figure 94: Dissolved oxygen measurement; ETP Blower

Dissolved oxygen is a crucial ingredient in the efficient digestion of organic material during the biological stage of wastewater treatment. In the correct concentration and under the correct temperature conditions, dissolved oxygen helps to encourage the effective propagation of bacteria and other organisms in wastewater, which then feed on the sewage waste, converting it into carbon dioxide, water, and energy.

The oxygen needed for the aeration process is provided in one of two ways. Mechanical or surface aeration uses pumps or agitators on the surface of the tanks. The rate of aeration is controlled either by varying the speed and depth of the agitator, or the speed of the pump. In contrast, the diffusion method uses perforated pipes or domes in the base of the aeration tanks. The supply of oxygen is varied by changing the speed of the compressors which force air through the diffusers. In either case, accurate control of

dissolved oxygen levels is critical to ensure the optimum conditions for the digestion process. If levels are too low, then the bacteria growth will be reduced, affecting the rate of sewage breakdown. If levels are too high, energy costs can increase, and the effectiveness of the sensor can be impaired by the formation of slime. For this reason, the recommended optimum level for dissolved oxygen is generally set at between 1.5 and 2 ppm.

Sectoral Investment (INR Lakhs)	994
Percentage of energy savings %	Electrical = 20%
Approx. Reduction in energy consumption (TOE/year)	647
Approx. Reduction in GHG emission (TCO_2)	3,872
Simple Payback Period (Years)	0.5-2

9. Installation of VFD in air compressor

Rotary screw compressors are generally energy-efficient, and they generate less heat than normal air compressors. They consume less oil than other oil-flooded air compressors. In addition, they have minimum oil carryovers. The Audit team recommends installing Screw Compressor in place of a reciprocating compressor. There is a possibility of energy saving.

Technology Description

VFDs manipulate the frequency of their output by rectifying an incoming AC current into DC and then using voltage pulse-width modulation to recreate an AC current and voltage output waveform. It is known that variable speed drives reduce energy consumption, reduce energy costs, increase production and increase the life of electric motors.

Advantage/ Key benefits

1. Keeps starting current in control:
2. Demands lower power on start:
3. Helps in controlling operating speed and acceleration
4. Limits and adjusts torque
5. Saves energy and cost

Figure 95: VFD Air compressor

Sectoral Investment (INR Lakhs)	56
Percentage of energy savings %	Electrical =5%-10%
Approx. Reduction in energy consumption (TOE/year)	64
Approx. Reduction in GHG emission (TCO_2)	225.6
Simple Payback Period (Years)	1

10. Installation of Cascade Condensate Recovery System for energy savings and improving condensate recovery

Technology Description

Condensate is a potentially valuable resource as it is high purity (compared to feed water), contains virtually no total dissolved solids, and has high heat content. The purity and absence of dissolved solids make condensate ideal for use as boiler feedwater.

Reusing condensate minimizes the need for additional, cold makeup water that would require treatment and heating, which would incur additional costs. By returning condensate to the boiler feed tank the need for boiler blowdown is reduced which saves money by reducing the energy lost from the boiler during the blowdown process.

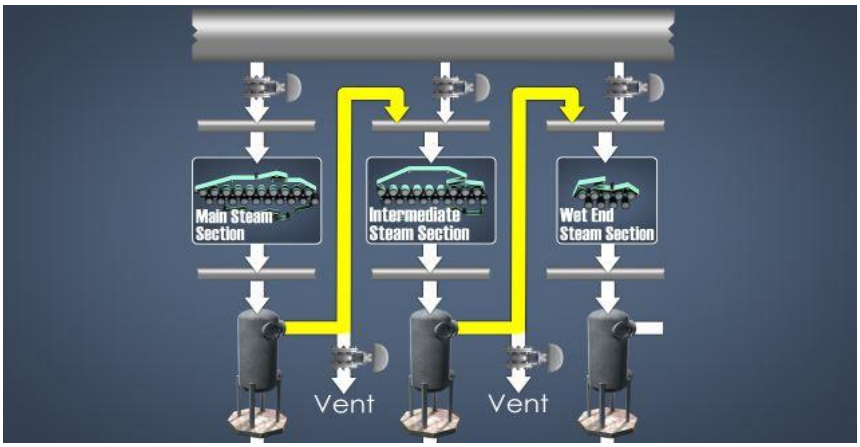


Figure 96: Sample cascaded condensate recovery system

Advantage/ Key benefits

Some of the key benefits of condensate recovery and reuse:

1. Significant savings on energy costs
2. High boiler feed water temperature minimizes dissolved oxygen and therefore helps prevent corrosion
3. Reduces the total dissolved solids (TDS) in the boiler feedwater
4. Minimizes the need for makeup water and associated costs
5. Reduces boiler feedwater treatment costs
6. Reduces the need for boiler blowdown and associated costs

Sectoral Investment (INR Lakhs)	20
Percentage of energy savings %	Thermal = 5%
Approx. Reduction in energy consumption (TOE/year)	18,346
Simple Payback Period (Years)	1-3

11. Dew Point Sensor with VFD in Air Blower of Paper machine Section

Technology Descriptions

The dew point of compressed air can be defined as the temperature at which water vapor suspended in the air can start condensing into liquid form at an equal rate as it is evaporating. This fixed temperature is the point at which the air is fully saturated with water and can no longer hold any more vaporized water except some of the vapor it contains which gets condensed.

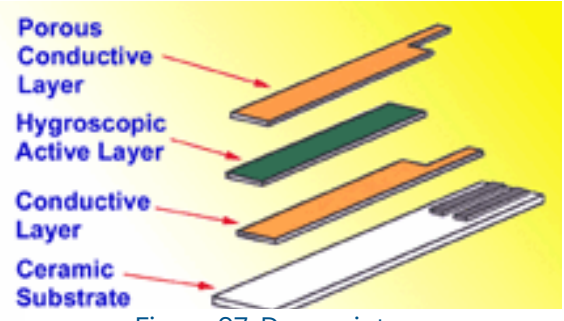


Figure 97: Dew point sensor

Dew point sensors work through an impedance. As the gas passes over the sensor, it absorbs water vapor onto a porous hygroscopic dielectric area between

conductive layers built atop a base ceramic substrate. Water molecules change the dielectric constant (K), which results in a change in the sensor's impedance.

Advantage/ Key benefits

1. Savings on energy costs
2. Monitoring moisture content

Sectoral Investment (INR Lakhs)	152
Percentage of energy savings %	Electrical = 20%
Approx. Reduction in energy consumption (TOE/year)	368
Approx. Reduction in GHG emission (TCO_2)	520
Simple Payback Period (Years)	0.5-2

12. Insulation of Boiler Surface

Technology descriptions

Refractory materials and refractory engineering play a very important role in the performance of boilers. Insulation reduces heat losses by about 55-65%. Over the lifetime of the boiler, insulation material wears off and increases heat loss. The deteriorating refractories may lead to an increase in energy losses by 0.1 – 0.2% per month. Insulation is an easy and low-cost method that not only performs on building skin but also on industrial processing equipment such as pipelines, furnaces, heat exchangers, and valves to reduce energy usage and CO2 emission.

Figure 98: Boiler insulation

Advantage/ Key benefits

1. Controls surface temperature for personnel protection.
2. Controls and stabilizes process temperatures.
3. Prevents condensation and subsequent corrosion on cold surfaces.
4. Increases fire protection.
5. Controls noise and vibrations

Sectoral Investment (INR Lakhs)	109
Percentage of energy savings %	Thermal = 1%
Approx. Reduction in energy consumption (TOE/year)	2072
Simple Payback Period (Years)	<1

13. Installation of the proper sized motor in the Plant

It was observed during the field visits that some of the motors are taking less load as compared to their rated power. Replacing the Underloaded motor with Proper Sized Motors will be the correct option in such cases.

Technology Description

Electric motors work by converting electrical energy to mechanical energy to create motion. Motors rarely operate at their full-load point. Proper sizing is a crucial aspect of motor selection. If a motor is undersized, it will not be able to control the load, leading to overshoot and ringing. If the motor is oversized, it may control the load, but it will also be larger and heavier, as well as more expensive in terms of price and cost of operations.

As loads on a motor are progressively increased, it begins to rotate slower until, at the full-load point, the operation occurs at the full-load speed. Thus, oversized and lightly loaded motors tend to operate at speeds that approach synchronously. An appropriately sized smaller or fully loaded energy-efficient motor, with a higher full-load rpm, may operate at a slower speed than the original oversized motor. This speed and load shift can be significant and will give more energy savings. Generally, this would result in a savings increase of approximately 50% greater than that predicted if speed correction factors are neglected.

Advantage/ Key benefits

Savings on energy costs

Sectoral Investment (INR Lakhs)	1,849
Percentage of energy savings %	Electrical = 2%-3%
Approx. Reduction in energy consumption (TOE/year)	2,861
Approx. Reduction in GHG emission (TCO_2)	18,096
Simple Payback Period (Years)	<1

14. Installation of energy-efficient lighting in place of T8 Lamps and Incandescent Bulb

Technology Description

It was observed by the Audit team that the audited paper clusters have already installed LED luminaire in the majority area of the plant, however, in a few areas of the factory the continued usage of T8 lamps and Incandescent bulb can be observed.

The use of energy-efficient lighting is one of the best and most cost-effective ways of reducing plant energy consumption. It is recommended by the audit team to replace all these remaining T8 lamps and Incandescent bulbs with energy-efficient lighting.

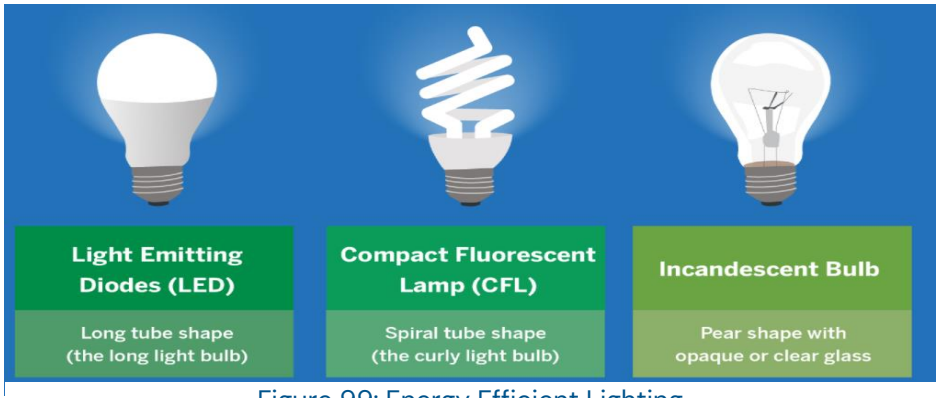


Figure 99: Energy Efficient Lighting

Advantage/ Key benefits

1. High efficacy (Lumens / Watt)
2. Environmentally friendly
3. Reduces work-related headaches
4. Reduces sick building syndrome

Sectoral Investment (INR Lakhs)	21
Percentage of energy savings %	Electrical = 0.2%
Approx. Reduction in energy consumption (TOE/year)	40
Approx. Reduction in GHG emission (TCO_2)	300
Simple Payback Period (Years)	<1

15. Installation of Hi-Consistency Pulper in place of low-Consistency Pulper

Currently, the pulper being used has a consistency of 3.5 % which can be drastically improved using a high consistency pulper which would require a lesser amount of water.

Technology Descriptions

Fiber to fiber friction creates excellent defibering and maintains the fiber length in its original size. Minimal breakdown of contaminants such as plastics, films, adhesives, hot melts, etc. helps easy removal in the next cleaning stage. Energy transfer is used skillfully by friction between fibers due to perfectly correct surface contours of flight and also utilizes higher consistency so the reduced amount of water usage. It also helps in reducing electricity consumption by around 10%.

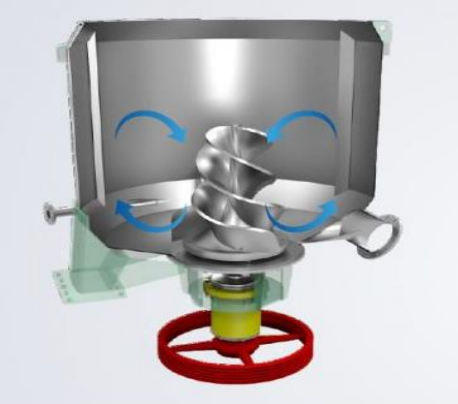


Figure 100: High consistency pulper

Advantage/ Key benefits

1. Using Turret multi–helical rotor, rapid cycling of pulp, and strong ability in defibering.
2. Energy-saving, less quantity of chemicals required.
3. High consistency to break pulp, small impurities, and high deinking efficiency.
4. Compact structure, easy to operate and maintain.

Sectoral Investment (INR Lakhs)	13860
Percentage of energy savings %	Electrical = 15%
Approx. Reduction in energy consumption (TOE/year)	5,075
Approx. Reduction in GHG emission (TCO_2)	36,309
Simple Payback Period (Years)	2-4

16. Replacement of IE 2 motors with IE 3 motors

The National Motor Replacement Program (NMRP) which is EESL's first of its kind program for the industrial sector was conceptualized after due consultation with industries & other stakeholders. NMRP will address the replacement of the installed stock of IE1 & sub-IE1 motors with IE3 motors. This will take the market higher than the Minimum Energy Performance Standard (MEPS) of IE2 which was mandated from 01.01.2018. The paper industries can take benefit of the scheme to improve their energy efficiency

Technology Descriptions

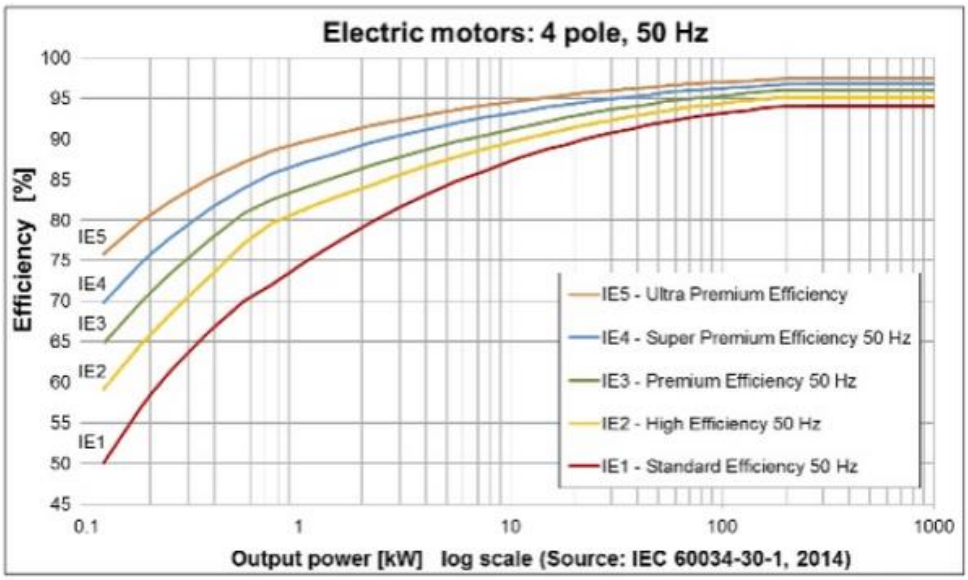


Figure 101 Efficiency curves for different motor classes

Replacing the old inefficient motors with IE-3(premium efficiency) & IE-4 (super premium efficiency) motors can help in reducing a lot of power consumption resulting in considerable savings.

Advantage/ Key benefits

1. IE3 motors provide premium efficiency which helps in reducing CO2 emission levels
2. energy-efficient motors usually have higher service factors, longer insulation and bearing lives

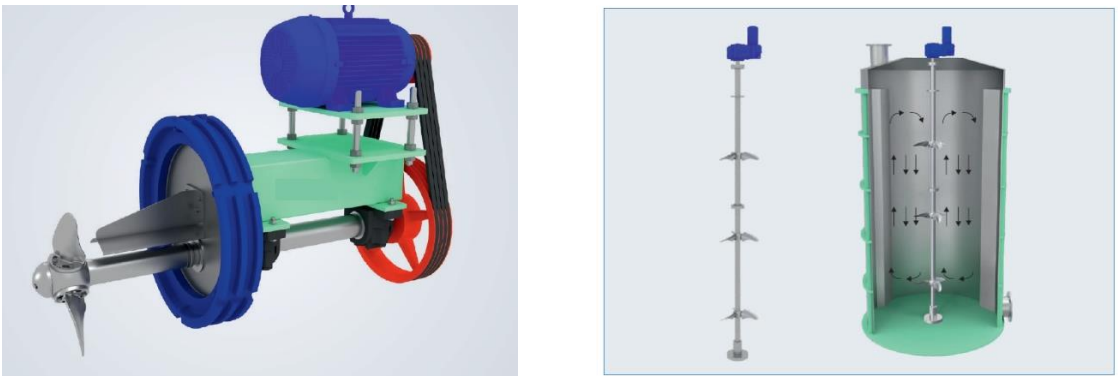
Sectoral Investment (INR Lakhs)	6,076
Percentage of energy savings %	Electrical = 3%
Approx. Reduction in energy consumption (TOE/year)	4,410
Approx. Reduction in GHG emission (TCO_2)	22,236
Simple Payback Period (Years)	1-3

17. Replacement of present agitators with energy efficient agitators

Technology Description

It was observed that the plant management is still using the old agitators in different chests in the pulp section. Replacing agitators which are continuously running in the plant replacing which can lead to large amounts of energy savings. Approximately 15 % reduction in energy consumption is possible by using energy-efficient agitators

There are mainly two types of agitators. Horizontal agitator and vertical agitators. Directly coupled agitators are also available in the market. These energy-efficient agitators give effective agitation at low power consumption. They can have adjustable blade angles as well as a guiding plate which avoids rotation of pulp and reduces power consumption thereby increasing efficiency



(a) Horizontal (b) Vertical

Figure 102: Types of Agitators

Advantage/ Key benefits

6. Reduce your energy costs for agitation
7. Low maintenance costs due to a very long seal service life
8. Greater productivity because of reduced downtime

Sectoral Investment (INR Lakhs)	3,500
Percentage of energy savings %	Electrical = 15%
Approx. Reduction in energy consumption (TOE/year)	2,430
Approx. Reduction in GHG emission (TCO_2)	14,400
Simple Payback Period (Years)	1-2

18. Replacement of the SR Boxes with closed box system along with pressure-based VFD controlling at Chest Pump

Technology Descriptions

The audit team observed the operational parameters and flow distribution network of the chest pump which delivers material through SR Boxes. An overflow was observed from the SR boxes to chest no. 4. The flow distribution network is shown as below: -

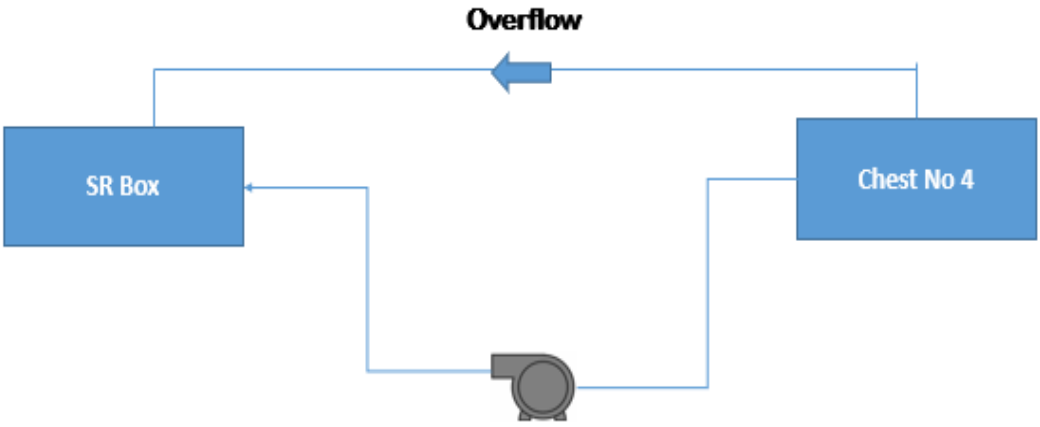


Figure 103 SR Boxes

The audit team recommends the plant management replace the SR Boxes with a closed box system along with pressure-based VFD controlling at Chest Pump to avoid overflow and maintain smooth operation

Advantage/ Key benefits

1. Automated operation with a feedback system
2. Electricity savings

Sectoral Investment (INR Lakhs)	20
Percentage of energy savings %	Electrical = 20%
Approx. Reduction in energy consumption (TOE/year)	24
Approx. Reduction in GHG emission (TCO_2)	208
Simple Payback Period (Years)	1-2

19. Replacing Vacuum Pumps and Installing Vacuum Blowers

Technology Descriptions

Vacuum pumps are used to maintain vacuum at serious sections of paper Machine to remove water by the flow of air. Vacuum pumps consume a significant amount of power for their operation in a paper machine. The latest trend is to replace vacuum pumps with vacuum blowers. The efficiency of vacuum pumps is around 40% whereas that of vacuum blowers is around 60%. The replacement with a vacuum blower will reduce the energy consumption by about 40%. It was observed by the audit team that the vacuum pump is currently present for the wire and press section. The wire section requires a very low vacuum which can be provided by the vacuum blower. We can replace the vacuum pump with a vacuum blower in the wire section.

Advantage/ Key benefits

1. Specific power consumption of a blower is generally 30-40% of a vacuum pump
2. Gives energy savings

Figure 104: Vacuum Pump & Vacuum Blower

Sectoral Investment (INR Lakhs)	15,437
Percentage of energy savings %	Electrical = 20%
Approx. Reduction in energy consumption (TOE/year)	8,120

Approx. Reduction in GHG emission (TCO_2)	49,933
Simple Payback Period (Years)	2-4

20. Insulation of condensate drums

Technology Descriptions

Condensate pots are commonly used on the condensing sides of some reboilers, such as those that are heated by steam or refrigerant vapor. These pots provide a liquid seal that prevents uncondensed vapor from blowing out of the reboiler into the condensate system. Insulation is an easy and low-cost method that not only performs on building skin but also on industrial processing equipment such as pipelines, furnaces, heat exchangers, and valves to reduce energy usage and CO2 emission.

The Audit team recommends installing Insulation on the Condensate drum on the Boiler.

Figure 105: Condensate drum

Advantage/ Key benefits

1. Controls surface temperature for personnel protection.
2. Controls and stabilizes process temperatures.
3. Prevents condensation and subsequent corrosion on cold surfaces.
4. Increases fire protection.
5. Controls noise and vibrations

Sectoral Investment (INR Lakhs)	13.6
Percentage of energy savings %	Thermal = 1%
Approx. Reduction in energy consumption (TOE/year)	232
Simple Payback Period (Years)	1-2

21. Installation of Microturbines at Paper Mill

Technology Descriptions

It was observed that a lot of plants in the paper sector are generating steam at High Pressures i.e., above 10 kg/cm_2, and reducing it to 3 kg/cm^2 in the reducer valve. The plant has a steam demand at 2 kg/cm^2. It is recommended to install a back-pressure turbine for generating power from the pressure reduction. The back-pressure turbine will reduce the pressure as per process requirement and will generate power also.

Figure 106 Back pressure turbine

Advantage/ Key benefits

1. Microturbines have shown good perspectives for the distributed generation of electricity in the low-capacity range because they have high reliability and simple design
2. Generation of electricity from otherwise waste energy by PRDS system

Sectoral Investment (INR Lakhs)	4,026
Percentage of energy savings %	Electrical = 5-10%
Approx. Reduction in energy consumption (TOE/year)	17,776
Approx. Reduction in GHG emission (TCO_2)	169,730
Simple Payback Period (Years)	1-2

22. Installation of Solar PV panel

Technology Descriptions

It was observed that all the paper plants in the paper sector have space available on the terrace. The space can be used for the installation of solar rooftop PV panels. The capacity of solar panels can be installed depending on the efficiency of the panels. The paper plant building has very good in-house electricity demand, these panels can be directly connected to the grid supply. There will be a considerable reduction in the electricity bills by installing PV panels.

Advantage/ Key benefits

1. Solar energy is a clean and renewable energy source.
2. Once a solar panel is installed, solar energy can be produced free of charge.
3. Solar energy causes no pollution

Figure 107 Solar PV plant

Sectoral Investment (INR Lakhs)	29,417
Percentage of energy savings %	Electrical =3%-10%
Approx. Reduction in energy consumption (TOE/year)	13,978
Approx. Reduction in GHG emission (TCO_2)	133,308
Simple Payback Period (Years)	3-6

23. Installation of VFD in De-inking recirculation pumps in place of Throttling

In the de-inking plant, there was a two-stage de-inking carried out with recirculation pumps in the de-inking tank. There are three pumps in pumps each stage used for recirculating the pulp in deinking tanks. There was a high level of throttling in these pumps. The schematic diagram is shown below.

Technology Description

VFDs manipulate the frequency of their output by rectifying an incoming AC current into DC and then using voltage pulse-width modulation to recreate an AC current and voltage output waveform.

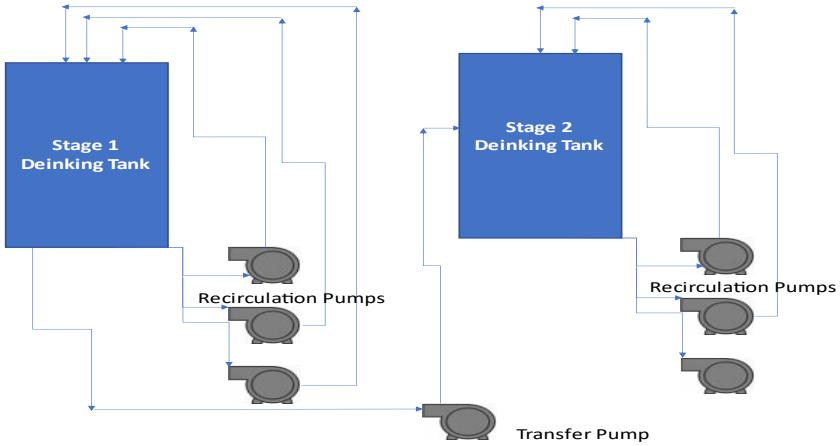


Figure 108: De-inking recirculation system

Advantage/ Key benefits

1. Keeps starting current in control:
2. Reduces power line disturbances
3. Demands lower power on start:
4. Helps in controlling operating speed and acceleration
5. Limits and adjusts torque
6. Saves energy and cost

Sectoral Investment (INR Lakhs)	215.2
Percentage of energy savings %	Electrical = 10%
Approx. Reduction in energy consumption (TOE/year)	224
Approx. Reduction in GHG emission (TCO_2)	2,128
Simple Payback Period (Years)	1-2

24. Installation of Pocket ventilation system in the dryer of a paper machine

Technology Description

Pocket Ventilators improve the drying rate, moisture profile, and production for paper machines. The ventilators prevent sweating, corrosion, and fibre build-up. Pocket ventilators are custom engineered for various qualities of paper produced. In the process, ambient air is heated up to a temperature of around 100 to 110°c in steam air heaters and is then delivered using a centrifugal fan, via supply air ducting and blow boxes into the cylinder pockets through the permeable dryer screens for ventilation of cylinder pockets and also for conditioning of dryer fabrics. This dry and hot supply air ventilates the cylinder pockets and provides a controlled drying environment by keeping a low and uniform humidity level in-cylinder pockets.

Advantage/ Key benefits

Improve the drying rate, moisture profile, and production for paper machines

Sectoral Investment (INR Lakhs)	25,680
Percentage of energy savings %	Thermal = 8%
Approx. Reduction in energy consumption (TOE/year)	296,400
Simple Payback Period (Years)	1-3

Figure 109: Pocket ventilating system

25. Installation of Thermocompressor on dryer section of paper machine

It was observed that plant is having a turbine for power generation. The plant is generating steam at high pressure for the Boiler. There is some flash steam generated in the condensate recovery tank. This is a lean steam of pressure 0.5 kg/cm^2. This steam cannot be directly used in any application. But if his lean steam is passed from the thermo compressor with high-pressure steam then the output can be in the usable pressure range. We can easily get 4 kg/cm^2 pressure with a thermo compressor. These 4 kg/cm^2 pressures can be used in the dryer section. There is a marginal amount of high steam also utilized to get this range of pressure.

Technology Description

A Thermocompressor is a steam control device that uses high-pressure steam (motive steam) to induce flow from a lower pressure steam source (suction steam) and discharge the mixture at an intermediate pressure. The high pressure is used to create a high-velocity jet that mixes with and accelerates the suction steam.

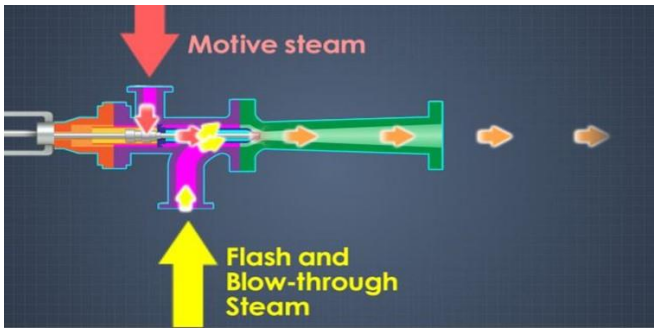


Figure 110: Thermocompressor diagram

Advantage/ Key benefits

1. Stationary equipment and no moving part.
2. Minimum maintenance requirement.
3. Saves thermal energy

Sectoral Investment (INR Lakhs)	312
Percentage of energy savings %	Thermal = 5%-10%
Approx. Reduction in energy consumption (TOE/year)	53,244
Simple Payback Period (Years)	0.5-2

26. Replacing the roll press with shoe press in paper machine

Technology Description

Water is removed in three successive steps in a paper machine in the wire, press, and dryer sections. Shoe presses can create high dryness for all grades and usually, this dryness level translates to increased production. The shoe press can create a 5-10% dryness improvement over the roll presses it replaced, and this allowed the dryer-limited machine to increase production by 20%. Further, it is turned out, the profits from increased production and the reduction in furnish cost far outweighed the steam savings per ton. The linerboard strength improvement made it possible to decrease refining energy and eliminate wet-end starch. After the paper is formed, it is pressed to remove as much water as possible. Normally, pressing occurs between two felt liners pressed between two rotating cylinders. Extended nip presses use a large concave shoe instead of one of the rotating cylinders. The additional pressing area adds dwell time in the nip and allows for greater water extraction (about 5-7% more water removal) to a level of 35-50%. Greater water extraction leads to decreased energy requirements in the dryer, which leads to reductions in steam demand. Furthermore, reduced dryer loads allow plants to increase capacity up to 25% in cases where production is dryer limited.

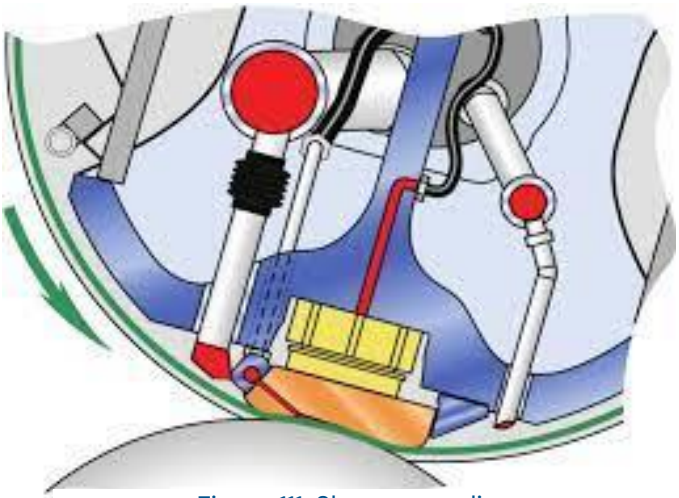


Figure 111: Shoe press diagram

Advantage/ Key benefits

Papermill operating with a roll press, the change to the shoe press will improve the dryness of paper by 5-10 basis. This will reduce steam consumption by about 20-40%. The audit team have observed that there is a significant energy saving opportunity available if the plant switches to show press in place of roll press

Sectoral Investment (INR Lakhs)	68,267
Percentage of energy savings %	Thermal = 15%
Approx. Reduction in energy consumption (TOE/year)	142,613
Simple Payback Period (Years)	1-2

27. Installation of Economizer in Boiler section

Technology Descriptions

A boiler economizer is installed into the exhaust stream of the boiler. Exhaust waste heat is recovered by an industrial finned tube that lines the inside of the economizer. Using that exhaust instead of throwing it away can lead to significant savings of energy. The Audit team recommends installing of Economizer on the Boiler. The economizer gives savings up to 60%.

Figure 112: Economizer

Advantage/ Key benefits

1. It recovers more heat of flue gases which normal air pre-heater cannot do.
2. Improved boiler efficiency
3. In power plants where it is not used, a large quantity of water is required to cool the flue gas before desulphurization which is minimized by using economizers.

Sectoral Investment (INR Lakhs)	3,120
Percentage of energy savings %	Thermal = 2-5%
Approx. Reduction in energy consumption (TOE/year)	14,629
Simple Payback Period (Years)	1-2

28. Installation of soot blower system in the boiler WHR system

Technology Description

In biomass power plants, incomplete combustion of solid fuel leads to soot formation. Soot is sticky and causes fouling on internal furnace tubes or heating and reaction surfaces of boilers. As a result, soot build-up in various boiler parts (WHR system) increases flue gas temperature, contributes to reduced boiler thermal efficiency, and incurs high energy costs. To mitigate this, cleaning via soot blowing is an important maintenance action. [18]

This activity is part of maintenance management, to improve the reliability and availability of the plant. Hence, it is not considered an energy efficiency measure. Further, an advanced system such as online monitoring is also available which can be considered depending on the plant size and boiler condition, fuel characteristics, and the revenue loss because of shutdown activities.

For better performance of the boiler, it is important to uniformly clean the boiler surface while maintaining high heat transfer efficiency. This can be achieved by measuring the degree of fouling at each section in the radiation and convection zone of the boiler with the help of calculating the cleanliness factor and zonal heat absorption in the boiler heating surfaces. Frequent operation of soot blowers leads to wastage of steam required for soot blowing and increases the maintenance cost. Less blowing causes too much deposition on the heating surfaces and hence decreases boiler performance as well as increases the emission level. Therefore, the boiler heating surface mustn't be cleaned unnecessarily or excessively to maintain a low level of deposition, higher heat transfer, and less emission. Some boiler manufacturers and consulting companies have developed a soot blowing optimization system based on a monitoring system of heat transfer and temperature measurements of the boiler. [19]

The conventional way of cleaning and keeping clean the boilers and dust collectors is with the use of steam, water, or compressed air or simply by vibrators or shot cleaning. These methods can be applied either manually or mechanically.

Alternatively, Sonic Soot Blowers can also be considered which is, a proven alternative to conventional steam soot blowers in power generation plants that burn a range of fossil fuels and other waste fuels including biofuels. Depending on the application and boiler plant design, Sonic Soot Blowers usually totally replace existing high maintenance steam soot blowers whether retractable or rotary. In a few cases, Sonic Soot Blowers can be used to supplement steam soot blowers and reduce their usage.

[18] Soot blower for biomass boiler - Link
[19] Boiler soot blowing advanced system (Use of SMART clean compact) - Link

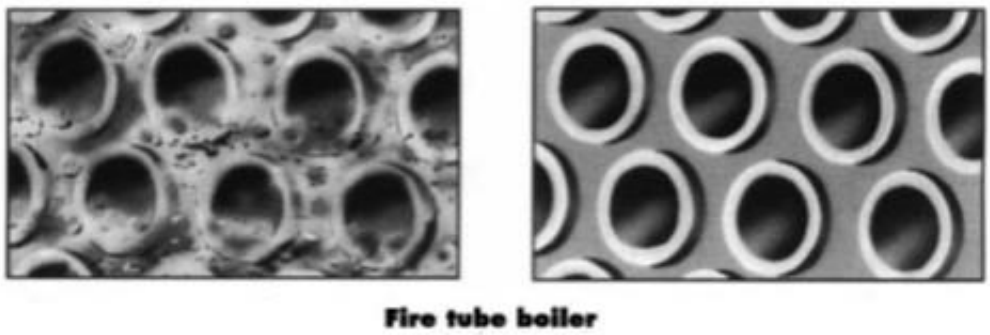


Figure 113: Fire tube boiler without (Left) and with (Right) soot blowing system

It is recommended to install the soot blowing system in the boiler WHR system. This will reduce the flue gas exit temperature due to the boiler WHR system's improved effectiveness. The economic benefits of using soot blowers are reduced fuel consumption, reduced water washing, reduced boiler WHR system (WHR) repair jobs, and improved reliability and availability of boiler.

Advantage/ Key benefits

1. It can be arranged in various parts of the boiler and can blow dust on the heating surface of the furnace chamber, horizontal flue, and tail shaft.
2. Improves heat transfer rates
3. Improves boiler life

Sectoral Investment (INR Lakhs)	264
Percentage of energy savings %	Thermal = 5%
Approx. Reduction in energy consumption (TOE/year)	779
Simple Payback Period (Years)	1-3

29. Reduction of GHG emissions by shifting towards biomass from coal

It was observed by the audit team that the plant currently uses coal in the boiler to meet the energy demands. The Audit team recommends Using Biomass fuel in place of coal for minimizing the Green House Gases and to create a clean environment for working.

Technology Descriptions

Biomass has come on strong as an alternative to traditional power sources. Many plants across the nation have considered or begun converting from coal to biomass, either as part of a co-firing strategy combining biomass and coal or as a biomass-only setup. Common forms of biomass energy include wood pellets, wood chips, torrefied biomass pellets, and charcoal.

Figure 114: Biomass boiler and wood pellet fuel

Advantage/ Key benefits

1. Use of biomass for energy production is characterized by low levels of GHGs emissions when compared to coal
2. Prices of biomass are comparatively low if a plant is in a nearby agriculture region.

Approx. Reduction in GHG emission (TCO_2)	6,800,000
Simple Payback Period (Years)	>5

30. Installation of Screw Press in Place of Potcher for Pulp Washing

Technology Descriptions

With the advancement of technology, now there is better washing equipment available called screw washer, which replaces the present Potcher system used for washing the pulp. The screw washer leads to reduced water consumption also. The Screw Press is built for dewatering of pulp suspensions from inlet consistencies of 3-12% to outlet consistencies up to 30% and even higher.

Advantage/ Key benefits

1. Water savings
2. high dewatering rate, high pulp drying.
3. high pulp concentration, low power consumption

Figure 115: Screw press

Sectoral Investment (INR Lakhs)	104
Percentage of energy savings %	Electrical = 10%
Approx. Reduction in energy consumption (TOE/year)	112
Approx. Reduction in GHG emission (TCO_2)	62
Simple Payback Period (Years)	1-2

31. Installation of Pressurized Headbox in paper machine

Technology Descriptions

Conventional headbox installed, provides head by naturally depending on the level of pulp maintained in the headbox. A pressurized headbox is available that creates and maintains the head by pressurized air over the pulp in the chamber. The constant head provides better quality of paper and eases the operation at high speeds. The overall productivity of the paper mill increases leading to reduced specific energy consumption.

Figure 116: Pressurized headbox

Advantage/ Key benefits

Installation of the pressurized headbox on the paper machine will lead to improved paper quality and reduced paper breakage leading to a reduction in the production loss due to paper breakage. The increase in the production level will lead to the reduced specific energy consumption of the paper machine. A good, pressurized headbox system can lead to a reduction in reduction in steam and electricity consumption by 3%.

Sectoral Investment (INR Lakhs)	1,800
Percentage of energy savings %	Electrical = 3%; Thermal = 3%
Approx. Reduction in energy consumption (TOE/year)	3,280
Approx. Reduction in GHG emission (TCO_2)	1,328
Simple Payback Period (Years)	3-5

B2 – State of the Art Technologies

As the Indian paper industry is largely fragmented with lower capacity with an individual paper mill, it is also prone to using outdated technology. Resultantly, it is estimated that both the raw material as well as the power consumption is higher as compared to a modern paper mill. Adoption of new technology by domestic paper producers would lead to the emergence of more competitiveness in critical areas including a quantifiable increase in productivity, quality improvement with reduced cost, improvement in energy efficiency, and better compliance with environmental protection legislation and safeguards for eco-sustainability of the products. Because the nature of emerging technologies is constant and rapid change, the information presented in this report is also subject to change. The following are the list of innovative emerging technologies:

Table 22: List of innovative emerging technologies with commercialization status and potential benefits

No.	Category/Technology Name	Commercialization Status	Potential Benefits	Link
	Emerging Pre-treatment Technologies			
1	Microwave Pre-treatment for Chemical Pulping	Development stage	40% reduction in pulping chemical usage; Improves pulp yield and throughput by 40 percent in existing kraft pulp mills	Source
2	Biological Pre-treatment for Mechanical Pulping	Enzymatic pre-treatment: Pilot stage; Fungal pre-treatment: Semi commercial	mechanical pulping energy consumption reduces by 25-40%; Improves paper quality, e.g., enhanced paper strength and reduced pitch content	Source
3	Chemical Pre-treatment with Oxalic Acid for Mechanical Pulping	Pilot Stage	Reduces mechanical pulping energy use by 20- 30%	Source
	Emerging Pulping Technologies			
4	Directed Green Liquor Utilization Pulping	Demonstration Stage	Increases pulp yield 1 to 3 %; Reduces energy consumption by up to 25% in the pulping process	Source
5	Membrane Concentration of Black Liquor	Development stage	Reduces energy cost by 30% for black liquor evaporation as compared to a conventional evaporator	Source
6	Dual pressure Reheat Recovery Boiler	Pilot Stage	Improves steam cycle efficiency Increases electricity generation for the same fuel input	Source
7	Recycled Paper Fractionation	Demonstration Stage	Improves pulp quality; Reduce electricity use by 11 to 13% and thermal energy use by 40% as compared to traditional deinked (DIP) lines	Source
8	Surfactant Spray Deinking	Demonstration Stage	Reduces fiber loss up to 50%; Reduces water and deinking chemical use; Increases DIP yield by approximately 3.5%	Source
10	Pulsed Power Technology for Decontamination of Recycled Paper	Demonstration Stage	Reduces energy use by 10 to 15% for the pulsed power technology compared to conventional methods for decontamination in a recycled	Source

No.	Category/Technology Name	Commercialization Status	Potential Benefits	Link
			paper mill by improving the efficiency of hydro cyclone cleaner, deinking cells, and dissolved and dispersed air flotation units	
11	Steam cycle washing	Demonstration Stage	20% decrease in electricity consumption and a 40% overall reduction in fuel or steam consumption for unbleached pulp production	Source
	Emerging Papermaking Technologies			
12	Aq-vane Technology	Development stage	the filler content in papermaking can be increased to 45% from the previous 35% and energy consumption was reduced by 16%	
13	High Consistency Papermaking	Commercialization Status	Reduces energy use in stock preparation, vacuum system, and dewatering; Electricity savings are estimated at 8%; Reduces water consumption in papermaking; Saving fiber use by 5-8 percent	Source
14	Dry Sheet Forming	Commercialization Status	Reduces drying energy consumption by 50%; Increases electricity use of 150 to 250 kWh/t paper; as investment costs 30 to 50 percent of those for a conventional non-integrated paper mill and lower O&M costs	Source
15	Displacement Pressing/ Twin roll press	Commercialization Status	Pulp consistency can be increased up to 10-11%. Pulp washers' capacity can be increased up to 30%	Source
16	Impulse drying in the wet pressing process		Reduces water evaporation in dryer section by 175 to 350 kg water/t paper Reduces steam consumption for drying around 10-25%	Source
17	New Fibrous Fillers	Demonstration Stage	Reduces energy use by 25%	Source
18	Laser Ultrasonic Stiffness Sensor	Demonstration Stage	Overall, mill-scale energy savings of 3% have been estimated	Source
	Emerging Paper Drying Technologies			
19	Gas-fired Dryer	Commercialization Status	Reduces drying energy consumption by 10-20%; Increases production by up to 20%	Source
20	Boost Dryer	Pilot Stage	Reduces specific energy consumption; Increases drying efficiency and increases drying capacity by approximately 12 %	
21	Condebelt Dryer	Commercialization Status	Reduces steam consumption by 10 to 20%; Improves paper properties,	Source

No.	Category/Technology Name	Commercialization Status	Potential Benefits	Link
			and significantly improves paper strength (by 20 to 60%)	
22	Microwave Drying	Development stage	Reduces overall energy consumption by 12%; Increases paper machine speed by 30%	
	Emerging Byproducts/Biomass/Waste Heat Utilization Technologies			
23	Black Liquor Gasification	Various stage	Increases pulping process energy recovery by 10%; Increases pulp mill power production by two to three times; Increases pulp yield by about 5 to 7%	Source
24	Biomass Gasification	Various stage	Reduces fossil fuel use and CO2 emissions for pulp and paper mills; Lowers nitrogen oxide (NOx) emissions 30 to 40%	Source
25	LignoBoost	Commercialization Status	Odor-free bio-composite can be produced from lignin. Plants produce lignin of high value and consistently high quality,	Source
26	Other Integrated Biorefinery	Various stage	Poly-generation units could reduce the heating and cooling demand of a Kraft mill by 29 and 11% respectively while producing about 2.2 MW of electricity.	Source
27	Use of Residuals in Concrete Production	Pilot Stage		Source
28	Transport Membrane Condenser	Various stage	Increase fuel-to-steam efficiency by as much as 15 percent (for up to 95-percent fuel-to-steam efficiency), and can capture 20 percent of boiler water for reuse without the need for further water treatment	Source

B3 – Best Operating Practices

The following are the best practices for Indian MSME paper plants:

Areas	Best practices	Monitorable parameters	Key Parameters
Pulping, Papermaking & related process	1. High pulp concentration (high consistency technique) 2. Recovery and use of the low-temperature streams from effluents and other waste heat sources to heat buildings, boiler feedwater, and process water 3. Optimized dewatering in the press section of paper machine/wide nip press 4. Optimization of the operating mode in existing refiners (e.g., reduction of no-load power requirements) 5. Optimization of heat recovery, air system, insulation 6. Use of waste heat for sludge drying or upgrading of dewatered biomass	➢ SEC Thermal (TOE/Tonne of Production) ➢ SEC Electrical (TOE/Tonne of Production)	➢ Kraft SEC Thermal (TOE/Tonne):0.169 SEC Electrical (TOE/Tonne):0.024 Water consumption (kL/Tonne):1.0 ➢ Writing & Printing SEC Thermal (TOE/Tonne): 0.205 SEC Electrical (TOE/Tonne): 0.047 ➢ Newsprint SEC Thermal (TOE/Tonne):0.128 SEC Electrical (TOE/Tonne):0.052 Water consumption (kL/Tonne):4.7 ➢ Specialty & Others SEC Thermal (TOE/Tonne):0.235 SEC Electrical (TOE/Tonne):0.054 Water consumption (kL/Tonne):5.2
Electrical system	1. Installing capacitors in the AC circuits decrease the magnitude of reactive power. 2. Minimizing the operation of idling or lightly loaded motors	➢ **Motors:** ○ Voltage (Volt) ○ Current (Ampere)	➢ Transformer Efficiency = 99.5% & above

Areas	Best practices	Monitorable parameters	Key Parameters
	3. Avoiding the operation of equipment above its rated voltage 4. When replacing motors, using energy-efficient motors 5. Check the power supply for harmonics and apply filters if required 6. Use: • Direct coupling where possible • Synchronous belts or cogged V-belts in place of V belts • Helical gears in place of worm gears 7. Rewinding: avoid rewinding after 2 times and replace with an EEM, or use a reliable rewinding contractor (up to 2-3 times)	○ Power factor ○ Electricity consumption (kWh) ➢ **Transformers:** ○ Voltage (Volt) ○ Current (Ampere) ○ Power (kVA) ○ Oil temperature (°C) ○ Winding temperature (°C) ○ Tap position ○ Harmonics % ➢ **Lighting System:** ○ Illumination (lux) ○ Electricity consumption (kWh)	➢ IE3/IE4 Standard motors recommended ➢ LED Lighting as per requirement ➢ Motor Loading close to 100% ➢ P.F. should be maintained around 1. ➢ Transformer LT voltage should be maintained around 410 to 415 volts. ➢ Transformer(s) should be operated at above 40-50% load of the rated power.
Boiler	1. Preheat combustion air with waste heat. (22 0 C reduction in flue gas temperature increases boiler efficiency by 1%) 2. Use variable speed drives on large boiler combustion air fans with variable flows. 3. Burn wastes if permitted. 4. Clean burners, nozzles, strainers, etc. 5. Improve oxygen trim control (e.g. -- limit excess air to less than 10% on clean fuels). (5% reduction in excess air increases boiler efficiency by 1% or: 1% reduction of residual oxygen in stack gas increases boiler efficiency by 1%) 6. Automate/optimize boiler blowdown. Recover boiler blowdown heat. 7. Inspect for scale and sediment on the waterside. (A 1 mm thick scale (deposit) on the waterside could increase fuel consumption by 5 to 8%.) 8. Inspect for soot, flyash, and slag on the fireside. (A 3 mm thick soot deposition on the heat transfer surface can	➢ Steam pressure (bar) ➢ Steam generation (kg/hr.) ➢ Fuel consumption ➢ Air ratio (kg/kg fuel) ➢ Flue gas temperature (°C) ➢ Feedwater temperature (°C) Surface temperature (°C)	➢ **Air ratio targets for boiler (Load Factor % = 50 to 100):** ○ Coal = 1.32–1.38 ○ Biomass = 1.32–1.39 ○ Liquid fuel = 1.18–1.24 ○ Gas fuel = 1.12–1.15 ➢ Boiler Efficiency should be greater than 80%.

Areas	Best practices	Monitorable parameters	Key Parameters
	cause an increase in fuel consumption to the tune of 2.5%) 9. Optimize boiler water treatment. 10. Recycle steam condensate.		
Steam System	1. Fix steam leaks and condensate leaks. (A 3 mm diameter hole on a pipeline carrying 7 Kg/cm2 steam would waste 33 Kilo liters of fuel oil per year) 2. Use more-efficient steam desuperheating methods. 3. Maintain the lowest acceptable process steam pressures. 4. Ensure condensate is returned or re-used in the process. (60 C raise in feed water temperature by economizer/condensate recovery corresponds to a 1% saving in fuel consumption, in boiler) 5. Inspect steam traps regularly and repair malfunctioning traps promptly.	➢ Steam Temperature (°C) ➢ Steam Pressure (bar) ➢ Steam Flow (m3/sec.) ➢ Insulation Temperature (°C) ➢ Condensate Recovery %	➢ Specific steam consumption should be close to design value ➢ Insulation of Steam lines and condensate drum should not exceed 50oC. ➢ Condensate Recovery should be above 80%.
Pumping System	1. Operate pumping near the best efficiency point. 2. Modify pumping to minimize throttling. 3. Adapt to wide load variation with variable speed drives or sequenced control of smaller units. 4. Balance the system to minimize flows and reduce pump power requirements. 5. Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return.	➢ Electricity consumption (kWh) ➢ Suction head (meter) ➢ Delivery head (meter) ➢ Flow rate (m^3/sec.) ➢ Fluid temperature (°C)	➢ Pump Efficiency should be greater than 80%.
Fan & Air Blower	1. Use smooth, well-rounded air inlet cones for fan, blower air intakes. 2. Avoid poor flow distribution at the fan inlet. 3. Minimize fan, blower inlet, and outlet obstructions. 4. Clean screens, filters, and fan blades regularly. 5. Use aerofoil-shaped fan blades. 6. Minimize fan, blower speed. 7. Use low-slip or flat belts. 8. Check belt tension regularly. 9. Use variable speed drives for large variable fan, blower loads.	➢ Electricity consumption (kWh) ➢ Suction head (mm WC) ➢ Delivery head (mm WC) ➢ Fluid temperature (°C)	➢ **Peak Efficiency Range (%)** ○ Airfoil backward curved/inclined = 79% to 83% ○ Modified radial = 72% to 79% ○ Radial = 69% to 75% ○ Pressure blower = 58% to 68% ○ Forward curved = 60% to 65%

Areas	Best practices	Monitorable parameters	Key Parameters
Air Compressors	1. Consider variable speed drive for a variable load on positive displacement compressors. 2. Change the oil filter regularly. 3. Periodically inspect compressor intercoolers for proper functioning. 4. Study part-load characteristics and cycling costs to determine the most efficient mode for operating multiple air compressors. 5. Avoid oversizing -- match the connected load. 6. Reduce air compressor discharge pressure to the lowest acceptable setting. (Reduction of 1 kg/cm2 air pressure (8 kg/cm2 to 7 kg/cm2) would result in 9% input power savings. This will also reduce compressed air leakage rates by 10%) 7. Minimize purges, leaks, excessive pressure drops, and condensation accumulation. (Compressed air leak from 1 mm hole size at 7 kg/cm2 pressure would mean power loss equivalent to 0.5 kW) 8. Take air compressor intake air from the coolest (but not air-conditioned) location.	➢ Air pressure (kg/cm2) ➢ Inlet temperature (OC) ➢ Loading time (sec.) ➢ Unloading time (sec.) Electricity consumption (kWh)	➢ **Reciprocating:** ○ FAD Range (cfm) = 20 to 7000 ○ Pressure range (bar) = 0.8 to 12 ○ SPC range (kW/cfm) = 0.20 to 0.35 ➢ **Screw (Single stage):** ○ FAD Range (cfm) = 50 to 1500 ○ Pressure range (bar) = 0.8 to 13 ○ SPC range (kW/cfm) = 0.14 to 0.25 ➢ **Screw (Multistage):** ○ FAD Range (cfm) = 50 to 1500 ○ Pressure range (bar) = 0.8 to 24 ○ SPC range (kW/cfm) = 0.18 to 0.35
Cooling Tower	1. Control cooling tower fans based on leaving water temperatures. 2. Control to the optimum water temperature as determined from the cooling tower and chiller performance data. 3. Use two-speed or variable-speed drives for cooling tower fan control if the fans are few. Stage the cooling tower fans with on-off control if there are many. 4. Turn off unnecessary cooling tower fans when loads are reduced. 5. Periodically clean plugged cooling tower water distribution nozzles.	➢ Ambient dry bulb temperature (°C) ➢ Ambient wet bulb temperature (°C) ➢ Cooling water inlet temperature (°C) ➢ Cooling water outlet temperature (°C) ➢ Cooling duty water flow rate (m^3/hr.) ➢ Makeup water (m^3/day)	➢ Cycle of concentration (COC) should be maintained between 8 to 10. ➢ Approach should be maintained at 4 °C to 5 °C. ➢ Drift loss should be 0.001 % – 0.005 % of circulating flow rate

Areas	Best practices	Monitorable parameters	Key Parameters
	6. Replace splash bars with self-extinguishing PVC cellular-film fill. 7. Optimize cooling tower fan blade angle on a seasonal and/or load basis.		
Water System	1. Monitoring and optimizing water usage 2. Evaluation of water recirculation options 3. Balancing the degree of closure of water circuits and potential drawbacks; adding additional equipment if necessary 4. Reusing process water to substitute for freshwater (water recirculation and closing of water loops) 5. In-line treatment of (parts of) process water to improve water quality to allow for recirculation or reuse	➢ Fresh Water Consumption (m3/day) ➢ Water Recycling rate (m3/day) ➢ Water consumption per ton of production (m3/tonne of production)	➢ Water Recovery should be 80% and above. ➢ Specific water consumption RCF based mill Kraft: 1 to 3 m3/ton Writing Printing Newsprint/ Special Paper mills: 5-10 m3/ton

Annexure C – Strategies for Decarbonization & Circular Economy

Annexure C1 – RE Potential

Nearly 58% of the geographical area potentially represents the solar hotspots in the country. The Solar Radiation in India is around 300 days with 5.6 – 6 kWh/m2/day. There is a huge potential in the country for solar power due to the geographical location and terrain of the country. India aims to achieve 450 GW Renewable energy capacities by 2030, of which about 280 GW is expected to be solar energy. The various state government has launched Solar Policy for MSME units. The key point of the solar policy from Gujarat is mentioned below:

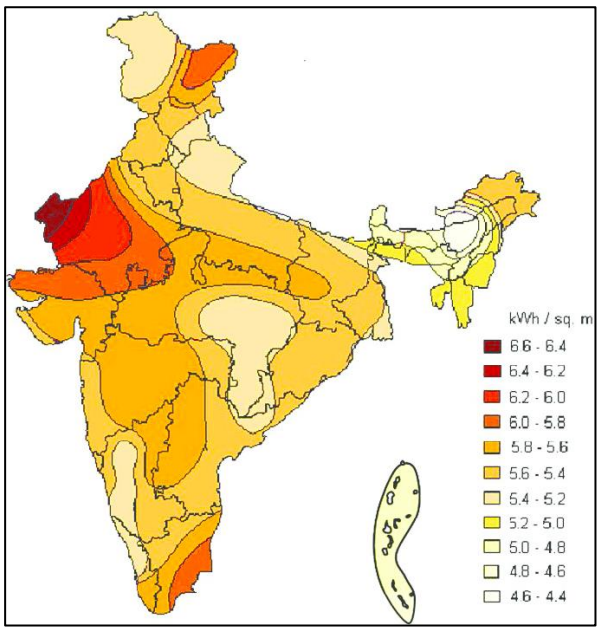


Figure 117: India solar radiation

- Existing ceiling of 50% of sanctioned load or contracted demand for setting up a solar project is removed.
- A group of consumers can set up solar projects for self-consumption as a collective ownership project and can consume the generated solar energy in the ratio of ownership.
- Security Deposits to be furnished by a developer to DISCOMs for PPA have been reduced from 25 lakh per MW to 5 lakh per MW.
- DISCOMs will install bi-directional energy meters to record the import and export of energy for consumers utilizing solar generation systems. Prosumers can choose to get a one-time payment of net energy exported at the end of the 12-month settlement period
- Benefits of the solar projects set up under this policy can be availed for a project life of 25 years.

The Papermill in the MSME clusters has annual electricity consumption of 277 million kWh which is currently being sourced from the DISCOMs. From energy audits, we have estimated solar rooftop potential of around 2,052 MW in the Paper cluster. The capacity of 120 MW of community-based solar park is required to cater 100% of the electricity requirement of the mills, which will incur an investment of ~ 8,207 INR Crore rupees. Solar power will be able to reduce 23% of CO_2 emissions from the paper cluster.

Table 23: RE Potential

Cluster name	Solar Potential (Solar Park) (MW)	Area Required for Solar Park Installation (km^2)[20]	Investment Required for Solar Park (INR Crore)	Emission Reduced (Million TCO2)	% Of reduction in emissions from the cluster
Vapi	206	3.3	743	0.23	20%
Morbi	349	5.6	1,287	0.39	16%

[20] Thumb rule used: For 150 MW solar park installation 2.4 km^2 area is required with 600 INR Crore Investment (Source: Link)

Cluster name	Solar Potential (Solar Park) (MW)	Area Required for Solar Park Installation (km^2)[20]	Investment Required for Solar Park (INR Crore)	Emission Reduced (Million TCO2)	% Of reduction in emissions from the cluster
Kashipur	268	4.3	1,034	0.30	52%
Muzaffarnagar-Saharanpur	122	1.9	461	0.13	21%
Erode-Coimbatore	177	2.8	694	0.20	35%
Paper Sector	2,052	33	8,207	2.27	23%

Annexure C2 – Fuel switch possibility from fossil-based fuel to electricity

The paper industry uses both thermal and electrical energy to produce paper. Steam is pivotal in the paper industry for the process of drying the paper, heating of chemicals, heating rollers, and cooking of wood chips in the digester (for large paper plants). The reason steam is used in paper processing is because of the uniform heating of rolls, steam carries ample heat and precision in steam temperature. To generate steam, steam boilers are required. steam boilers are highly efficient for generating steam and power for processing purposes. The generated steam is operated in an insulated, closed-loop system. Hence, steam boilers are efficient and reliable for the process industry's operations.

The Indian MSME paper plants are presently grappling with gradually reducing quantities of fossil fuel. They are undergoing the transition from fossil-based fuels to the use of biomass for their energy demand. Biomass fuels reduce dependency on fossil fuels and help to reduce greenhouse gases as they are carbon neutral. The current situation of biomass usage in the cluster and potential to replace coal (GHG emitting fuel) is shown below:

Table 24: Biofuel Potential

Cluster	Vapi	Morbi	Kashipur	Muzaffarnagar-Saharanpur	Erode-Coimbatore
Total GHG Emitting Fuel Usage (MT)	1,285,150	2,610,075	929,441	299,721	255,754
Total Biofuel Usage (MT)	-	-	142,863	609,502	129,306
Total GHG Emitting Fuel Usage (TOE)	221,329	343,618	100,000	151,629	30,908
Total Biofuel Usage (TOE)	-	-	5,238	52,798	29,163
Estimated demand of Biomass (@GCV – 3500 kCal/kg) to replace coal (MT)	632,368	981,765	285,714	433,225	88,308
Investment requirement to retrofit/replace the coal-based boiler to biomass boiler (INR Lakh)	20,140	23,612	1,021	521	2,587
GHG Emissions Savings (MT)	935,236	2,012,488	272,753	512,536	362,628
% GHG Emissions Savings in the Cluster	81%	84%	48%	79%	65%

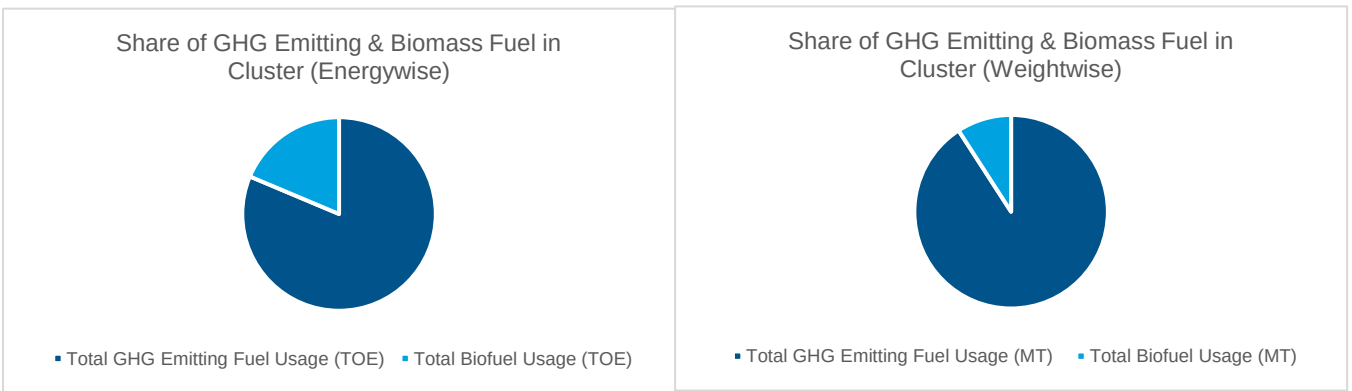


Figure 118: Share of GHG & Non-GHG Emitting Fuel

Apart from the potential use of biomass boiler, there is the potential to electrify the coal-based boiler. The comparison of a Steam boiler with an electric boiler is mentioned below -

Steam Boiler vs Electric Boiler

Table 25: Steam Boiler vs Electric Boiler

Details	Units	Typical plant with 20 TPD capacity	
		Fossil Fuel based Steam Boiler	Electric Boiler
Annual Fuel	Tonnes	2,860	
Fuel Cost	Rs./ton	4,314	
Fuel GCV	kCal/kg	5,299	
Thermal Energy	kCal	15,155,140,000	
	TOE	1,516	
Electrical Energy	kCal		15,155,140,000
	kW		17,622,256
Electricity charges	Rs. /kWh		7
Electrical boiler size	kW		2,448
Thermal cost (Annual)	Rs. Lakhs	12	
Electric boiler operational charges (Annual	Rs. Lakhs		123

If we compare the current scenario, the operating cost of an electric boiler is almost 10 times the cost of steam boilers. There will be an investment required too for switching to electric boilers, which is another constraint. Further, there is a boiler size constraint.

Table 26: Electric boilers size and model availability

Sr. No.	Company	Boiler Model	KW	Kg/hr. of Steam	Remarks
1	Hi-Therm Boilers	ES-54	54	84 Kg/hr. at 5 bar	Source
2	Hi-Therm Boilers	ESN-72	72	115 Kg/hr. at 5 bar	
3	Thermodyne Engineering Systems	Electra – Electrode Type		Up to 1320 Kg/hr.	Source
4	Maxima	ESB Series		Up to 200 kg/hr. at 7 kg/cm2 & 10.54 kg/cm2	Source
5	Cleaverbrooks	HSB	Up to 3.3 MW	Up to 17.5 kg/cm2	Source (International)

As can be seen from the above data, there is a size constraint for an electric boiler. The electric boiler of very small sizes (Indian technology supports up to 135 kW) has been installed in India in non-paper sectors. Also, the MSME paper plant requirement for an electric boiler is a minimum of 2-3 MW with a steam requirement of 5-6 TPH. In the present scenario, the best possibility is to completely switch from GHG emitting fuel to biomass-based fuel for the steam requirement. Therefore, it is recommended to shift from the coal-based steam boiler to electric in phases and consider as a long-term strategy for decarbonization of MSME paper plants.

Annexure D – Existing EE Policy initiatives and programs for the sector

Different schemes by the government bodies in the MSME units are given below:

Table 27: Financial Schemes by Government Bodies

Programs	Implementation Agency	Description	Nature of assistance	Source
Micro and Small Cluster Development Program	Ministry of MSME (Govt. of India)	To improve the competitiveness of MSME clusters by focusing on common problems. Primary focus on sustainability and growth of MSMEs by addressing common issues such as "access to technology", "skills and quality", "market access", "access to capital", etc.	**Common Facility Centers:** Grant up to 70% of total project cost (maximum INR 20 Cr)	Link
		Also targeting the capacity development, create/upgrade infrastructural facilities in industrial parks such as training centers, testing centers, effluent treatment plant, etc.	**Infrastructure Development:** Grant up to 60% of total project cost (maximum INR 10 Cr for Industrial estate & INR15 Cr for the flatted factory complex	
Credit linked Capital Subsidy Scheme (CLCSS) *(At present the Scheme is under revision and will be launched soon after obtaining the necessary approvals.)*	Ministry of MSME (Govt. of India)	The primary objective of this scheme is to aid the technology up-gradation of micro and small enterprises, especially in rural and semi-urban areas. Industries that are transforming from small-scale to medium-scale due to the sanction of additional loans under the CLCSS are also eligible for the subsidy.	Businesses can avail of up to 15% subsidy (with a maximum limit of up to Rs. 1 crore) on investment in eligible machinery.	Link
			The subsidy of 15% is available only to businesses that have invested in eligible plant machinery by using term loans borrowed from the pre-approved list of PLIs (Public Lending Institutions).	
Credit Guarantee Fund Trust	Ministry of MSME (Govt. of India) and Small Industrial Development Bank of India (SIDBI)	Scheme is jointly promoted by MoMSME and SIDBI. Trust fund created is to implement "Credit Guarantee Scheme" for providing collateral-free loan up to a limit of INR 200 lakh to individual MSME on payment of a guaranteed	Credit Guarantee Scheme for providing collateral-free loan up to a limit of INR 200 lakh to individual MSME	Link

Programs	Implementation Agency	Description	Nature of assistance	Source
		fee to the bank by the MSME.		
		The corpus of CGTMSE is contributed by the Government of India and SIDBI. Max up to 85% of the loan amount to the bank is guaranteed by the Trust Fund.		
Scheme of Micro Finance Programme	The Development Commissioner of Small-Scale Industries (SSIs) under the Ministry of MSME	SIDBI offers micro-credit facilities to MSMEs who are engaged in industrial activities. These credit facilities are offered through Micro Finance Institutions (MFIs) or (NGOs). MFIs/NGOs source funds from SIDBI and make the funds available to MSMEs for their commercial needs.	The Government of India provides funds for Micro-Finance Programme to SIDBI, which is called the 'Portfolio Risk Fund' (PRF). At present, SIDBI takes a fixed deposit equal to 10% of the loan amount. The share of MFIs/NGOs is 2.5% of the loan amount and the balance of 7.5% is adjusted from the funds provided by the Government of India.	Link
Energy Efficiency in Small and Medium Enterprises (SMEs) sector	Bureau of Energy Efficiency (BEE)	To improve the energy efficiency of the SME sector in India through accelerating adoption of energy efficient technologies, knowledge sharing, capacity building, and development of financial innovative financial mechanisms.	Following are the key activities under implementation – a) Technical Assistance and Capacity Building of energy-intensive SME sectors. b) Promoting Energy Efficiency and Technology Upgradation in SMEs through the ESCO route. c) Energy mapping of SME clusters on pan India basis	Link
Promoting Energy Efficiency and Renewable Energy in MSMEs in India (GEF – UNIDO – BEE Project)	Bureau of Energy Efficiency (BEE)	The project "Promoting Energy Efficiency and Renewable Energy in MSMEs in India" aims towards developing and promotion of market environment for introducing energy-efficient technologies and enhancing the use of renewable energy technologies in process applications in energy-intensive MSMEs in 5 sectors (brass, ceramics,	Implementation of more than 50 energy-efficient technologies as pilot projects. Around Rs. 1 Crore has been sanctioned as a grant for the implementation of the pilot projects. The project has so far achieved annual energy savings of more than 8500 TOE with Annual monetary savings of 3802 Lakhs rupees. Implemented 17 demo projects in 7 clusters with the	Link

Programs	Implementation Agency	Description	Nature of assistance	Source
		dairy, foundry, and hand tools). The project further has scaled up the activities to the national level (in 12 Clusters) to reduce energy usage per unit of product, improve the productivity and competitiveness of units, thereby reducing overall carbon emissions and improving the local environment	financial assistance of INR 87.9 Lakhs.	
Financing of Energy Efficiency at MSME (GEF – WB – BEE Project)	Bureau of Energy Efficiency (BEE)	To increase demand for energy efficiency investments in target micro, small and medium enterprise clusters and to build their capacity to access commercial finance. The project is being implemented in two phases and more than 20 clusters in India	Annual Energy savings of 25000 TOE with an average ROI of 18 months has been achieved under this project so far. Three Hundred Fifty (350) energy-saving measures were identified during the implementation of ISO – 50001. Thus, an annual saving of INR 900 Lakhs was estimated. Approximately, 330 crores rupees of investment were made by participating MSMEs to implement 3000 energy efficiency measures.	Link
Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE)	Bureau of Energy Efficiency (BEE)	The Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE) is a risk-sharing mechanism to provide commercial banks with partial coverage of risk involved in extending loans for energy efficiency projects. The Government of India has approved around INR 312 crores for PRGFEE.	BEE will select a Public Financial Institution as the Implementing Agency (IA) for implementing all the activities under PRGFEE. The PFI will take a guarantee from the PRGFEE before disbursement of the loan to the borrower. The Guarantee will not exceed INR 300 lakhs per project (proposed to increase up to INR 1,500 lakhs) or 50% of the loan amount, whichever is less	Link
ZED Certification Scheme for SME	Ministry of MSME (Govt. of India)	ZED Certification scheme that supports Micro, Small, and Medium Enterprises (MSMEs) to achieve Zero Defect and Zero Effect (ZED) manufacturing. It also provides ZED Assessment for certification which	The subsidies provided by the government under this scheme are as follows: • Micro enterprises: 80% • Small enterprises: 60%	Link

Programs	Implementation Agency	Description	Nature of assistance	Source
		promotes the manufacturing of world-class quality products. This scheme supports the 'Make in India' campaign. It is financed by the Government of India and falls under the Ministry of Micro, Small, and Medium Enterprises.	• Medium enterprises: 50% • An additional subsidy of 5% is provided to MSMEs that are owned by women in the SC/ST category. • An additional subsidy of 5% is provided to MSMEs located in northeast India and J&K.	

Different schemes by the financial institutions to uptake the energy efficiency in the MSME units is given below:

Table 28: Financial Schemes by Financial Institutions/Banks

Schemes	FIs/Bank	Purpose	Eligible Borrower	Interest rate	Loan Amount and Tenure	For more information
Timely Working Capital Assistance to Revitalise Industries in Times of Corona Crisis (TWARIT)	Small Industrial Development Bank of India (SIDBI),	The objective of the scheme (ECLGS) is to provide needed relief to MSMEs, whose operations are impacted by COVID - 19	All existing borrower accounts including under Credit Delivery Arrangement with combined outstanding credit facilities up to ₹25 crores as on 29.2.2020, and an annual turnover of up to ₹100 crores for FY 2019-20 are eligible under the Scheme	Uniform rate of 8.25% p.a. with annual reset	Up to 20% of total outstanding loans with SIDBI up to ₹25 crores as on February 29, 2020, with cap exposure of ₹5 crores or as modified by Govt of India / NCGTC, subject to borrower meeting all the eligibility criteria.	Link
			The Scheme is valid for existing customers on the books of the Bank. All borrowers which have not been classified as SMA 2 or NPA by any of the Member Lending Institutions as on 29th February 2020 will be eligible for the Scheme		Tenure - 4 years (moratorium of 1 year + repayment of principal in 3 years)	
SIDBI Assistance to Facilitate Emergency Response Against	Small Industrial Development Bank of India (SIDBI)	To meet emergency / additional working capital requirement of all existing MSMEs having confirmed	For New to Bank customer - At least two years of cash profits and account not in SMA1/2 category	5% p.a. fixed on reducing balance basis	Maximum up to ₹100 Lakh (linked to turnover of the unit)	Link

Schemes	FIs/Bank	Purpose	Eligible Borrower	Interest rate	Loan Amount and Tenure	For more information
Corona Virus – Plus (SAFE PLUS)		order(s) from Central/ State Govt./ Govt. agencies nominated for the purpose and who are manufacturing any products or providing any services directly related to fighting Corona Virus (Covid-19)	For existing Bank customers - Cash profit in last audited balance sheet and account not in SMA1/2 category		Tenure: Revolving WCTL - Repayable over 4-month cycle based on execution schedule of govt orders i.e. each drawal against each order to be repaid gradually over a period of 4 months and payment may be made anytime during these 4 months	
Financing End to End Energy Efficiency Investments in MSMEs (4E Financing Scheme)	Small Industrial Development Bank of India (SIDBI)	For implementing Energy Efficiency measures on an end-to-end basis. For meeting the part cost of	MSME units in the manufacturing or services sector.	9.25% to 10% p.a.	Up to 90% of Project cost	Link
		i. capital expenditure for the purchase of equipment/ machinery, installation, civil works, commissioning, etc. (Energy Efficiency measures as recommended in DPR),	Applicant unit should be in operation for at least three years and should have earned cash profit in the last two years of operation and should not be in default to any bank/FI.		Loan amount INR 10 – 150 lakhs	
		ii. Any other related expenditure required by unit, provided it is not more than 50% of (i).			Repayment period (incl. moratorium period of up to 6 months) shall not be	

Schemes	FIs/Bank	Purpose	Eligible Borrower	Interest rate	Loan Amount and Tenure	For more information
		Financing of second-hand machinery/equipment; purchase of land and construction of a building (except minor civil works) shall not be taken up under the scheme.			more than 36 months for loans up to INR 50 lakh and 60 months for loans beyond INR 50 lakh	
SIDBI – Loan for Purchase of Equipment for Enterprise's Development Plus (Speed Plus)	Small Industrial Development Bank of India (SIDBI)	Machinery purchased from identified OEMs manufacturing high-end machines or authorized dealers / Indian subsidiaries of such foreign OEMs, which have a strong brand reputation and with whom SIDBI has entered into an MoU	MSME units with at least 5 years of operations with stable sales and cash profits in the immediate past 3 years.	9.25% to 10% p.a.	Up to 100% financing	Link
		For Existing Customer: Any OEM	Minimum net sales of ₹ 5 crores and no operating loss in the immediate past two years		2 to 5 years including a moratorium of 3-6 months.	
		Proposed machinery should relate to the same line of business				
SIDBI Term-Loan Assistance for Rooftop Solar Pv Plants (Star)	Small Industrial Development Bank of India (SIDBI)	Financing for Solar Panels / Equipment (Including all accessories) from established suppliers, manufacturers, aggregators, etc.	Age of unit: New – 4 years, Existing – 2 years	9.10% to 10.20% p.a.	Up to 100% financing	Link
			2 years cash profits & satisfactory repayment track record		Repayment up to 5 years (including moratorium of 3 to 6 months)	
			Proposed Solar rooftop capacity not to exceed the connected load			
			Only On-site projects			

Schemes	FIs/Bank	Purpose	Eligible Borrower	Interest rate	Loan Amount and Tenure	For more information
			Stand-alone and Grid-connected, both covered			
SIDBI Make in India Soft Loan Fund for Micro Small and Medium Enterprises (Smile)	Small Industrial Development Bank of India (SIDBI)	To support the MSME enterprises in the manufacturing as well as services sector undertaking expansion, to take advantage of new emerging opportunities, as also undertaking modernization, technology upgradation, or other projects for growing their business	Covering new enterprises in the manufacturing as well as services sector. Existing enterprises undertaking expansion, to take advantage of new emerging opportunities, as also undertaking modernization, technology up-gradation, or other projects for growing their business	Attractive Interest Rates starting from 8.36% onwards (subject to change)	Quantum of assistance: Minimum Loan Size - ₹ 10 lakh for Equipment Finance & Others: ₹ 25 lakh Tenure and moratorium: Repayment period up to 10 years and moratorium of up to 36 months Minimum Promoter Contribution of 15% subject to Maximum DER of 3:1	Link
Energy Savings for Micro, Small & Medium Enterprises	Canara Bank	To support the MSME enterprises for acquiring/ adopting energy conservation/savings equipment	Units under Small and Medium Enterprises Cost of energy for the unit should constitute not less than 20% of the total cost of production Unit should possess energy audit report issued by an approved energy Consultant/Auditor	Attractive Interest Rates	Maximum Rs 100 lakhs in the form of Term loan Tenure and moratorium: Repayment period up to 5-7 years and moratorium of up to 6 months Margin: 10% of the project cost	Link

Schemes	FIs/Bank	Purpose	Eligible Borrower	Interest rate	Loan Amount and Tenure	For more information
Scheme for Financing Energy Efficiency Projects	Bank of Baroda	Financing SMEs for the acquisition of equipment, services and adopting measures for enhancement of energy efficiency/conservation of energy.	Units under Small and Medium Enterprises	Base rate plus 4.00% p.a	Up to 75% of the total project cost, subject to a maximum of Rs. 1/- crore. (Minimum amount of loan Rs. 5/- Lakhs). IRDEA, at present, gives a grant of Rs. 25,000/- for projects costing Rs. 1/- crore or below to meet the partial cost of Energy Audit. This grant is available for the first 100 projects (SME Sectors only) approved by them. Maximum 5 years, including moratorium, if any.	Link
SBI - Project Uptech	State Bank of India	To provide financial assistance to the MSME for technology upgradation e.g., productivity improvement aids, quality control, testing equipment, special purpose machines, low-cost automation, computers, product	MSME units with Investment in Plant & Machinery up to Rs 10 Crores	SBI Prime lending rates	Medium Term Loan Quantum: 90% of the project cost subject to a Maximum of 1 Crore and a Minimum of Rs.2 Lacs. Tenure: 5-7 years including a moratorium period of 12 months.	Link

Schemes	FIs/Bank	Purpose	Eligible Borrower	Interest rate	Loan Amount and Tenure	For more information
		development, consultancy, etc.				

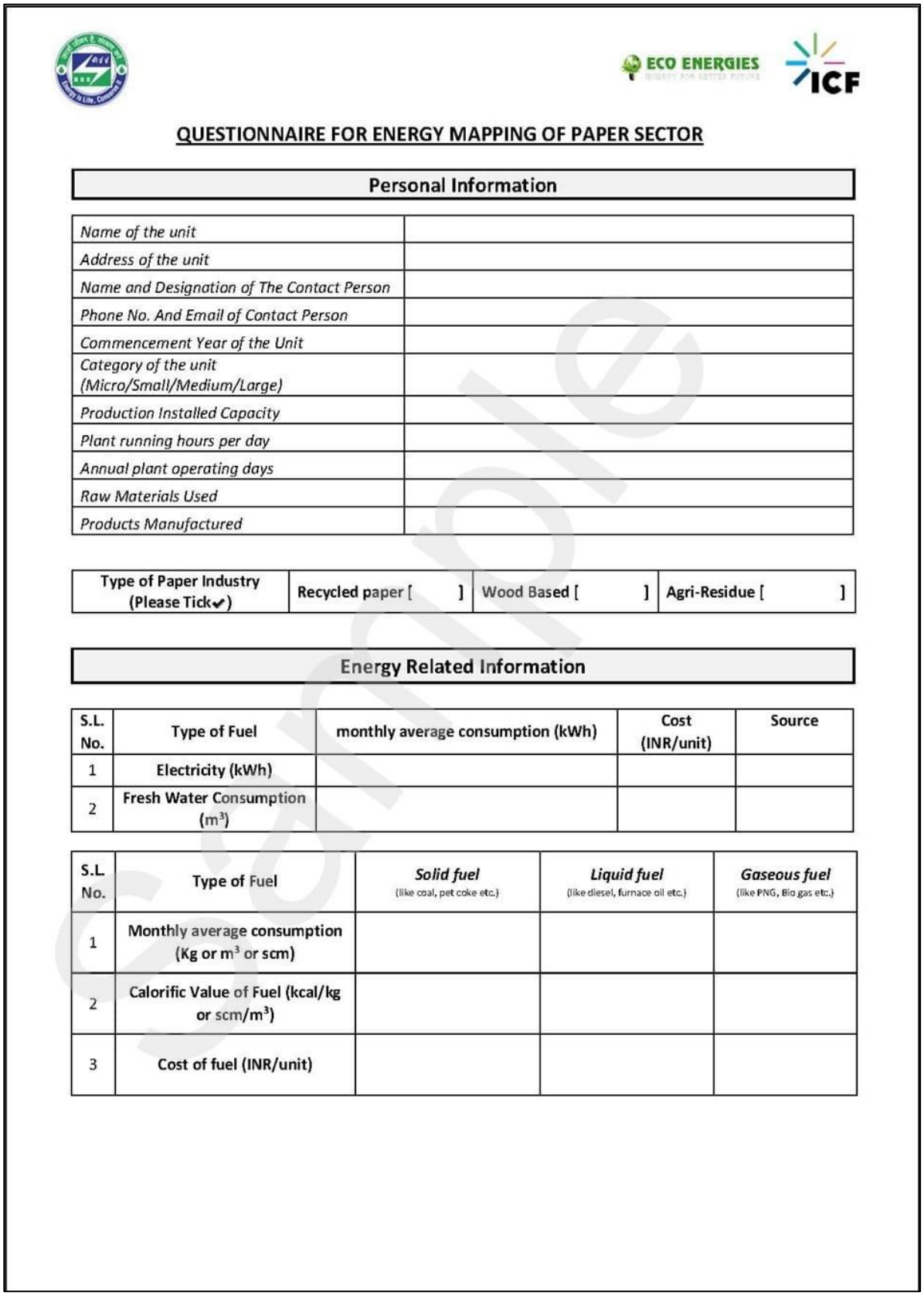
Different schemes run by the Ministry of Micro Small and Medium Enterprises for the MSME units are given below:

Table 29: Schemes run by Ministry of Micro Small and Medium Enterprises

Programs	Implementation Agency	Description	Nature of assistance	For more information
Lean Manufacturing Competitiveness Scheme	The Government of India (GoI)	The Government of India (GoI) has upscaled the Lean Manufacturing Competitiveness Scheme (LMCS) for Micro, Small, and Medium Enterprises (MSMEs) to reduce waste in the manufacturing process and improve global competitiveness in the MSME sector.	Lean Management consultants will work with the specially formed team Special Purpose Vehicle (SPV)/Distinct Product Group (DPG) for Lean Management in the unit for 18 months.	Link
			The 80% of hiring cost of LMC is reimbursed through NMIUs to SPVs/Units and 20% of the cost has to be borne by the SPVs/units	
Technology and Quality Upgradation Support to MSMEs	NMCP (National Manufacturing Competitiveness Program) along with GOI	The scheme advocates the use of energy-efficient technologies (EETs) in manufacturing units to reduce the cost of production and adopt a clean development mechanism.	Funding support of up to 75% for awareness programs, subject to a maximum of Rs 75,000 per program;	Link
			Implementation of energy-efficient technologies in MSME units 75% of actual expenditure for cluster-level energy audit and preparation of model DPR;	
			Setting up of Carbon Credit Aggregation Centres. 50% of actual expenditure subject to maximum Rs 1.5 lakh per DPR	
			25% of the project cost as subsidy by the Government of India, balance amount to be funded through a loan from SIDBI/banks/ financial Institutions.	
			75% subsidy towards licensing of products to national/ international standards: up to 1.5 lakh for national and up to 2 lakh for international standard	

Annexure E – Miscellaneous

Annexure E1 – Survey Questionnaire



ECO ENERGIES

ICF

QUESTIONNAIRE FOR ENERGY MAPPING OF PAPER SECTOR

Personal Information

Name of the unit	
Address of the unit	
Name and Designation of The Contact Person	
Phone No. And Email of Contact Person	
Commencement Year of the Unit	
Category of the unit (Micro/Small/Medium/Large)	
Production Installed Capacity	
Plant running hours per day	
Annual plant operating days	
Raw Materials Used	
Products Manufactured	

Type of Paper Industry (Please Tick✔)	**Recycled paper [ ]**	**Wood Based [ ]**	**Agri-Residue [ ]**

Energy Related Information

S.L. No.	Type of Fuel	monthly average consumption (kWh)	Cost (INR/unit)	Source
1	Electricity (kWh)			
2	Fresh Water Consumption (m^3)			

S.L. No.	Type of Fuel	*Solid fuel* (like coal, pet coke etc.)	*Liquid fuel* (like diesel, furnace oil etc.)	*Gaseous fuel* (like PNG, Bio gas etc.)
1	Monthly average consumption (Kg or m^3 or scm)			
2	Calorific Value of Fuel (kcal/kg or scm/m^3)			
3	Cost of fuel (INR/unit)			

Production Related Information

S.L. No.	Product Name	Monthly average production (tonnes)
1		
2		
3		
4		

Other information

Type of Pulping (Chemical/mechanical/semi):

Type of Paper Machine:

Water discharge (ZLD/ETP):

Chemical recovery:

Captive Power Plant (If yes, Capacity in MW):

Electricity generation through Captive Power Plant (Monthly kWh):

Import/export of Pulp:

Process Flow Diagram

:

Figure 119: Survey Questionnaire

Annexure E2 – Project Flyer

Figure 120: Project Flyer

Annexure E3 – Sample Agenda

Bureau of Energy Efficiency
Ministry of Power, Government of India

ICF

NATIONAL LEVEL STAKEHOLDER CONSULTATION WORKSHOP "ENERGY AND RESOURCE MAPPING OF MSME CLUSTERS IN INDIA" PAPER SECTOR

EAST & WEST GODAVARI CLUSTER

Background

The Micro, Small and Medium Enterprises (MSME) sector contributes significantly to the economic and social development of the country by fostering entrepreneurship and generating largest employment opportunities. The operation of the MSME units accounts for a sizeable portion of energy in its manufacturing costs. Majority of the units are operating on obsolete and low efficiency technology. To address this issue the Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India has initiated an ambitious project of mapping the energy intensive MSME sub-sectors across the country.

The Paper sector is among the other energy intensive MSME sub-sectors covered under the project. The BEE has entrusted ICF to undertake the study in the Paper sector. In this regard, workshops have been conducted in Muzaffarnagar-Saharanpur, Kashipur, Morbi, Vapi & Erode-Coimbatore to take feedback on policy support required from various stakeholders. ICF is organizing a national level stakeholder consultation workshop for the Paper units in the west and east Godavari region.

Objective

ICF has done a holistic study regarding energy and resource mapping in selected Paper clusters of the country. Based on this study, ICF has prepared a draft of the policy roadmap for the Paper sector MSMEs. The objective of the webinar is to interact closely with the industries and associations on the identified energy efficiency interventions, understand the challenges the units are facing in advancing towards the low carbon operations and discuss on different policy support required to make the sector energy & resource efficient and environment friendly.

Bureau of Energy Efficiency
Ministry of Power, Government of India

ICF

Date: 24/11/2021 Wednesday

Rajahmundry, West-East Godavari

AGENDA

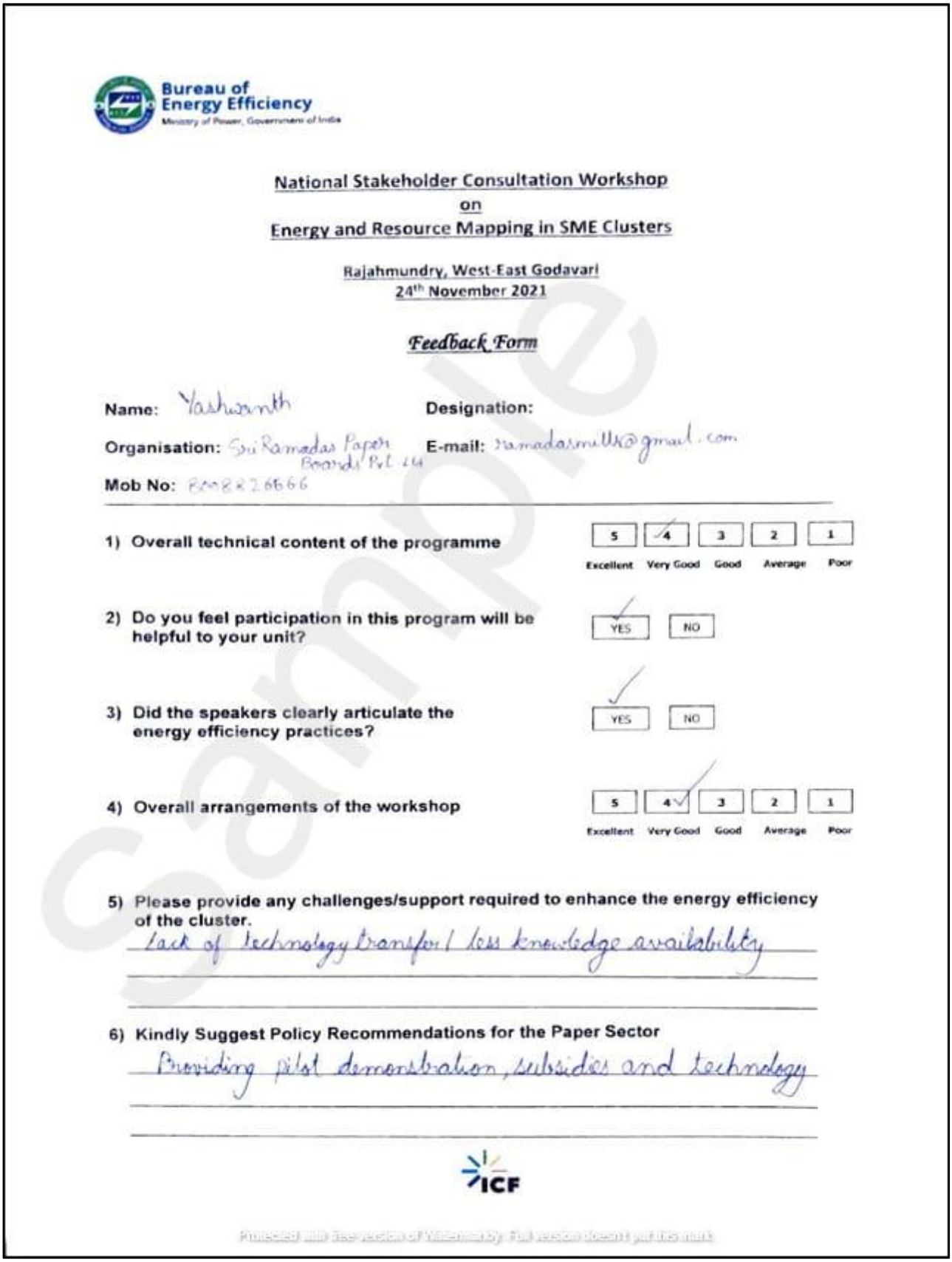
Session	
14:30 – 15:00 HRS	**REGISTRATION OF PARTICIPANTS**
15:00 – 15:20 HRS	**INTRODUCTORY REMARKS** • Shri. R. Rajendran, President, A.P. Recycled Paper Mills Association • Representative from MSME-DI
15:20 – 15:40 HRS	**SETTING THE CONTEXT** • Shri. Milind Deore, Director, Bureau of Energy Efficiency (BEE), Ministry of Power • Shri. A. Chandrasekhar Reddy, CEO, Andhra Pradesh State Energy Conservation Mission (APSECM)
15:40 – 16:10 HRS	**Project Overview (ICF)** • Project Introduction • Sectoral profile and key findings • Case Studies • Policy Interventions
16:10 – 17:10 HRS	**Views on energy efficiency and policy suggestions** • Dr. Sanjay Tyagi, Scientist, Central Paper and Pulp Research Institute (CPPRI) • Representative from Indian Agro & Recycled Paper Mills Association (IRPMA) • Mr. Rohit Pandit, Secretory General, Indian Paper Manufacturers Association (IPMA) • Shri. Kasi Vishwanath, MD, Seshasayee Paper & Boards • Shri. Thiru V Mohan. General Manager (Energy), Tamil Nadu Newsprint and Papers Ltd. • Shri, Ashish Gupta, President, Emami Paper Mills Ltd.
17:10 – 17:40 HRS	**Cutting Edge Technologies by technology providers** • Harmit Singh, Group Head Business Development, Kessels Engineering Works Pvt. Ltd. • Representative from Industrial Boilers Limited (IBL)
17:40 – 18:00 HRS	**Open house for Discussion (Q&A)**
18:00 HRS	**Closing remarks and Vote of thanks.**
	Networking & Dinner

Conducted By
ICF Consulting India Pvt. Ltd.

Supported By
Bureau of Energy Efficiency, Ministry of Power

Figure 121: Sample Agenda

Annexure E4 – Sample Feedback Form



Bureau of Energy Efficiency
Ministry of Power, Government of India

National Stakeholder Consultation Workshop
on
Energy and Resource Mapping in SME Clusters

Rajahmundry, West-East Godavari
24th November 2021

Feedback Form

Name: Yashwanth **Designation:**

Organisation: Sri Ramadas Paper Boards Pvt Ltd **E-mail:** ramadasmills@gmail.com

Mob No: 8008226666

1) **Overall technical content of the programme**

5	4 ✓	3	2	1
Excellent	Very Good	Good	Average	Poor

2) **Do you feel participation in this program will be helpful to your unit?**

YES ✓	NO

3) **Did the speakers clearly articulate the energy efficiency practices?**

YES ✓	NO

4) **Overall arrangements of the workshop**

5	4 ✓	3	2	1
Excellent	Very Good	Good	Average	Poor

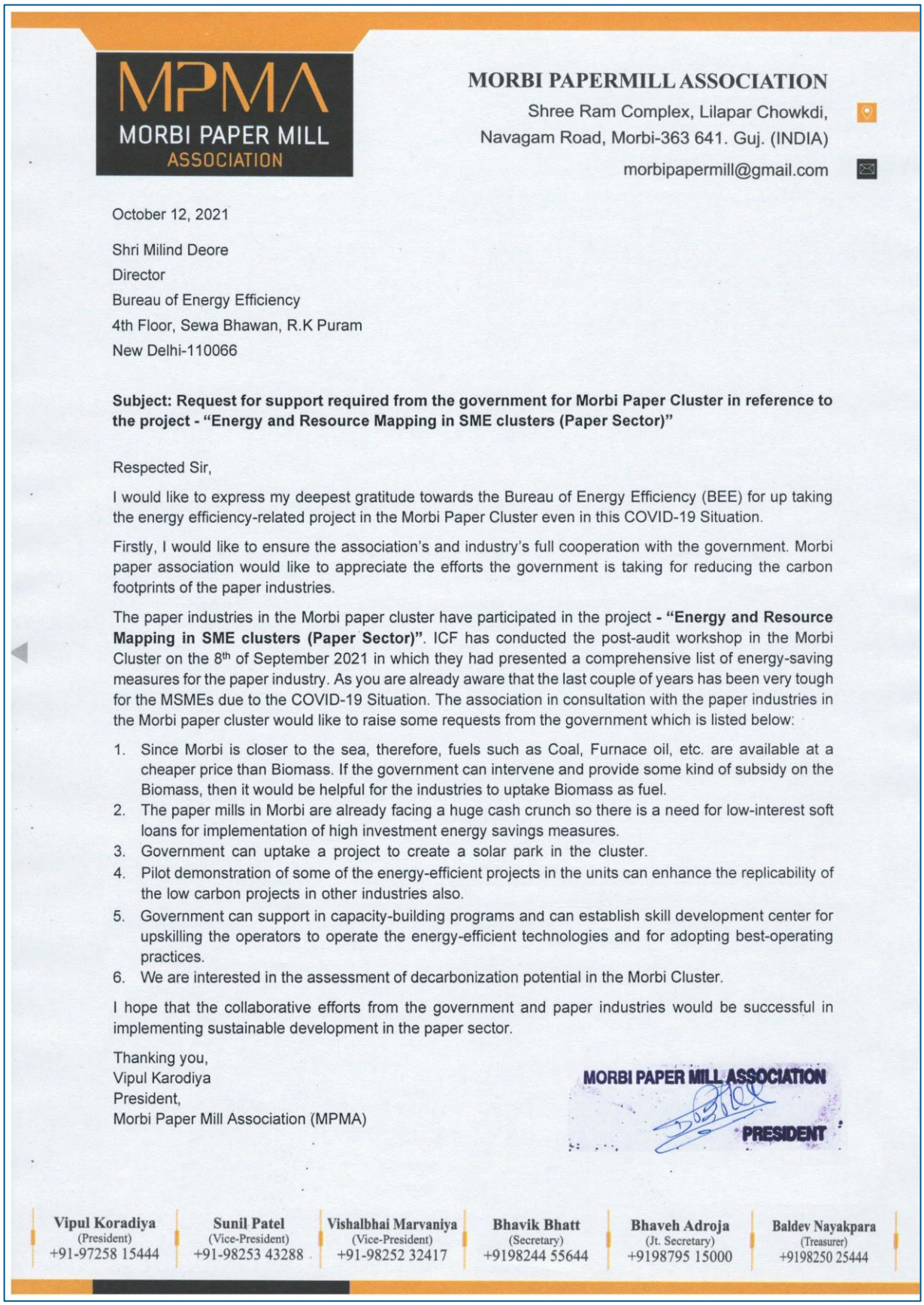
5) **Please provide any challenges/support required to enhance the energy efficiency of the cluster.**
Lack of technology transfer / less knowledge availability

6) **Kindly Suggest Policy Recommendations for the Paper Sector**
Providing pilot demonstration, subsides and technology

ICF

Figure 122: Sample Feedback Form

Annexure E5 – Support Letter from Paper Association



MPMA
MORBI PAPER MILL ASSOCIATION

MORBI PAPERMILL ASSOCIATION
Shree Ram Complex, Lilapar Chowkdi,
Navagam Road, Morbi-363 641. Guj. (INDIA)
morbipapermill@gmail.com

October 12, 2021

Shri Milind Deore
Director
Bureau of Energy Efficiency
4th Floor, Sewa Bhawan, R.K Puram
New Delhi-110066

Subject: Request for support required from the government for Morbi Paper Cluster in reference to the project - "Energy and Resource Mapping in SME clusters (Paper Sector)"

Respected Sir,

I would like to express my deepest gratitude towards the Bureau of Energy Efficiency (BEE) for up taking the energy efficiency-related project in the Morbi Paper Cluster even in this COVID-19 Situation.

Firstly, I would like to ensure the association's and industry's full cooperation with the government. Morbi paper association would like to appreciate the efforts the government is taking for reducing the carbon footprints of the paper industries.

The paper industries in the Morbi paper cluster have participated in the project **- "Energy and Resource Mapping in SME clusters (Paper Sector)"**. ICF has conducted the post-audit workshop in the Morbi Cluster on the 8th of September 2021 in which they had presented a comprehensive list of energy-saving measures for the paper industry. As you are already aware that the last couple of years has been very tough for the MSMEs due to the COVID-19 Situation. The association in consultation with the paper industries in the Morbi paper cluster would like to raise some requests from the government which is listed below:

1. Since Morbi is closer to the sea, therefore, fuels such as Coal, Furnace oil, etc. are available at a cheaper price than Biomass. If the government can intervene and provide some kind of subsidy on the Biomass, then it would be helpful for the industries to uptake Biomass as fuel.
2. The paper mills in Morbi are already facing a huge cash crunch so there is a need for low-interest soft loans for implementation of high investment energy savings measures.
3. Government can uptake a project to create a solar park in the cluster.
4. Pilot demonstration of some of the energy-efficient projects in the units can enhance the replicability of the low carbon projects in other industries also.
5. Government can support in capacity-building programs and can establish skill development center for upskilling the operators to operate the energy-efficient technologies and for adopting best-operating practices.
6. We are interested in the assessment of decarbonization potential in the Morbi Cluster.

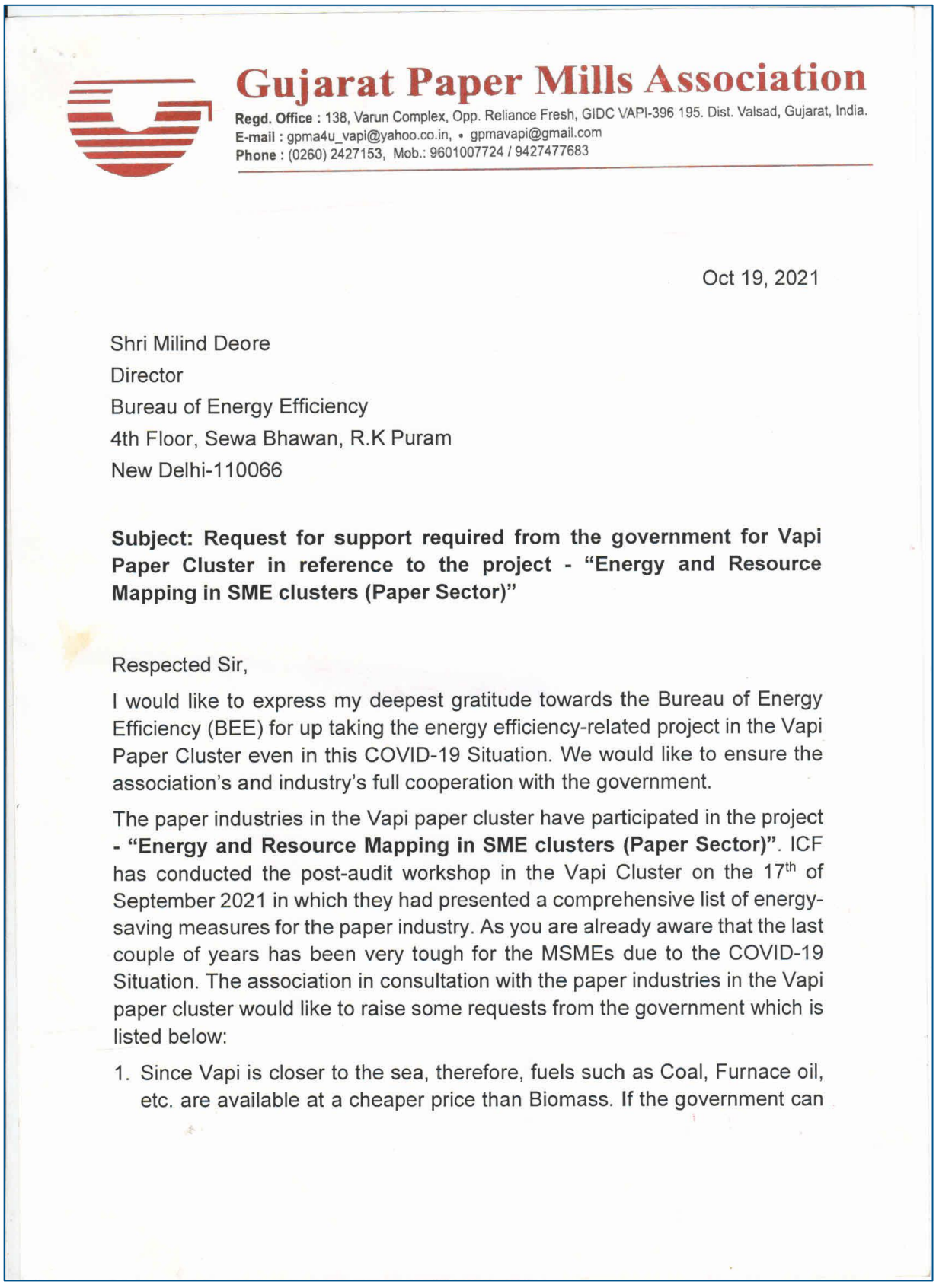
I hope that the collaborative efforts from the government and paper industries would be successful in implementing sustainable development in the paper sector.

Thanking you,
Vipul Karodiya
President,
Morbi Paper Mill Association (MPMA)

MORBI PAPER MILL ASSOCIATION
PRESIDENT

Vipul Koradiya	Sunil Patel	Vishalbhai Marvaniya	Bhavik Bhatt	Bhaveh Adroja	Baldev Nayakpara
(President)	(Vice-President)	(Vice-President)	(Secretary)	(Jt. Secretary)	(Treasurer)
+91-97258 15444	+91-98253 43288	+91-98252 32417	+9198244 55644	+9198795 15000	+9198250 25444

Figure 123: Letter from Morbi Paper Mill Association



Gujarat Paper Mills Association

Regd. Office : 138, Varun Complex, Opp. Reliance Fresh, GIDC VAPI-396 195. Dist. Valsad, Gujarat, India.
E-mail : gpma4u_vapi@yahoo.co.in, • gpmavapi@gmail.com
Phone : (0260) 2427153, Mob.: 9601007724 / 9427477683

Oct 19, 2021

Shri Milind Deore
Director
Bureau of Energy Efficiency
4th Floor, Sewa Bhawan, R.K Puram
New Delhi-110066

Subject: Request for support required from the government for Vapi Paper Cluster in reference to the project - "Energy and Resource Mapping in SME clusters (Paper Sector)"

Respected Sir,

I would like to express my deepest gratitude towards the Bureau of Energy Efficiency (BEE) for up taking the energy efficiency-related project in the Vapi Paper Cluster even in this COVID-19 Situation. We would like to ensure the association's and industry's full cooperation with the government.

The paper industries in the Vapi paper cluster have participated in the project **- "Energy and Resource Mapping in SME clusters (Paper Sector)"**. ICF has conducted the post-audit workshop in the Vapi Cluster on the 17th of September 2021 in which they had presented a comprehensive list of energy-saving measures for the paper industry. As you are already aware that the last couple of years has been very tough for the MSMEs due to the COVID-19 Situation. The association in consultation with the paper industries in the Vapi paper cluster would like to raise some requests from the government which is listed below:

1. Since Vapi is closer to the sea, therefore, fuels such as Coal, Furnace oil, etc. are available at a cheaper price than Biomass. If the government can

Figure 124: Letter from Vapi Paper Mill Association

Gujarat Paper Mills Association

Regd. Office : 138, Varun Complex, Opp. Reliance Fresh, GIDC VAPI-396 195. Dist. Valsad, Gujarat, India.
E-mail : gpma4u_vapi@yahoo.co.in, • gpmavapi@gmail.com
Phone : (0260) 2427153, Mob.: 9601007724 / 9427477683

intervene and provide some kind of subsidy on the Biomass, then it would be helpful for the industries to uptake Biomass as fuel.

2. The paper mills in Vapi are already facing a huge cash crunch so there is a need for low-interest soft loans for implementation of high investment energy savings measures.
3. Government can uptake a project to create a solar park in the cluster. ***(Required estimated capacity 10 MW to 30 MW)***
4. Pilot demonstration of some of the energy-efficient projects in the units can enhance the replicability of the low carbon projects in other industries also.***)***
5. Government can support in capacity-building programs and can establish skill development center for upskilling the operators to operate the energy-efficient technologies and for adopting best-operating practices.

I hope that the collaborative efforts from the government and paper industries would be successful in implementing sustainable development in the paper sector.

Thanking you,

For Gujarat Paper Mill Association

for Sunil Agarwal
President

Figure 125: Letter from Gujarat Paper Mill Association

Annexure E6 – Major Stakeholders in Various Clusters

Muzaffarnagar-Saharanpur Major Stakeholders

Association name	Contact details
Indian Paper Manufacturers Association (IPMA)	Mr. A.S Mehta President, IPMA, 3rd Floor, PHD House, 4/2 Siri Institutional Area New Delhi – 110 016 (India)
Indian Agro & Recycled Paper Mills Association (IARPMA)	Mr. Pramod Agarwal President, IARPMA 404, Vikrant Tower, 4 Rajendra Place New Delhi – 110008, INDIA
Indian Pulp & Paper Technical Association	Mr. Sanjay K. Singh President, IPPTA CPPRI Campus, Paper Mill Road Near Himmat Nagar Saharanpur
UP Paper Mill Association	Mr. Pankaj Agarwal President, 9837022374 179, Patel Nagar, New Mandi, Muzaffarnagar, 251001 Email: bindlas@usa.com

Kashipur Major Stakeholders

Association name	Contact details
Indian Paper Manufacturers Association (IPMA)	Mr. A.S Mehta President, IPMA, 3rd Floor, PHD House, 4/2 Siri Institutional Area New Delhi – 110016
Indian Agro & Recycled Paper Mills Association (IARPMA)	Mr. Pramod Agarwal President, IARPMA 404, Vikrant Tower, 4 Rajendra Place New Delhi – 110008, India
Indian Pulp & Paper Technical Association	Mr. Sanjay K. Singh President, IPPTA CPPRI Campus, Paper Mill Road Near Himmat Nagar Saharanpur, Uttar Pradesh
Indian Newsprint Manufacturers Association (INMA)	Mr. Rahul Khanna 57, Panchkuian Road (Opp. Metro Pillar No. 6), New Delhi – 110001 info@inma.org.in, sg@inma.org.in
Paper Units Chapter - Kumaon Garhwal Chamber of Commerce and Industry	Mr. Pawan Agarwal President, 9837048885 Naini Tissues, Moradabad Rd, Kashipur, Uttarakhand 244713 Email: pawan@nainigroup.com

Vapi Major Stakeholders

Association name	Contact details
Indian Paper Manufacturers Association (IPMA)	Mr. A.S Mehta President, IPMA, 3rd Floor, PHD House, 4/2 Siri Institutional Area New Delhi – 110016
Indian Agro & Recycled Paper Mills Association (IARPMA)	Mr. Pramod Agarwal President, IARPMA 404, Vikrant Tower, 4 Rajendra Place New Delhi – 110008, India
Indian Pulp & Paper Technical Association	Mr. Sanjay K. Singh President, IPPTA CPPRI Campus, Paper Mill Road Near Himmat Nagar Saharanpur, Uttar Pradesh
Indian Newsprint Manufacturers Association (INMA)	Mr. Rahul Khanna President, INMA, 57, Panchkuian Road (Opp. Metro Pillar No. 6), New Delhi – 110001 info@inma.org.in, sg@inma.org.in
Gujarat Paper Mill Association, Vapi	Mr. Sunil Agarwal President, Varun Complex, 135, Gunjan Rd, Near Reliance Super, GIDC Housing Board Colony, Phase 2, GIDC, Vapi, Gujarat 396195 Contact: 07874390801
Vapi Industrial Association (VIA)	Mr. Kamlesh Patel President, VIA, Plot No. 135, VIA House, GIDC, Vapi - 369195 Gujarat, India (0260) 2430950, (0260) 2431950 info@viavapi.org

Morbi Major Stakeholders

Association name	Contact details
Indian Paper Manufacturers Association (IPMA)	Mr. A.S Mehta President, IPMA, 3rd Floor, PHD House, 4/2 Siri Institutional Area New Delhi – 110016
Indian Agro & Recycled Paper Mills Association (IARPMA)	Mr. Pramod Agarwal President, IARPMA 404, Vikrant Tower, 4 Rajendra Place New Delhi – 110008, India
Indian Pulp & Paper Technical Association	Mr. Sanjay K. Singh President, IPPTA CPPRI Campus, Paper Mill Road Near Himmat Nagar Saharanpur, Uttar Pradesh
Morbi Paper Mills Association	Mr. Kirit Kultaria President Tirthak Paper Mills Pvt. Ltd., Lilapar Road, Rajkot District, Morbi, Gujarat 363641

Association name	Contact details
Rafaleshwar Industrial Association	Mr. Devendra Bachubhai Patel Director, Samay Polypack, S. No. 53/1p1, Canal Road, Tal. & Dist. Morbi, LILAPAR Rajkot GJ 363641 Email: samaypolypack@yahoo.co.in
Morbi Wankaner Industrial Development Association	Mr. Jaydeep Bharatbhai Patel Director, Shop No. 6, 4th Floor, Laxmi Plaza Opp. G.I.D.C, Shanala Road, Morbi, Rajkot, Gujarat. 363641 Email: kardamp99@gmail.com

Erode-Coimbatore Major Stakeholders

Association name	Contact details
Indian Paper Manufacturers Association (IPMA)	Mr. A.S Mehta President, IPMA, 3rd Floor, PHD House, 4/2 Siri Institutional Area New Delhi – 110016
Indian Agro & Recycled Paper Mills Association (IARPMA)	Mr. Pramod Agarwal President, IARPMA 404, Vikrant Tower, 4 Rajendra Place New Delhi – 110008, India
Indian Pulp & Paper Technical Association	Mr. Sanjay K. Singh President, IPPTA CPPRI Campus, Paper Mill Road Near Himmat Nagar Saharanpur, Uttar Pradesh
Indian Newsprint Manufacturers Association (INMA)	Mr. Rahul Khanna President, INMA, 57, Panchkuian Road (Opp. Metro Pillar No. 6), New Delhi – 110001 info@inma.org.in, sg@inma.org.in
Kraft Paper Manufacturers of South India	Mr. K. Swaminathan Secretary, Old #130, Bells Road Triplicane, Chennai - 600 005 Contact: +91-9840057208 ks@southkraft.com

Annexure E7 – Technology penetration level over years

S.L. No.	Tech intervention	Scenario	2019	2025	2030	2035	2040	2045	2050
1	Installation of Hi-Consistency Pulper in place of low-Consistency Pulper	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%
		BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
2	Replacement of IE 2 motors with IE 3 motors	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%
		BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
3	Replacement of present agitators with energy efficient agitators	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%
		BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
4	Installation of Screw Press in Place of Potcher for Pulp Washing	Pessimistic/no change	0%	4%	8%	13%	17%	21%	25%
		BAU	0%	7%	13%	20%	27%	33%	40%
		Global BP	0%	10%	20%	30%	40%	50%	60%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
5	Replacement of the SR Boxes with closed box system along with pressure-based VFD controlling at Chest Pump	Pessimistic/no change	0%	4%	8%	13%	17%	21%	25%
		BAU	0%	7%	13%	20%	27%	33%	40%
		Global BP	0%	10%	20%	30%	40%	50%	60%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
6	Installation of VFD in De-inking recirculation pumps in place of Throttling	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%
		BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
7	Installation of VFD Controlled Vacuum System Automation	Pessimistic/no change	0%	8%	17%	25%	33%	42%	50%
		BAU	0%	12%	23%	35%	47%	58%	70%
		Global BP	0%	15%	30%	45%	60%	75%	90%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
8	Replacing Vacuum Pumps and Installing Vacuum Blowers	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%
		BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
9	Dew Point Sensor with VFD in Air Blower of Paper machine Section	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%
		BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%

S.L. No.	Tech intervention	Scenario	2019	2025	2030	2035	2040	2045	2050
10	Installation of Pressurized Headbox in paper machine	Pessimistic/no change	0%	8%	17%	25%	33%	42%	50%
		BAU	0%	12%	23%	35%	47%	58%	70%
		Global BP	0%	15%	30%	45%	60%	75%	90%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
11	Installation of Oxygen Analyzer and controlling the excess air in the boiler	Pessimistic/no change	0%	8%	17%	25%	33%	42%	50%
		BAU	0%	12%	23%	35%	47%	58%	70%
		Global BP	0%	15%	30%	45%	60%	75%	90%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
12	Installation of Microturbines at Paper Mill	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%
		BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
13	Installation of Energy Monitoring System (EMS) to optimize the power consumption	Pessimistic/no change	0%	8%	17%	25%	33%	42%	50%
		BAU	0%	12%	23%	35%	47%	58%	70%
		Global BP	0%	15%	30%	45%	60%	75%	90%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
14	Use of DO (Dissolved Oxygen) sensor and optimization of ETP Blowers	Pessimistic/no change	0%	8%	17%	25%	33%	42%	50%
		BAU	0%	12%	23%	35%	47%	58%	70%
		Global BP	0%	15%	30%	45%	60%	75%	90%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
15	Replacing the present pumps with proper head pumps	Pessimistic/no change	0%	8%	17%	25%	33%	42%	50%
		BAU	0%	12%	23%	35%	47%	58%	70%
		Global BP	0%	15%	30%	45%	60%	75%	90%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
16	Installation of proper sized motor in the Plant	Pessimistic/no change	0%	8%	17%	25%	33%	42%	50%
		BAU	0%	12%	23%	35%	47%	58%	70%
		Global BP	0%	15%	30%	45%	60%	75%	90%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
17	Installation of VFD in air compressor	Pessimistic/no change	0%	8%	17%	25%	33%	42%	50%
		BAU	0%	12%	23%	35%	47%	58%	70%
		Global BP	0%	15%	30%	45%	60%	75%	90%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
18	Installation of energy efficient lighting in place of T8 Lamps and Incandescent Bulb	Pessimistic/no change	0%	8%	17%	25%	33%	42%	50%
		BAU	0%	12%	23%	35%	47%	58%	70%
		Global BP	0%	15%	30%	45%	60%	75%	90%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
19	Reduction of GHG emissions by	Pessimistic/no change	0%	4%	8%	13%	17%	21%	25%

S.L. No.	Tech intervention	Scenario	2019	2025	2030	2035	2040	2045	2050
	shifting towards biomass from coal	BAU	0%	7%	13%	20%	27%	33%	40%
		Global BP	0%	10%	20%	30%	40%	50%	60%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
20	Freshwater saving by Rainwater Harvesting	Pessimistic/no change	0%	8%	17%	25%	33%	42%	50%
		BAU	0%	12%	23%	35%	47%	58%	70%
		Global BP	0%	15%	30%	45%	60%	75%	90%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
21	Installation of Solar PV panel	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%
		BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
22	Installation of Pocket ventilation system in dryer of paper machine	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%
		BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
23	Installation of Thermocompressor on dryer section of paper machine	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%
		BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
24	Replacing the roll press with shoe press in paper machine	Pessimistic/no change	0%	4%	8%	13%	17%	21%	25%
		BAU	0%	7%	13%	20%	27%	33%	40%
		Global BP	0%	10%	20%	30%	40%	50%	60%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
25	Installation of Dryer Insulation in paper machine section	Pessimistic/no change	0%	8%	17%	25%	33%	42%	50%
		BAU	0%	12%	23%	35%	47%	58%	70%
		Global BP	0%	15%	30%	45%	60%	75%	90%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
26	Installation of Cascade Condensate Recovery System for energy savings and improving condensate recovery	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%
		BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
27	Insulation of condensate drums	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%
		BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
28	Overhauling of Existing Air	Pessimistic/no change	0%	5%	10%	15%	20%	25%	30%

S.L. No.	Tech intervention	Scenario	2019	2025	2030	2035	2040	2045	2050
	Preheater in Boiler section	BAU	0%	10%	20%	30%	40%	50%	60%
		Global BP	0%	13%	27%	40%	53%	67%	80%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
29	Insulation of Boiler Surface	Pessimistic/no change	0%	8%	17%	25%	33%	42%	50%
		BAU	0%	12%	23%	35%	47%	58%	70%
		Global BP	0%	15%	30%	45%	60%	75%	90%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
30	Installation of Economizer in Boiler section	Pessimistic/no change	0%	4%	8%	13%	17%	21%	25%
		BAU	0%	7%	13%	20%	27%	33%	40%
		Global BP	0%	10%	20%	30%	40%	50%	60%
		Sustainable	0%	17%	33%	50%	67%	83%	100%
31	Installation of soot blower system in the boiler WHR system	Pessimistic/no change	0%	4%	8%	13%	17%	21%	25%
		BAU	0%	7%	13%	20%	27%	33%	40%
		Global BP	0%	10%	20%	30%	40%	50%	60%
		Sustainable	0%	17%	33%	50%	67%	83%	100%