

Food Processing Sector Energy Mapping – Draft National Report

Energy Mapping of MSME Food Processing Sector



**Bureau of Energy Efficiency,
(Ministry of Power, Govt. of India)**

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4th Floor, Sewa Bhawan, R.K. Puram
New Delhi 110 066, India

Study by:

PricewaterhouseCoopers Pvt. Ltd.
17th Floor, Building 10C, DLF Cybercity,
Gurgaon 122002

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Table of Contents

1. Introduction	2
1.1. Approach and Methodology	3
2. Food Processing Sector Overview	6
2.1. Indian Food Processing Sector	7
2.2. Key Growth Drivers of the Market: End-user Segment Insights:	7
2.3. Key Challenges	8
2.4. Geographical Coverage	9
3. Rice Mill Sector	16
3.1. Overview of Rice Mill Industry	16
3.1.1. Northern Region	16
3.1.2. Southern Region	17
3.1.3. Eastern Region	19
3.2. Sector Level Stakeholders	22
3.3. Energy Consumption and Benchmarking of Rice Mill Sector	26
3.3.1. Energy Consumption	26
3.3.2. Energy Benchmarking	27
3.3.3. SEC Comparison Among Various Rice Mill Clusters in India	29
3.4. Energy Efficiency Potential in Rice Mill Sector	33
3.4.1. Energy consumption at Cluster Level	34
3.4.2. Prominent Technologies being Adopted in Rice Mill Sector	35
3.4.3. Sector Level Rice Production and SEC Details	35
3.4.4. Sector Level Energy Consumption	37
3.4.5. Projections of Energy Saving Potential	37
3.4.6. Estimated CO ₂ Emission Reduction Potential	42
4. Ready-to-Cook (RTC) and Ready-to-Eat (RTE)	46
4.1. Overview of RTC and RTE Industry	46
4.1.1. Northern Region	46
4.1.2. Western Region	48
4.1.3. Southern Region	48
4.2. Sector Level Stakeholders	49
4.3. Energy Consumption and Benchmarking of RTC and RTE Sector	52
4.3.1. Energy Consumption	52
4.3.2. Energy Benchmarking	54
4.3.3. SEC comparison across various clusters across India	56
4.4. Energy Efficiency Potential in RTC-RTE Food Processing sector	62
4.4.1. Energy Consumption at Cluster Level	62
4.4.2. Prominent Technologies Adopted in RTC-RTE Food Processing Sector	63

4.4.3. Sector Level Production and SEC Details	65
4.4.4. Sector Level Energy Consumption	66
4.4.5. Projections of Energy Saving potential	67
4.4.6. Estimated CO ₂ Emission Reduction Potential	73
5. Seafood Processing Sector	75
5.1. Overview of Seafood Processing Industry	75
5.1.1. Western Region	75
5.1.2. Eastern Region	76
5.1.3. Southern Region	76
5.2. Sector Level Stakeholders	77
5.3. Energy Consumption and Benchmarking of Seafood Processing Sector	79
5.3.1. Energy Consumption.....	79
5.3.2. Energy Benchmarking.....	80
5.3.3. SEC comparison across various clusters across India	81
5.4. Energy Efficiency Potential in Seafood Processing sector	85
5.4.1. Energy Consumption at Cluster Level	86
5.4.2. Prominent Technologies Adopted in Seafood Processing Sector	87
5.4.3. Sector Level Production and SEC Details	88
5.4.4. Sector Level Energy Consumption	89
5.4.5. Projections of Energy Saving potential	89
5.4.6. Estimated CO ₂ Emission Reduction Potential	94
6. Recommendations and Implementation Plan.....	97
6.1. Barriers and Challenges in Adoption of EE Technologies	97
6.1.1. Technical Barriers	98
6.1.2. Financial Barriers	98
6.1.3. Regulatory and Infrastructure Related Barriers:	100
6.1.4. Miscellaneous	100
6.1.5. SWOT Analysis	101
7. Integrated Policy Roadmap	103
7.1.1. Technology Capacity Building.....	109
7.1.2. <i>Creating Conducive Environment for Increasing the Adoption of EE</i>	115
7.1.3. Financial Incentives for Adoption of Low Carbon Technologies	125
7.1.4. Collaborative Efforts Among Institutional Stakeholders and IDAs	130
7.1.5. Regulatory Options to Promote Energy Efficiency.....	133
Annexure	139
A. Production process and technology adopted.....	141
Type of production processes in food processing.....	141
Rice mills	141
RTE-RTC Food Products	144
Processed seafood products.....	146
B. EE Technology compendium	149
EE Technologies and Best Practices for Process Applications	149
State of the Art Technologies in Food Processing.....	173

Best Operating Practices	182
List of Vendors / Suppliers of Energy Efficient Technology Solutions	188
C. Existing EE Policy initiatives and programs for the sector	190
D. Other schemes relevant for food processing MSMEs	204

List of Tables

Table 1: Sub-category wise prominent clusters	9
Table 2: Subsector wise mapping	12
Table 3 Details of the Kaithal Rice Mill Cluster	17
Table 4: Details of the Villupuram Rice Mill Cluster	17
Table 5: Details of the Vellore Rice Mill Cluster	18
Table 6: Details of the Warangal Rice Mill Cluster	19
Table 7: Details of the Ganjam and Nayagarh Rice Mill Cluster	19
Table 8: Details of the Balasore Rice Mill Cluster	20
Table 9: Details of the Bargarh Rice Mill Cluster	21
Table 10: Details of the Berhampur Rice Mill Cluster	21
<i>Table 11 List of key industry associations</i>	22
Table 12 EnPI related terms and definitions	28
Table 13: SEC benchmark data for Indian MSME rice mill units	30
Table 14: Summary of BoPs and EE technologies for different food processing sub-sectors	31
<i>Table 15: Energy share of different fuels in rice mill clusters (Units - toe).....</i>	34
<i>Table 16: Production data for the FY 23.....</i>	36
<i>Table 17: Sector level energy consumption for the different products (FY 23)</i>	37
Table 18: Methodology for segregating EETs	38
<i>Table 19: Process specific replication potential of technologies across rice mill clusters.....</i>	38
<i>Table 20: Replication potential of energy conservation measures across rice mill clusters</i>	39
<i>Table 21: Summary of the energy saving potential for different sub-categories in rice in Actual scenario.....</i>	41
Table 22: Fuel consumption and Emissions (BAU and proposed scenarios)	43
Table 23: Details of Ludhiana RTC-RTE cluster	47
Table 24: Details of Allahabad Bakeries Cluster	47
Table 25: Details of Pune RTC-RTE Cluster	48
Table 26: Details of Coimbatore Bakeries Cluster	48
<i>Table 27 List of key industry associations</i>	49
Table 28: RTE/RTC product wise brief process flow.....	52
Table 29 EnPI related terms and definitions.....	55
Table 30: SEC benchmark data for Indian MSME RTC-RTE food processing units	57
Table 31: Summary of BoPs and EE technologies for different RTC-RTE food processing sub-sectors	58
Table 32: Energy share of different fuels in RTC-RTE food processing clusters (Units – toe).....	63
<i>Table 33: Production data for the FY 23.....</i>	66
<i>Table 34: Sector level energy consumption for RTE and RTC products (FY 23)</i>	67
Table 35: Methodology for segregating EETs	68
Table 36: Process specific replication potential of technologies across RTE & RTC clusters	68
<i>Table 37: Replication potential of energy saving measures across RTE & RTC clusters</i>	69
<i>Table 38: Summary of the energy saving potential for different sub-categories in RTE-RTC in Actual scenario</i>	71
<i>Table 39: Proposed long term Sector level SEC – RTE-RTC (Actual scenario).....</i>	72
Table 40: Fuel consumption and Emissions – RTE-RTC Sector (BAU and proposed scenarios)	73
Table 41: Details of Veraval Seafood Cluster.....	75
Table 42: Details of Bhubaneshwar Seafood Cluster.....	76
Table 43: Details of Kochi Seafood Cluster.....	77
Table 44: EnPI related terms and definitions.....	81
Table 45: SEC benchmark data for Indian MSME seafood processing units	82
Table 46: Summary of BoPs and EE technologies for different seafood processing sub-sectors	83
Table 47: Energy share of different fuels in Kochi seafood processing cluster (Units – toe)	86
Table 48: Methodology for segregating EETs	90
Table 49: Process specific replication potential of technologies across seafood processing clusters	90
<i>Table 50: Replication potential of energy saving practices across seafood processing clusters.....</i>	91
<i>Table 51: Summary of the energy saving potential for seafood processing subsector in Actual scenario</i>	92
<i>Table 52: Proposed long term Sector level SEC – Seafood processing (Actual scenario).....</i>	93
Table 53: Fuel consumption and Emissions – Seafood Processing Sector (BAU and proposed scenarios)	94
Table 54: Implementation Roadmap	105
Table 55: Paddy cleaner for a 1.5 TPH mill.....	149
Table 56: Separator for a typical mill	150
Table 57: Plastic bucket for elevators for typical mill.....	150
Table 58: Mechanized Soaking and Cooking unit	151
Table 59: Cost benefit analysis of thyristor based control for electric ovens	152
Table 60: Savings by relining of combustion zone and surface walls of baking oven	153
Table 61: Savings by maintaining air to fuel ratio in oven	153

Table 62: Savings by recovering waste heat from flue gas of Ovens	154
Table 63: Savings from radiation loss from accumulator pipe.....	155
Table 64: Replacement of Ammonia Reciprocating Compressors with VFD based Screw Compressors	155
Table 65: Defrosting with the help of hot gas in cold storages.....	156
Table 66: Installing FRP blades fans at evaporator side FCU	156
Table 67: Installation of air curtains to cease heat loss by infiltration of air	157
Table 68 Installation of ON-OFF control for evaporator FCUs	157
Table 69 Cleaning condenser tubes	158
Table 70: Advanced Energy Management system.....	159
Table 71: Savings by reducing heat loss by relining doors and surface walls	160
Table 72: Savings by reducing heat loss from condensate pipeline	161
Table 73: Economizer for a 3 TPH boiler	161
Table 74: Optimization of air supply and reduction of unburns	162
Table 75: Replacement of old boiler with EE boiler (4 TPH)	162
Table 76: Savings by optimization of excess air in Thermopac	163
Table 77: Savings by recovering waste heat from Thermopac	163
Table 78: Savings by reducing heat losses from Thermopac surfaces.....	163
Table 79: Savings by reducing heat losses from Reserve Oil Tanks	164
Table 80: Savings by reducing heat losses from electric heater	165
Table 81: Savings by reducing heat losses from diesel heater	165
Table 82: Installation of additional receiver for machine shop	166
Table 83: Installation of VFD for existing air compressor	166
Table 84: Savings by reducing the compressor pressure	166
Table 85: Savings by replacement of old inefficient compressor with new EE VSD compressor.....	167
Table 86: Direct drives for fans and dryer blowers	168
Table 87: Adoption of IE4 motors	168
Table 88: Direct drives for fan and pump motors	168
Table 89: Conversion of existing flat V belt to cogged V-belt system	169
Table 90: Hot air generator for paddy drying.....	169
Table 91: Solar water heater energy savings for a typical mill	170
Table 92: Biomass gasifiers for power generation in a medium mill	170
Table 93: Savings by biogas generation	171
Table 94: Savings by replacing inefficient ETP pumps with EE pumps	171
Table 95: Savings by replacing fluorescent tubes with LED tubes	171
Table 96: Savings by using BLDC fans	172
Table 97: Savings by using energy efficient air conditioner	172
Table 98: Cost benefit analysis of AI paddy dryer.....	173
Table 99: Cost benefit analysis of installing an online moisture meter	175
Table 100: Cost benefit analysis of semi-automatic parboiling system.....	175
Table 101: Cost benefit analysis for shaftless rice whitener	177
Table 102: Cost benefit analysis of new age rice polisher	178
Table 103: Cost benefit analysis of Individual Quick Freezer	180
Table 104: Cost benefit analysis of Rotary Rack Baking Oven.....	180
Table 105: Cost benefit analysis of Turbo Drop Cookie Depositor	181
Table 106: Cost benefit analysis of brine freezers	182
Table 107: Best Operating practices for process equipment and auxiliaries	183
Table 108: Best Operating practices for Utilities in food processing industry	185
Table 109: List of prominent technology vendors.....	188
Table 110: Major features and key takeaways from different schemes	196
Table 111: Schemes by SIDBI supporting technology implementation in MSMEs	202

List of Figures

Figure 1: Gross Value Added (GVA) by Food Processing Industries	7
Figure 2: Key challenges for the food processing industry.....	9
Figure 3: Food Processing clusters in India	12
Figure 4: Typical energy consumption in parboiled rice mill.....	26
Figure 5: Typical energy consumption in raw rice mill.....	26
Figure 6: Product mix in prominent rice mill clusters	29
Figure 7: SEC benchmarks for different rice mill clusters across the country	30
Figure 8: Share of different fuels across two rice mill clusters	34
Figure 9: Sub-category wise rice production projections.....	36
Figure 10: Projections of energy consumption and savings.....	41
Figure 11: Change in SEC for the rice mill sector by implementation of EE and state of the art technologies	42
Figure 12: Energy Consumption in Frozen Food Unit	52
Figure 13: Energy consumption in RTC food manufacturing unit.....	53
Figure 14: Energy consumption in RTE food manufacturing unit.....	53
Figure 15: Geographic spread of prominent RTC-RTE clusters	57
Figure 16: Share of different fuels across two RTC-RTE Food Processing clusters	63
Figure 17: Sub-category wise RTC-RTE production projections.....	66
Figure 18: Energy consumption scenarios RTE-RTC	71
Figure 19: SEC projection under various scenarios for RTE-RTC sector	72
Figure 20: Energy consumption in dry seafood processing	79
Figure 21: Energy consumption in wet seafood processing	79
Figure 22: Geographic spread of prominent Seafood clusters.....	82
Figure 23: Share of different fuels in Kochi seafood cluster	87
Figure 24: Production projection of processed seafood products	89
Figure 25: Energy consumption scenarios for seafood processing sector.....	92
Figure 26: SEC projection under various scenarios for seafood processing sector.....	93
Figure 27: Barriers and challenges for EET implementation.....	97
Figure 28: Technical Barriers	98
Figure 29:MSME specific financing barriers	99
Figure 30: Financing institution specific barriers	99
Figure 31: Regulatory and infrastructure related barriers.....	100
Figure 32: Other barriers for EE implementation.....	100
Figure 33: SWOT Analysis	101
Figure 34: Integrated Policy Roadmap	104
Figure 35: Role of various stakeholders in Roadmap Implementation.....	138
Figure 36: Process flow diagram of typical rice mill unit.....	143
Figure 37: Process flow diagram of bakery unit	145
Figure 38: Process flow diagram of sauces.....	145
Figure 39: Process flow diagram of Sweet Corn	145
Figure 40: Process flow diagram of Frozen Fruits and Vegetables	146
Figure 41: Paddy Cleaner.....	149
Figure 42: Separator	150
Figure 43: Iron and Plastic bucket for elevators	150
Figure 44: Mechanized Soaking	151
Figure 45: Recuperative burner (Source: Industrial Heating).....	152
Figure 46: Thermal images of surface of oven	153
Figure 47: Wire mesh baking fixture	154
Figure 48: Accumulator pipe	154
Figure 49: Illustrative schematics of IoT based EMS system.....	158
Figure 50: Illustrative hot zones where relining is required	159
Figure 51: Illustrative hot zones where insulation is required.....	161
Figure 52: Schematic of boiler Economizer	161
Figure 53: Thermal images of surface of Electric Heater	164
Figure 54: Present Compressed air layout	165
Figure 55: Proposed Compressed air layout	165
Figure 56: VFD for compressors	166
Figure 57: Piping after compressor	167
Figure 58: IE4 motor	168
Figure 59: Hot air generator	169
Figure 60: Biogas generation plant.....	170
Figure 61: PV diagram of Solar PV system	172
Figure 62: Operating mechanism of AI based paddy dryers	173

Figure 63: Water recycling system	174
Figure 64: Online Moisture Meter	174
Figure 65: Semi-automatic parboiling system	175
Figure 66: Sorting in various types of rice	176
Figure 67: Optical Sorter Machine	176
Figure 68: New age rice whitener	177
Figure 69: New age rice polishers	178
Figure 70: Tunnel based solar paddy dryer.....	179
Figure 71: IQF Freezing System	179
Figure 72: Rotary Rack Baking Oven	180
Figure 73: Turbo drop cookie depositor.....	180
Figure 74: Immersion batch and continuous shower type brine freezing	181
Figure 75: EE loan financing process through Facilitation Centre	194

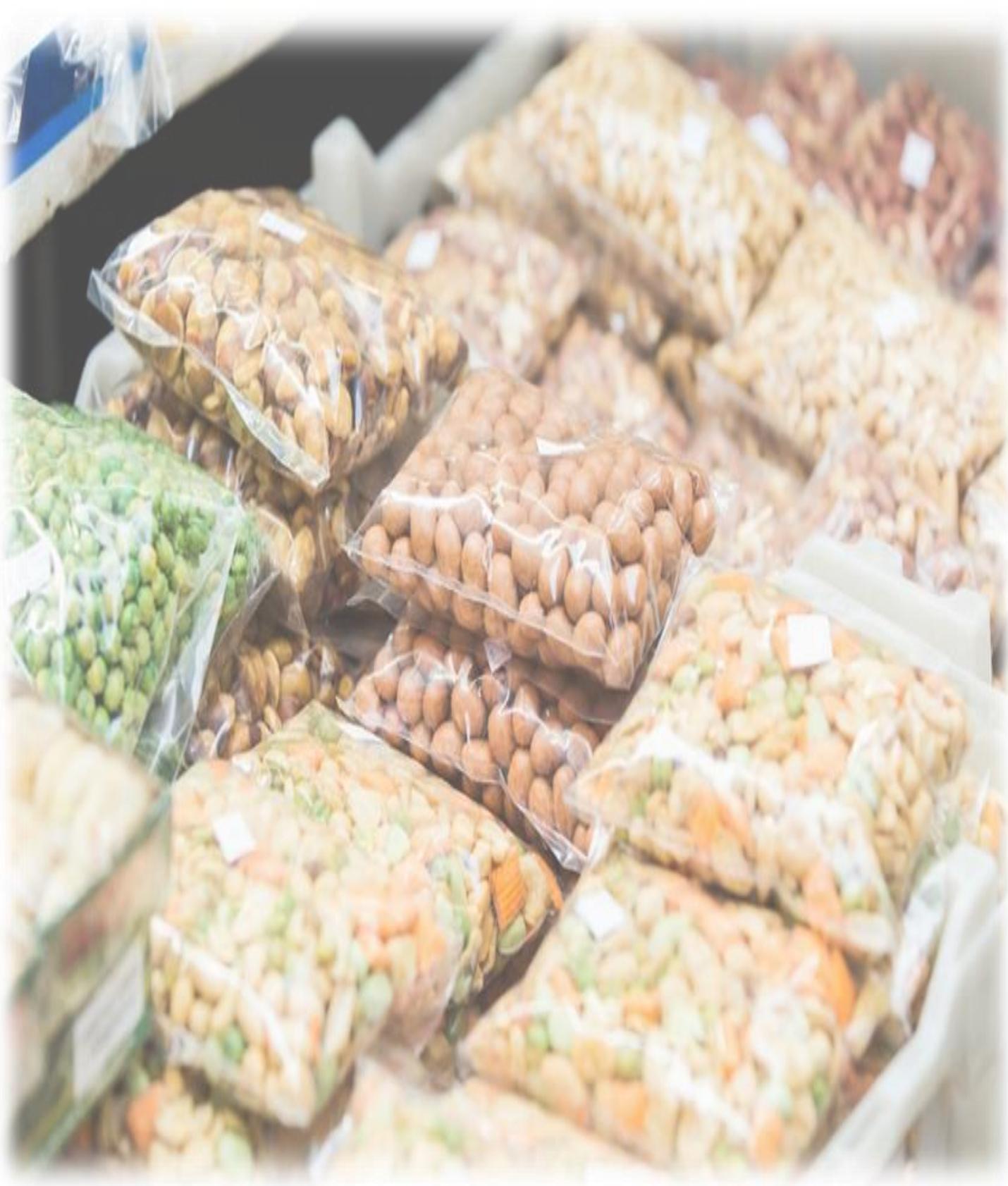
Abbreviations

4E	Energy Efficient End-use Equipment
ADEETIE	Assistance in Deploying Energy Efficient Technologies in Industries and Establishments
AI	Artificial Intelligence
AIBMA	The All India Bread Manufacturer's Association
AIREA	All India Rice Exporters' Association
AORMA	All Odisha Rice Millers' Association
APFC	Automatic Power Factor Control
B2B	Business to Business
BAU	Business as Usual
BEE	Bureau of Energy Efficiency
BLDC	Brushless Direct Current
BOP	Best Operating Practice
CAGR	Compound Annual Growth Rate
CES	Centre of Energy Studies
CFM	Cubic Feet per Minute
CFTRI	Central Food Technological Research Institute
CGTMSE	Credit Guarantee Scheme for Micro & Small Enterprises
CICU	Chamber of Industrial and Commercial Undertaking
CIPHET	Central Institute of Post-Harvest Engineering and Technology
CLCSS	Credit Linked Capital Subsidy Scheme
CO	Carbon Monoxide
COP	Coefficient of Performance
CRI	Color Rendering Index
CRRI	Central Rice Research Institute
DCCB	District Co-operative Central Bank
DG	Diesel Generator
DIC	District Industries Centre
DISCOM	Distribution Company
DPR	Detailed Project Report
EA	Energy Audit
ECM	Energy Conservation Measure
EE	Energy Efficiency
EETs	Energy Efficient Technologies
EMC	Energy Management Centre
EMRF	EESL MSME Revolving Fund
EMS	Energy Monitoring System
EnMS	Energy Monitoring System
EnPI	Energy Performance Indicator
EOI	Expression of Interest
ESCert	Energy Savings Certificates
ESCO	Energy Service Company
ETP	Effluent Treatment Plant
EU	European Union
FBMI	The Federation of Biscuit Manufacturers of India
FCU	Fan Coil Unit
FD	Forced draft
FEEMP	Financing Energy Efficiency at MSMEs" project
FI	Financial Institution

FSNM	Federation of Sweets and Namkeen Manufacturers
FY	Financial Year
GDP	Gross Domestic Product
GEF	Global Environment Fund
GHG	Greenhouse Gas
GIZ	German International Development Cooperation
GoG	Government of Gujarat
GoI	Government of India
GST	Goods and Services Tax
GVA	Gross Value Added
HAG	Hot Air Generator
HCCI	The Haryana Chamber of Commerce & Industry
HP	Horsepower
HSD	High Speed Diesel
IA	Industry Association
IC	Internal Combustion
ICAR	Indian Council of Agricultural Research
ICT	Information and Communications Technology
ID	Induced Draft
IDA	International Development Agency
IE	International Efficiency
IEEE	The Institute of Electrical and Electronics Engineers
IFC	The International Finance Corporation
IMANVVS	The Indore Mithai Aur Namkeen-Vikreta Vyapari Sangh
IoT	Internet of Things
IPM	Interior Permanent Magnet
IQF	Individual Quick Freezer
IRR	Internal Rate of Return
ISEER	Indian Seasonal Energy Efficiency Ratio
ISO	International Standards Organisation
ISTCL	India SME Technology Services Ltd.
ITI	Industrial Training Institute
JICA	Japan International Cooperation Agency
kgoe	Kilogram of Oil Equivalent
KPI	Key Performance Indicator
kVA	Kilo Volt Amperes
kWh	Kilo Watt Hour
LED	Light Emitting Diode
LMCS	Lean Manufacturing Competitiveness Scheme
LPG	Liquefied Petroleum Gas
LSP	Local Service Provider
M&A	Mergers and Acquisitions
M&V	Monitoring and Verification
Mn tCO ₂	Million Tonne of Carbon Dioxide
MNRE	Ministry of New and Renewable Energy
MoFPI	Ministry of Food Processing Industries
MoMSME	Ministry of Micro, Small and Medium Enterprises
MS	Mild Steel
MSEs	Micro and Small Enterprises
MSME	Micro, Small and Medium Enterprises

MSME DI	MSME Development Institute
MT	Metric Tonne
Mtoe	Million Tonne of Oil Equivalent
NABL	National Accreditation Board for Testing and Calibration Laboratories
NBFC	Non-banking Financial Company
NG	Natural Gas
NIFTEM-T	National Institute of Food Technology, Entrepreneurship and Management, Thanjavur
NIMSME	National Institute of MSMEs
NOS	National Occupational Standards
NPSH	Net Positive Suction Head
NPV	Net Present Value
NSDC	National Skill Development Corporation
NSIC	National Small Industries Corporation
NSQF	National Skills Qualification Framework
NTSCs	NSIC Technical Services Centers
OEM	Original Equipment Manufacturer
OUAT	Odisha University of Agriculture and Technology
PAE	Perform Achieve and Earn
PAT	Perform Achieve and Trade
PEACE	Promotion of Energy Audit and Conservation of Energy
PLC	Programmable Logic Controller
PMFME	PM Formalisation of Micro Food Processing Enterprises Scheme
PMKSY	Pradhan Mantri Krishi Sinchayee Yojana
PMU	Project Management Unit
PRGFEE	Partial Risk Guarantee Fund for Energy Efficiency
PRSF	Partial Risk Sharing Facility for Energy Efficiency
RE	Renewable Energy
RESCO	Renewable Service Company
RRBs	The Regional Rural Banks
RTC	Ready to Cook
RTE	Ready to Eat
SDA	State Designated Agency
SEAI	Seafood Exporters Association of India
SEC	Specific Energy Consumption
SEER	Seasonal Energy Efficiency Ratio
SIDBI	Small Industries Development Bank of India
SIDHIEE	Simplified Digital Hands-on Information on Energy Efficiency in MSMEs
SPC	Specific Power Consumption
SS	Stainless Steel
SWOT	Strength, Weakness, Opportunity, Threat
TEQUP	Technology Up-gradation Scheme for MSMEs
TFH	Thermic Fluid Heater
toe	Tonne of Oil Equivalent
tph	Tonne per Hour
TR	Tonne of Refrigeration
UCBs	Urban Co-operative Banks
UNDP	United Nations Development Programme
UNIDO	United Nations Industrial Development Organisation
USA	United States of America
VFD	Variable Frequency Drive

VSD Variable Speed Drive
WB World Bank
WHR Waste Heat Recovery
ZED Zero Defect and Zero Effect



1. Introduction

1. Introduction

Bureau of Energy Efficiency (BEE), a statutory body under the Ministry of Power, Govt. of India, has notified broad policies for promotion of Energy Efficiency (EE) in India. Industrial segment including MSME sector has remained one of the focus sectors of the BEE to enhance energy efficiency. Several initiatives have been taken by BEE from time to time to promote the competitiveness of MSME sector through sustainable use of energy, such as BEE SME program and support for WB-GEF & UNIDO-GEF programmatic interventions.

These and similar initiatives have contributed to improve efficiency of MSME clusters in the country. However, in quantitative terms, there is not much authentic information and data available with respect to MSME's energy consumption and energy saving opportunities. Also, prior interventions in MSME sector were limited to specific clusters, and do not comprehensively cover sector specific policy and implementation aspects.

In this context BEE has devised the "Energy and Resource Mapping Study" for various energy intensive MSME sectors including Food Processing MSME sector. The study aims to identify the present scenario of the food processing sector in terms of energy consumption, applicable EE technologies, readiness of the sector in adopting EE solutions and to develop a sector level EE policy roadmap for the Food Processing MSME sector. Following activities have been envisaged to execute this assignment:

Field Studies

- Review of Energy consuming processes & technologies
- Calculating Specific Energy Consumption benchmarks at process level
- Identifying EE solutions, technologies and best practices relevant to sector

Sector level energy mapping

- Calculating energy consumption at sector level and future projections
- Benchmarking Energy Consumption with other clusters & international benchmarks
- Estimating technology penetration level and Identifying EE potential at sector level

Energy efficiency policy roadmap

- Mapping needs of the food processing sector stakeholders at sector / cluster level
- Technical, financial and capacity building interventions required
- Policy and regulatory level recommendations for food processing MSME sector

Towards that objective, BEE has appointed PwC India to establish energy consumption patterns, highlight opportunities for EE technology upgradation along with policy recommendations and implementation plan for pacing up the EE initiatives in food processing clusters across India. To conduct this study, several initiatives are carried out by PwC India in Ludhiana, Kaithal, Pune-Mumbai, East and West Godavari, and Ganjam-Nayagarh clusters which directly and indirectly benefitted the food processing sector stakeholders:

- Detailed energy studies in 50 food processing units along with recommendations for energy improvement
- Analysed the Specific Energy Consumption (SEC) and energy benchmarking at sectoral / sub-sectoral level
- Identified energy efficient technologies relevant to the sector and developed technology roadmap

- Disseminated the learnings and created awareness on EE across Food Processing sector & clusters (MSMEs)
- Mapped the readiness of sector in adopting EE solutions and developed EE policy roadmap

1.1. Approach and Methodology

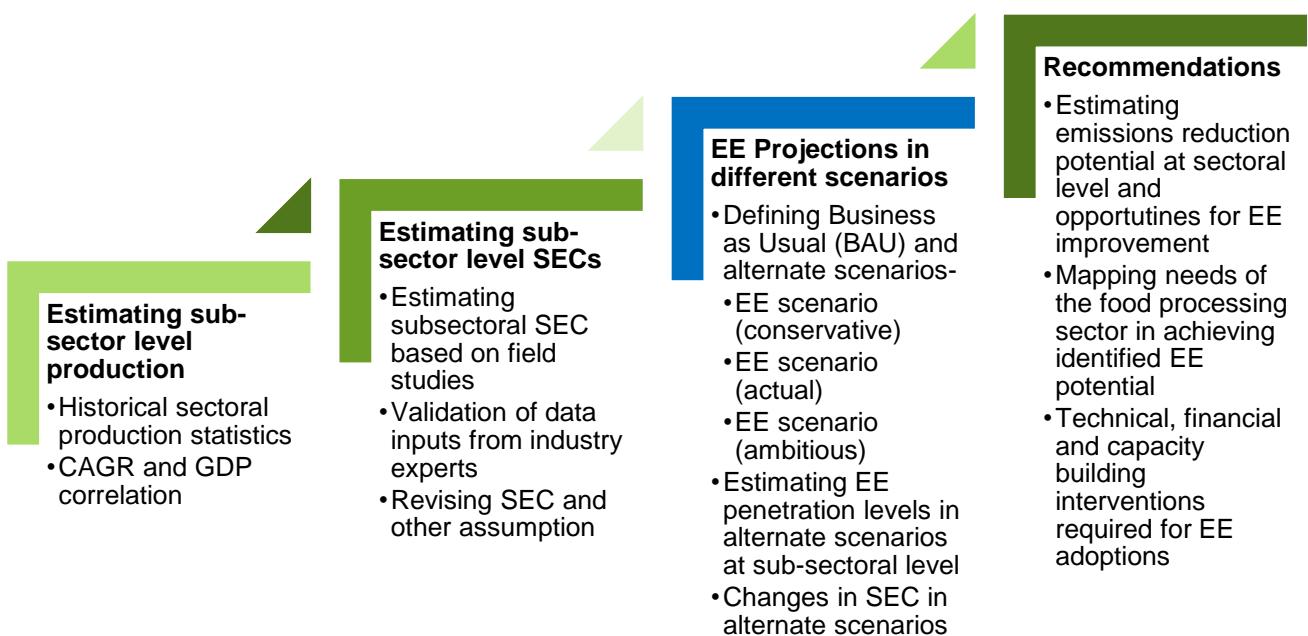
Based on our understanding of the objectives, we adopted a structured methodology that comprised of desk research, field studies, stakeholder consultations followed by assessment and analysis. Given the limitations associated with this desk-based study, the primary surveys and field studies were primarily targeted to collect data on the sector and best practices that could assist in EE projections.

We have followed the *mixed approach of primary surveys, one-to-one consultations, workshops, energy studies & secondary research* as shown in below section to achieve the project outcomes:

- Primary Surveys in 156 Food Processing units** covering 5 MSME clusters to collect information on
 - Type of products manufactured
 - Technology used for processes including baking, boiling, refrigeration, water removal, among others
 - Annual production and fuel-wise energy consumption
- Field studies in 50 MSME Food Processing units** covering 5 MSME clusters and products like rice, RTE food including baked products, and Fish products to analyze the following
 - Review of energy consuming processes & operations
 - Calculate specific energy consumption for processes
 - Identify energy efficiency solutions for the MSME food processing unit
- Secondary research on energy benchmarks and relevant EE technologies**
 - Identify process specific national and international energy benchmarks
 - Identify EE technologies relevant to the sector, techno-commercial feasibility
 - Estimation of technology penetration levels and projections for EE potential
- Knowledge dissemination workshops and stakeholder consultation**
 - 5 Inception workshops to explain about assignment objectives and project features
 - 5 Dissemination workshops to share project learnings and understand cluster needs
 - 5 Stakeholder consultation visits and 3 stakeholder workshops at regional level in 5 other MSME Food Processing clusters to understand sector needs & develop EE policy roadmap
 - 1 National level dissemination workshop to share the study results and present the sectoral roadmap
- One-to-one consultations with industry stakeholders** to understand food processing sector needs
 - Detailed discussions with Chamber of Industrial and Commercial Undertaking (CICU) – Ludhiana, Seafood Exporters Association of India

- One-to-one consultations with cluster level associations - Kaithal Rice Millers association - Kaithal, Haryana Rice Millers & Dealers Association – Tohana, Ganjam District Rice Mill Owners Association – Berhampur, Nayagarh Rice Millers Association, TISSA -Mumbai, The Seafood Exporters Association of India - Kochi, Indian Industries Association - Kanpur, Coimbatore District Bakery Owners Association, Arni Taluk Paddy & Rice Merchants Association – Arani (Tamil Nadu), Kundli Industries Association - Sonipat, Khordha Fish Processing Association - Odisha, The Indore Mithai Aur Namkeen-Vikreta Vyapari Sangh (IMANVVS)
- Consultations with technology suppliers, and local service providers

Building on the data collected, a deep dive analysis of sectoral energy outlook and EE reduction potential was conducted. An excel based model was developed to undertake the sub-sector level analysis for rice mills, ready-to-eat (including bakeries) and Fish processing sub-sectors based on *the boiling/baking/refrigeration/etc. technologies* from 2023 to 2033 to estimate energy consumption in BAU scenario and energy intensity reductions in EE conservative, actual and ambitious scenario.



Energy demand for the food processing sector is evaluated based on various contributing factors, which includes sub-sectoral production, specific energy consumption, energy efficiency improvement, etc.

This “BEE Energy Mapping Study” aims to generate a sector level energy efficiency roadmap for the Food Processing MSME sector. Findings of this study will also help to formulate policies and prepare the implementation plan for pacing up the EE initiatives in the food processing clusters across India.



2. Food Processing Sector Overview

2. Food Processing Sector Overview

The Food Processing sector in India is referred to as “A Sunrise sector” as it offers good business opportunities supported by retail sector growth, favorable economic policies and attractive Fiscal incentives. As a result, the GOI through the Ministry of Food Processing Industries (MoFPI) is taking all measures necessary to boost investment in this sector. This is evident from the fact that GOI has launched several schemes for supporting the growth in the food processing sector. Some of these schemes include:

- **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)** which is a national mission to improve farm productivity and practice resource efficiency
- **PM Formalisation of Micro Food Processing Enterprises Scheme (PMFME)** through which technical, financial and business-related support is provided to units for upgrading their enterprises

The major sub-sectors under the food processing sector in India include grains, sugar, edible oils, beverages, ready-to-eat/prepared food, seafood processing, and dairy products, among others. The food processing sector is remarkably diverse in nature as it caters to a range of products including fruits, grains, confectionery and bakery, fats and oils, spices and salts, among others. The MoFPI categories the industries under food processing as follows:

Confectionary	Ready-to-Eat Savories	Egg products
Edible Ices incl. Sherbet and Sorbe	Salts, Spices, Soups, Protein products	Fish products
Fats, Oils and Fat Emulsion	Bakery products	Fruit & vegetable products
Foodstuffs (nutritional uses)	Cereal products (For example, Rice mills, dal mills, etc.)	Prepared foods
Meat products	Dairy products	Beverages excl. Dairy product

Major Insights of food processing industry¹

- According to the European Food and Drink Industry, EU has the highest production for processed food with a share in turnover of 44% among all the regions worldwide, followed by USA with 20% of turnover and China with 19% of turnover.
- The agricultural production needs to grow by 70% and by almost 100% in fast developing economies, to feed the growing population of the world.
- There is an expected shift in global demand with emerging markets like India, Indonesia, China, Malaysia increasingly driving the global growth. The share of exports and imports for food products and beverages is growing tremendously in these markets. The growing customer base in these markets will result in the global food and drinks manufacturing industry shifting its base to these markets with an aim to come closer to their customers.
- With the growing concerns over food safety and the increasingly strict food safety related regulations, the food and drink manufacturing sector have to maintain the expected safety standards across its supply chain which is right now challenging considering the complex nature of their supply chain.

¹ Rentokil Initial plc

- Some of the macro factors affecting food security are raw material costs, supply chain vulnerability, energy cost, climate change, environmental and social responsibility, food safety risks, increased regulation, increasing M&A activity, among others.

2.1. Indian Food Processing Sector²

In India, the agriculture and allied sector has a share of 20.2% in GVA, 11.6% in total employment, 10.4% in India's exports, and hence holds economic importance in the country. The output of India's food processing sector which is also one of the largest in the world is expected to reach \$535 bn by 2025-26.

As per MoFPI, there were 40,581 registered units in India in 2018-19. Under the Mega Food Park scheme in the country, a total of 41 food parks have been sanctioned of which 22 are operational. The country has the capacity of storing 374.25 Lakh MT of perishable products like fruits and vegetables in its 8186 number of cold storages.

India's geographical location gives it an advantage to export items to regions such as Europe, the Middle East, Japan, Singapore, Thailand, Malaysia and Korea, among others which is one of the main reasons for India's food processing industry being export oriented. The exports of processed food from India were valued at Rs. 59,580.72 Crores and the retail market for food and groceries is expected to grow at a CAGR of 3.0% from 2022 to 2030.

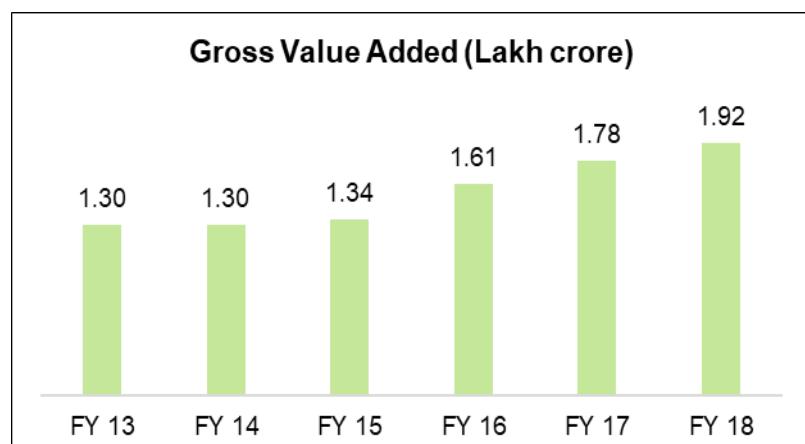


Figure 1: Gross Value Added (GVA) by Food Processing Industries

Figure 1³ depicts the gross value addition by food processing sector during the past few years.

Type of products

Rice: Majority of the rice mills in India process raw and parboiled varieties of rice. Raw rice is a type of rice variety which is not parboiled, steamed or cooked in any way. Parboiled or partially boiled rice is a type wherein the rice grains are boiled with the chaff intact. The boiling process makes the rice grain to absorb most of the nutrients from the chaff and bran. The chaff is discarded once the rice is boiled and cooled. India at present produces nearly 50%⁴ of parboiled paddy.

2.2. Key Growth Drivers of the Market: End-user Segment Insights.⁵

India's food processing sector is experiencing a growth as a result of proactive policy and other support from government, increasing consumption patterns, accessibility, raw material supply, and export demand, among other factors.

² <https://apeda.gov.in>

³ MoFPI

⁴ https://agritech.tnau.ac.in/postharvest/pht_cereal_rice_processing.html

⁵ <https://www.investindia.gov.in/siru/indian-food-processing-sector-untapped-growth-opportunity#:~:text=Rising%20household%20incomes%2C%20urbanization%20and,the%20total%20number%20of%20factories>

Government push: Initiatives from government for boosting the rural economy such as planned infrastructure spend of around INR 100 lakh crore and INR 25 lakh crore has set forth a high growth pathway for the food processing sector. Initiatives like the *Pradhan Mantri Kisan Sampada Yojna* for creating modern infrastructure with efficient supply chain management from farm to retail outlet and *Prime Minister Modi's Atmanirbhar Bharat vision* for formalization of Micro Food Processing Enterprises with an outlay of INR 10,000 crore are boosting the country's food processing sector.

Changing consumption patterns: India has a huge domestic market for the products of the food processing units. Factors like urbanization linked changing consumption patterns, increased gender equality among current workforce, increased consumption rates, large share of young population with growing income, among others have created a huge demand for food products. India has a huge working population which is largest in the world and hence the fast-paced urban working lifestyles is resulting in rising demand for ready-to-eat and ready-to-cook meals.

Access to diverse products: The increasing number of organized food retail outlets who are making a diverse range of options accessible to customers in attractive discounts is leading to increased sale of food products.

Raw material advantages: India has the advantage of availability of huge amount of raw material required for the food processing units as a result of large livestock base, wide crop variety, long coastline and inland water bodies resulting in increased marine production.

Export demand: India is well connected to key geographical locations making it one of the favorable sources for importing food products. In FY19, the value of exported processed food products had a share of 10.69%⁶ in India's total exports.

2.3. Key Challenges

The SMEs in food processing sector face challenges pertaining to supply chains, storage and transportation, access to credit and financing, among others which makes it difficult for them to compete with the large established players of the sector. Some of the major challenges hindering the growth of the sector are briefed below.

- Most of the food processing units in India operate in the small and medium enterprises category. As a result, they often lack the resources in terms of technical, financial and others to upgrade their processes and machineries as per latest industry standards.
- Lack of raw material availability as a result of low farm productivity (because of low level of mechanization), perishability, high seasonality, inefficient supply chains, etc.
- Only urban regions are contributing to the demand in the country
- Lack of sufficient cold storage infrastructure results in loss of food estimated at ~30% between farm gate to market. A study by NITI Aayog estimated the total post-harvest losses in the country at Rs 90,000 crore.
- Transportation related bottlenecks, for example, weather related obstacles, lack of proper connectivity, among others
- Almost 75% of the food processing segment is operating informally
- Various laws governing food safety and packaging

⁶ https://www.mofpi.gov.in/sites/default/files/eng_mofpi_annual_report_2018-19.pdf

- Most of the sector is engaged in primary processing which has a low value addition compared to secondary processing with a huge demand in export market
- Lack of adequate quality control and packaging units

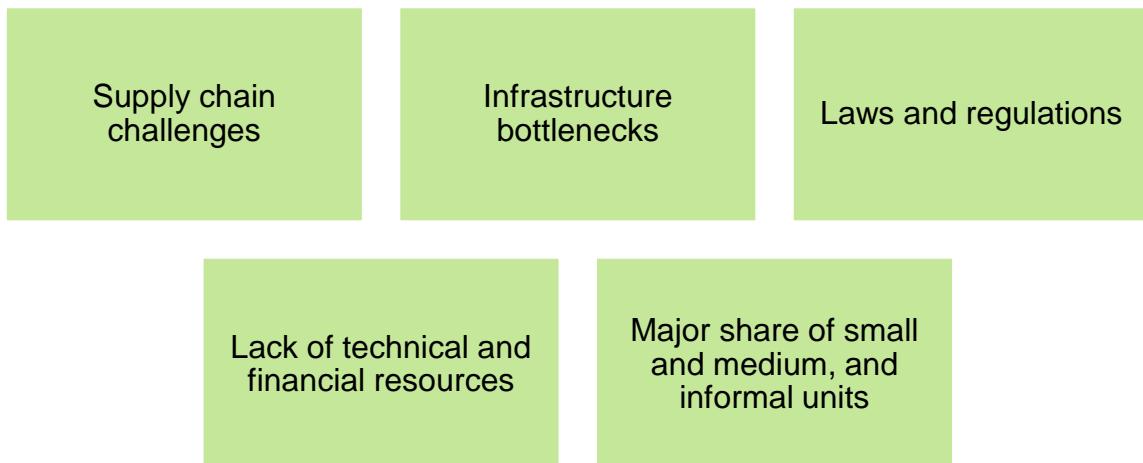


Figure 2: Key challenges for the food processing industry

2.4. Geographical Coverage

As per the Annual Survey of Industries (ASI) 2019-20, there are around 41,481 food processing units in the country. As per ASI 2019-20, Andhra Pradesh tops the list with 5737 units followed by Tamil Nadu at 4995, Telangana at 3989, Punjab at 3267, and Maharashtra at 2728. There are 24 Mega Food Parks operational in India as of now and additional 17 are approved under the Mega Food Park Scheme.⁷

There are various sub-categories in the food processing sector as mentioned in section 2.4. The prominent clusters under these sub-categories are mentioned below.

Table 1: Sub-category wise prominent clusters⁸

Sub-sector	Prominent clusters (no of units)
Prepared food/RTE excluding bakery	Indore, Pune (50), Nagpur (25), Ludhiana, Kanpur bakery and namkeen (50), Delhi NCR, Murshidabad, Rayagada, Palakkad, Nizamabad, Kanpur bakery and namkeen (50), Farrukhabad potato chips (510), Dhule banana chips (25), Luckerganj food pro./potato chips (30), Sarai Aakil banana chips (25), Gorakhpur bakery and namkeen (17), Farrukhabad namkeen (30)
Fish products	Bhubaneshwar (34), Kolkata (51), Mangalore (67), Kochi(115), Chennai(17), Tuticorin(41), Vijaywada (41), Bhimvaram (44), Porbandar(31), Veraval(102), Mumbai(62), Karnal (75), Nagapattinam dry Fish processing, Tiruvallur Fish products, Bhavnagar (80), Raigad dried Fish cluster (25), Balasore dry Fish (176), Jagatsinghpur dry Fish (50)

⁷ https://www.mofpi.gov.in/sites/default/files/list_of_mfp_as_on_30.04.2023_website.pdf

⁸ DCMSME, PIB, NITI Aayog

Sub-sector	Prominent clusters (no of units)
Dairy products	Gujarat, Punjab (50 including 21 large), Mathura, Banaskantha, Osmanabad Khawa, Hathras (25), Coorge (45), Salem, Karnal (150), Nuh (45), Ahmednagar (41), Bathinda (169), Jalandhar (324), Gopalpur(40),
Rice Mills (Cereal Products)	<p>Rice mill - Karnal-Yamunanagar (163), Khanna (200), Patiala-Rajpura (150), Red hills(100), Vellore(340), Viluppuram (50), Warangal(110), Balasore(25), Brahmapur(160), Bargarh(95), Ganjam (250), Rampur (150), Kurukshetra (230), Hardoi (70), Guntur (200), Nellore (300), Srikakulam (150), Eluru West Godavari (482), Ahmedabad (125), Nizamabad (199), Barnala (125), Sangrur (239)</p> <p>Dal mill - Indore (100), Hathras(60), Madurai, Tiruvarur, Vasad(160), Osmanabad(30), Zaheerabad (50), Banda Mini Dal mill (25), Siddharthnagar (20), Balrampur(35), Azamgarh mini(35), Ballia mini(35), Ghazipur mini(45), Mau mini(45), Shravasti mini(50), Sonbhadra (35)</p> <p>Poha mill - Rajnandgaon Poha and murmura (50)</p>
Bakery Products	Allahabad (130), Coimbatore (700), Ludhiana (170), Hisar (85), Jind (20), Karnal (60), Kanpur bakery and namkeen (50), Margoa (50), Miraj (41), Satara bakery and confectionary (22), Jalna (22), Ahmednagar bakery and confectionary (45), Bathinda biscuits, cakes, pastries, rusks and other bakery products(44), Phantket (136), Jagdishpur (40), Bokhra Sitamarhi (45), Jalandhar biscuits, cakes, pastries, rusks etc (88)
Salts, spices, soups, protein products	<p>Salt - Naupada (40), Nagapattinam, Tuticorin</p> <p>Spices - Guntur Chilli and Turmeric (100), Davangere (55), Hassan processing (50), Coorge pro. (50), Idukki (159), Wayanadu (85), Osmanabad vegetable and spices pro. (35), Nanded spices and chilli powder (95), Beed (28), Cuttack (40), Jagatsinghpur cereal based products and spices (40), Koraput pro. (40), Siddharthnagar (30)</p>
Meat products	Malkangiri pro. (30), Dantewada (4)
Foodstuffs (nutritional uses)	Jagatsinghpur cereal based products and spices (40)
Fats, Oils & Fat Emulsion	<p>Oil mills - Alwar-Sawai Madhopur (50), Kathua, Shravasti, Dewas(10), Rajkot, Akola, Kurnool, Bijapur, Kochi, Erode, Jalau Mustard (150), Shahjahanpur (25), Raebareli Mustard (40), Unnao Mustard (25), Adoni (20), Chitradurga (25), Chitradurga Groundnut Oil (40), Osmanabad soyabean (40),</p>

Sub-sector	Prominent clusters (no of units)
	Solapur natural edible oil (39), Dhule edible oil (25), Parbhani edible oil (32)
Edible Ices, incl. Sherbet, Sorbe	Bhimavaram (80), Porbandar (40), Veraval (90)
Confectionery	Indore (20), Satara Bakery and Confectionery Products (22), Ahmednagar Bakery & Confectionery Manufacturers (45)
Beverages, excl. dairy products	Dubbaka packaged drinking water (30), Gurdaspur drinking water (48), Guntur packages beverages (467), Bengaluru food and beverages (80), Dharmapuri beverages, Kanyakumari beverages, Karur beverages
Storage	Cold storage - Sonipat (90), Hathras (90), Agra (150), Mainpuri (40), Kanpur Nagar (50), Farrukhabad (60), Kannauj (40)
Sweeteners, including Honey	<p>Jaggery and sugar Gokak jaggery (120), Hoshiarpur jaggery (20), Balrampur sugar (25), Ramnathapuram Palm sugar products, Thanjavur sugarcane products, Kabirdham jaggery (60), Muzaffarnagar jaggery (89), Bhandara jaggery cluster(organic jaggery & other product) (100 micro and small), Kushinagar jaggery (30), Jalaun jaggery (35), Faizabad jaggery (60), Narsimhapur jaggery (200), Hazaribagh jaggery (500), Haridwar jaggery (23), Palamaneru jaggery (500), Mandya jaggery (40), Kabirdham (60), Belgaum jaggery, Idukki jaggery (180), Satara jaggery (42), Latur jaggery (35), Balrampur jaggery (25)</p> <p>Honey - Bahadurgarh (100), Lucknow (150), Mon (66), Garwah (69), Lohardaga (170), Almora (80), Vizianagaram pro. (100), Benaulim pro (23), Bicholim pro. (23), Wayanadu pro. (100), Kasargode Seashell/Musde Cluster/ Aracanut/ Pakku Cluster/ Honey Processing Cluster (130), Latur (77), Nanded pro. (90), Tynna (250), Durama bee keeping and honey pro. (45), William Nagar pro. (53), Umthiang Bee Keeping Cluster (Bee Keeping & Honey Cluster) (101), Nongthymmai Kyrdem Mawbsein, Kyrdem Cluster Bee Keeing & Honey Cluster (110), Koraput pro. (140), Nayagarh Bee wax honey pro. (550)</p>

Food processing industries are located in the clusters across India and some of these major clusters are presented in Figure 4.

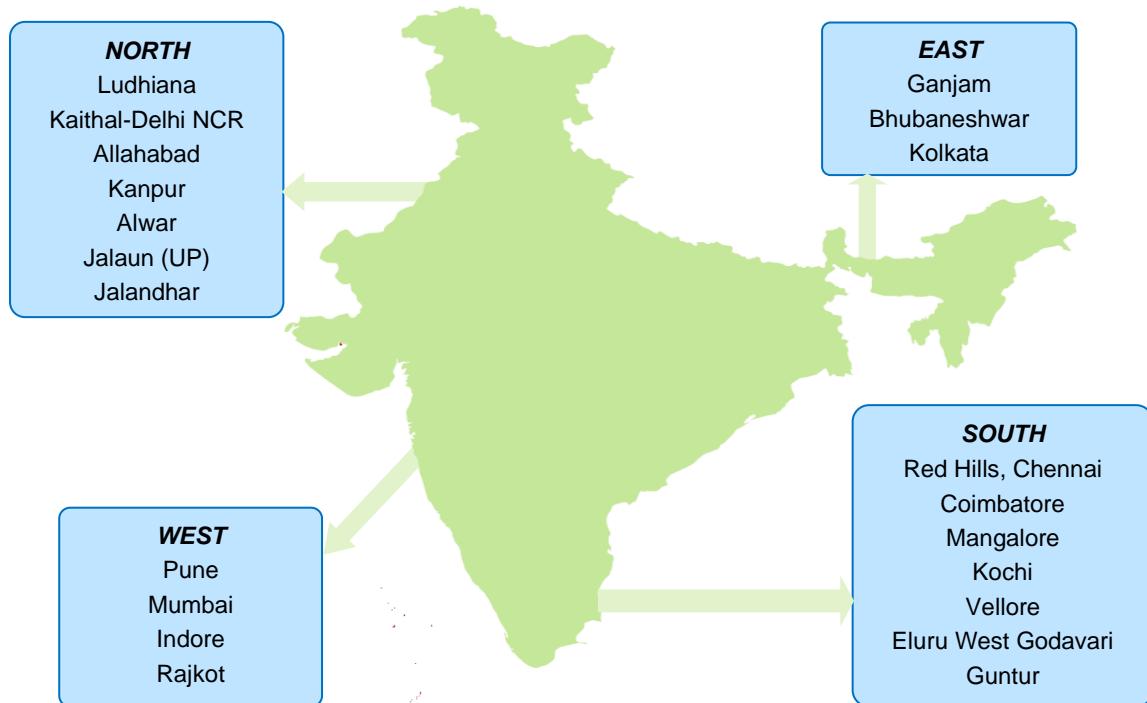


Figure 3: Food Processing clusters in India

The food processing sector has at least 15 subsectors including rice mills, bakeries, meat processing, dairy, beverages, fat and oil, among others. As part of this assignment, we did an in-depth study in rice mills, ready-to-eat/ready-to-cook, and seafood sub-sectors which were shortlisted considering parameters like energy intensity of the sub-sector, number of industries, replicability potential, among other factors. The sub-sector wise energy intensity, number of industries, replicability potential, and other relevant information are showcased in the table below.

Table 2: Subsector wise mapping⁹

Shortlisted cluster

S No.	Sub Sector	Energy Intensity	Total No. of Industries	Replicability Potential	Remarks
1	RTC/RTE excluding bakery	Biscuits - 0.523 toe/tonne; Savoury Snacks - 0.4 toe/tonne; Jams/Ketchup - 0.06 toe/tonne	34345	High	Highly energy intensive and large number of industries. In prepared food sector, 3 sub sector can be considered biscuits, savoury snacks & jam/ketchup.
2	Rice Mills (Cereal Products)	0.061	17600	High	Highly energy intensive, large number of industries and highly replicable sector
3	Seafood products	0.095	883	High	Less number of industries but highly replicable and highly

⁹ Source: MoFPI, SAMEEKSHA, Shakti Foundation, BEE, M. A. Sulaiman et. al., Ibrands Limited, EuSalt Salzburg 2015, Ullah, Khan, et. al., FnBNews, Patoliya, T., Garg, M., Ladha-Sabur, A. et. al.

S No.	Sub Sector	Energy Intensity	Total No. of Industries	Replicability Potential	Remarks
					energy intensive sector
4	Bakery Products	0.09	24163	Low	There are clusters and industries available for bakery sector and these units have high potential of replicability. And operation of these units are not dependent on the season.
5	Fats, Oils & Fat Emulsion	0.011	19019	High	Units are scattered across the cluster with no prominent Industry Association, which will make it challenging to project accurate cluster level findings. Hence not considered for Energy Audit.
6	Beverages, excl. dairy products	0.0122	22474	Medium	Industries are widely spread, not in confined cluster and has different process than food processing
7	Cold Storage	0.012	8200	High	Highly replicable, has large number of industries and better geographical spread. But these are not food processing industries.
8	Dairy products	0.012	21282	Medium	Industries are widely spread, not in confined cluster and has different process than food processing.
9	Sweeteners, including Honey	0.038	9183	Medium	Consist of many different processes in different sub sectors.
10	Salts, spices, soups, protein products	0.037	24277	Low	Consist of many different processes in different sub sectors.
11	Confectionery	0.037	8495	Medium	Consists of mainly large units.
12	Foodstuffs (nutritional uses)	0.03	4217	Medium	Consist of many different processes in different sub sectors.
13	Meat products	0.1	1976	Medium	Less number of industries
14	Fruit and vegetable products	0.011	16930	Low	Consist of many different processes in different sub sectors.
15	Edible Ices, incl. Sherbet, Sorbet	0.01	2548	Low	Consist of many different processes in different sub sectors

Colour coding	Energy Intensity	Total No. of Industries	Replicability Potential
	>0.05	>15000	High
	0.03-0.05	4000-15000	Medium
	<0.03	<4000	Low



3. Rice Mills: Sector Overview and Energy Saving Potential

3. Rice Mill Sector

3.1. Overview of Rice Mill Industry

Rice mill refers to an industry wherein the paddy procured from the farmers is processed using machineries for producing polished rice suitable for consumption. As rice is one of the staple foods in almost all parts of India, rice milling is a crucial industry which plays a role in the conversion of paddy to edible rice by removing the husk and other impurities. In India a vast range of rice is available like Basmati, Brown Rice, Mogra, Jasmine, Aizon, Ambemohar, Chakhao, Dubraj, Burma Black, Indrayani, Jeerakasala, Jawaful, Kalal, Joha, Kuttanad, Laxmi Bhog, Matta, Mysore Malliage, Patna, Parmal, Samba, Wada Kolam etc. having its own aroma and taste.¹⁰ According to a research by Market Research Future (MRFR), India's Rice Mill market is projected to grow at a CAGR of 3.51% between 2022 to 2030 reaching around USD 0.39 Billion by the end of 2030. The growth in rice mill industry is attributed to factors like the need to increase shelf life of rice grains and supportive policies from the government in India. The government is pushing the production of rice by giving incentives in the form of support prices, assured procurement, and subsidies on inputs like fertilisers, irrigation and electricity.¹¹

As per the Fourth Advance Estimates released by DAC&FW, the major rice producing states in India are West Bengal, Uttar Pradesh, Punjab, Andhra Pradesh, Odisha, Telangana, Tamil Nadu, among others. The region wise major rice mill clusters along with their details like production, type of rice processed, major technologies deployed, type of fuel used, among other details is described in the next subsections.

3.1.1. Northern Region

Kaithal has a rice mill cluster of about 146 operating rice mills, most of them are MSMEs. About 90% rice mills are engaged in the production of parboiled rice, as well as small quantities (about 10%) of raw rice. The total estimated production at cluster level is 1,368,010 tonnes per year. The various categories of rice processed by these mills include Basmati Raw Rice, Sella Rice, Steam Rice, Pusa Rice, White Rice, Sona Masuri Rice, Golden Rice, and Brown Rice, among others. Most of these raw materials are available locally.

The important by-products from rice mills through milling process include husk (23%) and bran (9%). Almost 90% of the cluster's energy requirement comes in the form of thermal energy from burning husk and the remaining energy requirement comes from grid electricity. The production technologies used by the cluster include rice husk-based boilers for meeting the thermal energy needs of parboiling, drying of parboiled paddy, among others; air compressors mainly of screw type for meeting the compressed air requirement of instrumentation and service air; motor driven applications for all the process machines like strainer machine, husk separator, destoner blower, FD fan, ID fan, vacuum blowers, silky blower, among others.

The Haryana Chamber of Commerce & Industries Association Kaithal, Rice Mills Association Kaithal, Rice Mill Association Cheeka, Kaithal Rice Mill Association are the associations with a presence in the Kaithal cluster.

¹⁰ <https://www.ibef.org/indianrice>

¹¹ <https://www.marketresearchfuture.com/reports/india-rice-milling-market-3566>

Table 3 Details of the Kaithal Rice Mill Cluster

Description	Details
Location	Haryana
Number of rice mill units	~146
Major rice products	Raw and parboiled rice
Type of fuel used in cluster	Electricity, Rice husk/ Cane straw, Diesel (an exceedingly small share)
Prominent Technologies used	Rice husk-based boiler, Air compressor, Motor driven applications
Prominent Industry association	<ul style="list-style-type: none"> • The Haryana Chamber of Commerce & Industries Association Kaithal • Rice Mills Association Kaithal • Rice Mill Association Cheeka • Kaithal Rice Mill Association
Prominent Institutes	District MSME Centre (DIC) – Kaithal MSME-DI Karnal
SDA	Haryana Renewable Energy Development Agency (HAREDA)

3.1.2. Southern Region¹²

Villupuram rice mill cluster has approximately 50 operational rice mills with current operating capacity of 30%. The estimated annual rice production from this cluster is around 76,000 tonnes. Most of the units in the cluster are processing parboiled rice. The cluster relies on the paddy which is procured from the open market for raw material. The type of rice processed in these mills include Ponni raw rice, Idli rice, BPT rice, Delux rice, ADT 36, Rajabogam delux, Sharbati basmati rice, short grain white rice, Parboiled rice, Broken rice, Paddy rice, White basmati rice, etc.

The rice mills use husk as their major source of energy followed by electricity from grid. The technologies deployed in the cluster are rice husk fired boiler, steaming bowl, wood fired dryer, milling machines like destoner, dehusker, whitener and polisher, among others.

The Federation of Tamil Nadu Rice Mill Owners & Paddy Rice Dealers Associations (FTPDA), Tiruchirappalli, and District level Rice Mill Association, Viluppuram are the prominent associations active in the region.

Table 4: Details of the Villupuram Rice Mill Cluster

Description	Details
Location	Tamil Nadu
Number of rice mill units	~50
Major rice products	Parboiled and raw rice
Type of fuel used in cluster	Electricity, Rice husk, Firewood

¹² TERI. 2015. Cluster Profile Report – Villupuram rice mills. New Delhi: The Energy and Resources Institute 8 pp. [Project Report No. 2014IE15]

ZENITH ENERGY SERVICES PVT LTD. Hyderabad. MANUAL ON ENERGY CONSERVATION MEASURES IN RICE MILLS CLUSTER VELLORE.

APITCO Limited, Hyderabad. MANUAL ON ENERGY CONSERVATION MEASURES IN RICE MILLING CLUSTER WARANGAL

Description	Details
Prominent Technologies used	Rice husk fired boiler, steaming bowl, wood fired dryer, milling machines like destoner, dehusker, whitener and polisher
Prominent Industry association	<ul style="list-style-type: none"> The Federation of Tamil Nadu Rice Mill Owners & Paddy Rice Dealers Associations (FTPDA), Tiruchirappalli District level Rice Mill Association, Viluppuram
Prominent Institutes	District Industries Centre (DIC) – Viluppuram MSME-DI Chennai, Coimbatore
SDA	Tamil Nadu Energy Development Agency (TEDA)

Vellore rice mill cluster has around 340 rice mills covering Arni, Arcot and Vellore regions. The rice produced in the cluster is of high quality and the most common variety of rice produced in the cluster for meeting the demand from domestic markets is the Ponni rice. The units purchase paddy from the farmers through various agents.

The main energy forms used by the units in the cluster are electricity, wood, GN husk and rice husk. The thermal energy-based fuels are used for the boilers and hot air dryers whereas electricity is used for machinery like Elevators, paddy cleaners, hullers, whiteners, silky, sortex, separators and air compressors.

Arni Taluk Paddy and Rice Merchant Association is one of the proactive associations at the cluster level.

Table 5: Details of the Vellore Rice Mill Cluster

Description	Details
Location	Tamil Nadu
Number of rice mill units	~340
Major rice products	Ponni rice
Type of fuel used in cluster	Electricity, Wood, GN husk and Rice husk
Prominent Technologies used	Boilers, hot air dryers, elevators, paddy cleaners, hullers, whiteners, silky, sortex, separators and air compressors
Prominent Industry association	<ul style="list-style-type: none"> The Federation of Tamil Nadu Rice Mill Owners & Paddy Rice Dealers Associations (FTPDA), Tiruchirappalli Arni Taluk Paddy and Rice Merchant Association, Arni
Prominent Institutes	District Industries Centre (DIC) – Vellore MSME-DI Chennai, Coimbatore
SDA	Tamil Nadu Energy Development Agency (TEDA)

Warangal rice mill cluster has around 110 units with an estimated cumulative annual production of 6,00,000 tonne. The units in the cluster processes majorly raw rice, followed by parboiled rice in some units and kalam rice in very few units.

The energy forms used by units in the cluster are rice husk or agro residue-based fuel for boilers in parboiled units, and electricity for paddy elevators, rubber shellers, motors, coin motors, whitener motors, polisher motors, air compressors and also in lighting systems.

The Warangal District Rice Millers Welfare Association is one of the active associations in the cluster.

Table 6: Details of the Warangal Rice Mill Cluster

Description	Details
Location	Telangana
Number of rice mill units	~110
Major rice products	Raw rice, parboiled rice and kalam rice
Type of fuel used in cluster	Electricity, Rice husk, Agro residue-based fuel
Prominent Technologies used	Boilers, paddy elevators, rubber shellers, motors, coin motors, whitener motors, polisher motors, air compressors
Prominent Industry association	• The Warangal District Rice Millers Welfare Association
Prominent Institutes	District Industries Centre (DIC) – Warangal MSME-DI Hyderabad
SDA	Telangana State Renewable Energy Development Corporation Ltd. (TSREDCO)

3.1.3. Eastern Region¹³

Ganjam and Nayagarh clusters have around 270 rice mills covering Berhampur, Hinjilicut, Bhanjanagar, Ganjam and Nayagarh areas. The total estimated production at cluster level is 1,111,949 tonnes per year. All mills located in the Ganjam cluster are producing raw rice and few units are also producing parboiled rice and allied food products. Most of these raw materials are available locally.

Electricity is the main source of energy, used for operating machineries like elevators, paddy cleaners, rubber shellers, separators, whiteners/cones and blowers. Only few units which produce parboiled rice use boilers for the steam generation.

All Odisha Rice Millers Association, Nayagarh Rice Millers' Association and Ganjam District Rice Mill Owners Association are the prominent associations at the state and cluster level.

Table 7: Details of the Ganjam and Nayagarh Rice Mill Cluster

Description	Details
Location	Odisha
Number of rice mill units	~270
Major rice products	Raw and parboiled rice
Type of fuel used in cluster	Electricity, Rice husk, Diesel (an exceedingly small share)
Prominent Technologies used	Rice husk-based boiler, Air compressor, Motor driven applications
Prominent Industry association	• All Odisha Rice Millers Association • Nayagarh Rice Millers' Association

¹³ TERI. 2016. Cluster Profile Report – Balasore Rice Mills. New Delhi: The Energy and Resources Institute 8 pp. [Project Report No. 2014IE15]

TERI. 2015. Cluster Profile Report – Bargarh rice mills. New Delhi: The Energy and Resources Institute 10 pp. [Project Report No. 2014IE15]

TERI. 2016. Cluster Profile Report – Berhampur rice mills. New Delhi: The Energy and Resources Institute 8 pp. [Project Report No. 2014IE15]

Description	Details
	<ul style="list-style-type: none"> • Ganjam District Rice Mill Owners Association
Prominent Institutes	District Industries Centre (DIC) – Berhampur District Industries Centre (DIC) – Nayagarh MSME-DI Cuttack, Rourkela and Rayagada
SDA	Odisha Renewable Energy Development Agency (OREDA)

Balasore rice mill cluster has around 25 mills in operation with an estimated cumulative annual rice production of around 122,400 tonnes. Majority of the rice mills in the cluster are processing parboiled rice. The varieties of rice processed in the cluster include Swarna rice, Ratna rice, Broken rice, White rice, Sonamasuri rice, Miniket rice, Basmati rice, Gobindobhag rice, etc. The units in the cluster rely majorly on the paddy supplied by government under PDS establishment for the raw material.

The forms of energy used by the rice mills include rice husk, electricity and diesel. The technologies deployed in the cluster include rice husk fired boiler, steaming bowl, dryer, destoner, dehusker, whitener and polisher, among others.

North Odisha Chamber of Commerce & Industry (NOCCI), Balasore Chamber of Industries & Commerce (BCIC), Balasore Rice Millers Association, All Odisha Rice Millers Association – Bhubaneshwar, Central Rice Research Institute (CRRI), Cuttack and Odisha University of Agriculture and Technology (OUAT), Bhubaneswar are the prominent stakeholders in the region.

Table 8: Details of the Balasore Rice Mill Cluster

Description	Details
Location	Odisha
Number of rice mill units	~25
Major rice products	Parboiled and raw rice
Type of fuel used in cluster	Electricity, Rice husk, Diesel (an exceedingly small share)
Prominent Technologies used	Rice husk fired boiler, steaming bowl, dryer, destoner, dehusker, whitener and polisher
Prominent Industry association	<ul style="list-style-type: none"> • North Odisha Chamber of Commerce & Industry (NOCCI) • Balasore Chamber of Industries & Commerce (BCIC) • Balasore Rice Millers Association • All Odisha Rice Millers Association – Bhubaneshwar • Central Rice Research Institute (CRRI), Cuttack • Odisha University of Agriculture and Technology (OUAT), Bhubaneswar
Prominent Institutes	District Industries Centre (DIC) – Balasore MSME-DI Cuttack, Rourkela and Rayagada
SDA	Odisha Renewable Energy Development Agency (OREDA)

Bargarh rice mill cluster has around 95 rice mill units with an estimated cumulative annual rice production of around 7,69,824 tonnes. Majority of the paddy processed in the cluster is for producing parboiled rice with raw rice having a small contribution in the total rice processed. The units in the cluster use the paddy supplied by the government under PDS establishment for raw material.

The units use rice husk produced as a by-product during rice processing for meeting majority of their energy needs. Electricity sourced from grid also contributes to a small share in the total energy consumption. The technologies deployed in the cluster include rice husk fired boiler and steaming bowl for steaming the paddy, dryer for drying the steamed paddy, and the destoner, dehusker, whitener and polisher for converting the dried paddy to rice, among other technologies.

Bargarh Rice Millers Association and State level Rice Mill Association – Bargarh are the prominent associations active at the cluster level.

Table 9: Details of the Bargarh Rice Mill Cluster

Description	Details
Location	Odisha
Number of rice mill units	~95
Major rice products	Parboiled and raw rice
Type of fuel used in cluster	Electricity and Rice husk
Prominent Technologies used	Rice husk fired boiler, steaming bowl, dryer, destoner, dehusker, whitener and polisher
Prominent Industry association	<ul style="list-style-type: none"> • Bargarh Rice Millers Association • State level Rice Mill Association – Bargarh • All Odisha Rice Millers Association – Bhubaneshwar • Central Rice Research Institute (CRRI), Cuttack • Odisha University of Agriculture and Technology (OUAT), Bhubaneswar
Prominent Institutes	District Industries Centre (DIC) – Bargarh MSME-DI Cuttack, Rourkela and Rayagada
SDA	Odisha Renewable Energy Development Agency (OREDA)

Berhampur rice mill cluster has around 160 number of rice mills with an estimated cumulative annual production of 31,320 tonnes. Majority of the rice mill units in the cluster are involved in the processing of raw rice. The units rely majorly on the paddy supplied by the government under PDS establishment for raw material.

The raw rice processing units use only electricity from the grid for various motive loads of the processing equipment. The processing technologies deployed in the raw rice units cover Sheller and De-husking machines to remove husk from the paddy surface, Cone polishers to remove bran from raw rice, Vibrators and Separators used at different stages of the process to remove contaminants like straw, seedless paddy, stone, grass leaves etc., separating stone, broken rice and carryover of paddy from Sheller, Graders used to separate different categories of rice with the help of vibrating mesh separator, among others.

The Ganjam District Rice Millers Association – Berhampur and the All Odisha Rice Millers Association – Bhubaneswar are the prominent associations active in the region.

Table 10: Details of the Berhampur Rice Mill Cluster

Description	Details
Location	Odisha
Number of rice mill units	~160
Major rice products	Raw rice (to a major extent)

Description	Details
Type of fuel used in cluster	Electricity
Prominent Technologies used	Sheller and De-husking machines, Cone polishers, Vibrators and Separators, Graders
Prominent Industry association	<ul style="list-style-type: none"> • Ganjam District Rice Millers Association – Berhampur • All Odisha Rice Millers Association – Bhubaneshwar • Central Rice Research Institute (CRRI), Cuttack • Odisha University of Agriculture and Technology (OUAT), Bhubaneswar
Prominent Institutes	District Industries Centre (DIC) – Berhampur MSME-DI Cuttack, Rourkela and Rayagada
SDA	Odisha Renewable Energy Development Agency (OREDA)

3.2. Sector Level Stakeholders

In context of our existing working relationships in several MSME clusters, the local level stakeholders show great interest and enthusiasm for energy efficiency initiatives and technical cooperation activities. These stakeholders can be positioned as opinion influencers among the local industrial community during project activities in any cluster.

The primary stakeholders in the cluster are the industry associations, individual food processing units and MSME DI/DIC. The other stakeholders include the technology suppliers, government agencies, financial institutions, and academic/training institutes.

Industry Association

Industry associations are increasingly becoming more professionally managed with dedicated staff for day-to-day operations. These associations serve as the first avenue to understand cluster dynamics such as energy efficiency technology needs, disseminate best practices among member units and also assist in organizing various cluster level awareness programmes on EE. Leveraging these industry associations from the initial stage of the study would be quite valuable in:

- Understand the membership profile of MSMEs in the cluster
- Cluster profile of Industrial association including number of MSMEs, size of MSME units
- Present business scenario, barriers for energy efficiency
- Support in reaching out to member industries for project activities

The major industry associations in the Indian food processing sector are presented next.

Table 11 List of key industry associations

Organization	Contact Details
All India Rice Exporters' Association (AIREA)	riceassociationindia@gmail.com
Haryana Chamber of Commerce & Industries Association Kaithal	9812034731
Rice Mills Association Kaithal	9896335728
Rice Mill Association Cheeka	9355572768
Kaithal Rice mill association	8607200031
All Odisha Rice Millers Association (AORMA)	+91 9433011631 secretary.aorma@gmail.com
Nayagarh Rice Millers' Association	+919437003700 ms.shubhalaxmi@gmail.com

Organization	Contact Details
Ganjam District Rice Mill Owners Association	+919437259175 tarunpatro1971@gmail.com
North Odisha Chamber of Commerce & Industry (NOCCI)	+919437295815 info@noccii.in
Balasore Chamber of Industries & Commerce (BCIC)	08984343436/09437666551 bcic@bcicbalasore.org

Government Institutes:

There are government support bodies, such as District MSME Centre (DIC) – Kaithal, District Industries Centre (DIC) – Berhampur, DIC – Nayagarh, DIC – Vellore among others in the clusters which also work towards the development of the cluster particularly for MSME industries. MSME-DI has office in Karnal, Cuttack, Rourkela, Rayagada, Visakhapatnam, among other places and support the execution and implementation of the schemes from MoMSME. The agency functions may also include development and promotion of programmes on EE and RE in the region.

National and Regional Stakeholders Associated with Rice Mill Sector

All India Rice Exporters' Association (AIREA)¹⁴

The All India Rice Exporters' Association (AIREA) is the apex trade body of the rice exporters from India. Founded in 1989, ever since it has been serving the rice trade industry. AIREA supports its member units in liaison with various State and Central government agencies with respect to the trade issues and policy matters. It maintains close liaison with The Agricultural & Processed Food Products Export Development Authority (APEDA), Ministry of Commerce, Ministry of Agriculture, National Plant Protection Organization (NPPO) and state Agriculture Departments etc. AIREA helps exporters with market intelligence, market leads, regulatory issues and participation in various exhibitions, trade fairs in India and overseas. AIREA also assists the Government of India in framing rice related policies in the best interest of trade and the country.

Currently AIREA has 97 members, and it also registers associate members from other industry stakeholders such as laboratories, logistics agencies, machinery and packaging industry etc. The 39-member strong Governing Body, a Supreme decision taking arm of AIREA comprises of committed and dedicated members whose strong knowledge base helps the industry in promoting external trade of rice. AIREA holds regular summits and industry experts and leaders are invited to speak on the various key aspects of the rice industry. AIREA looks to increase global exposure of Indian rice through participation in various food festivals and events like the Gulf Food Fair, Anuga Food Fair, SIAL, etc.

Haryana Chamber of Commerce & Industries Association Kaithal¹⁵

The Haryana Chamber of Commerce & Industry (HCCI) is a 50-year-old body and is established with limited liability and regulated according to the provision of the constitution. It has chapters in most of the districts of the state. Their vision is to make the Chamber the VOICE of the Industry and Trade in Haryana. HCCI's priority is to get all the chapters work together under a coordinated system so that they can be more effective in their approach to the problems. HCCI's aim is to have a close liaison with the State and the Central Government so that they are easily approachable to tackle the problems of HCCI. HCCI works to upgrade the standard of the industry, specially the MSME so that it can work with more ease and grow faster. The Chamber was involved in the updating the Enterprise & Employment Policy of Haryana, HSIIDC, HSVP & UHBVN Rule Books.

¹⁴ <https://airea.net/>

¹⁵ <http://www.hcci.in/president-message.html>

All Odisha Rice Millers Association (AORMA)¹⁶

All Odisha Rice Millers' Association "AORMA" is an organization constituted by the Rice Millers of the entire State. It was formed by some eminent Rice Millers in 2004. Presently they have 1400 rice millers as members across the state, out of which 121 members are Patron Member. The basic objective of their association is to represent their members at different forum, establishing good relation and better understanding among the members, Creating proper ecosystem for development of rice mill industries, and To act as a cluster towards raising the issues faced by the industries before the authorities of various departments and institutions.

North Odisha Chamber of Commerce & Industry (NOCCI)¹⁷

NOCCI's vision is to identify and strengthen the role of industry & commerce of North Odisha in tandem with the economic development of the state, & country. Founded with the aim to bring the industries, trade & commerce of North Odisha closer for providing a meaningful forum to interact to keep pace & integrate with the development of the state as well as fight for the rights, North Odisha Chamber of Commerce & Industry (NOCCI) is the interface for companies that want to do business both at the local and global level. NOCCI catalysis change for its member companies of all sizes, both from public and private sectors, by working closely with government on policy issues, enhancing efficiency, competitiveness and expanding business opportunities through a range of specialized services.

Balasore Chamber of Industries & Commerce (BCIC)¹⁸

The motto of BCIC established in 1989 is to encourage the industries and commercial establishments and help the business house to grow. It acts as a catalyst organization for enterprise promotion at district level. The chamber represents in different forums i.e., central Excise, Commercial Taxes, Railways, Labor, E.P.F., E.S.I. and committees of general and committees of its members both in industrial and commercial fields. The Chamber represent various grievances before the authorities and the Government. The activities of the Chamber include

- Representing the cases of any member with the appropriate authority
- Organizing workshops, seminars, interaction meets in association with Both Central and State Govt. Departments for the interest of its members
- Participating in developmental activities with district administration.
- Participating in policy making matters with State Govt.
- Organizing State/ National level Trade Fair & Vendor Development Meet in order to facilitate the marketing of MSE's products
- Participating in redressal of local issues raised from time to time.
- Chamber acts as SPV in development of Plastics Cluster

In addition, there are several cluster level associations like Rice Mills Association Kaithal, Rice Mill Association Cheeka, Kaithal Rice mill association, The Federation of Tamil Nadu Rice Mill Owners & Paddy Rice Dealers Associations (FTPDA), Tiruchirappalli, District level Rice Mill Association, Viluppuram, Arni Taluk Paddy and Rice Merchant Association, Arni, The Warangal District Rice Millers Welfare Association, Balasore Rice Millers Association, Central Rice Research Institute

¹⁶ <https://www.aorma.in/about-us>

¹⁷ <https://www.nocci.in/>

¹⁸ <https://www.bcicbalasore.org/>

(CRRI), Cuttack, Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, Bargarh Rice Millers Association, State level Rice Mill Association – Bargarh, Ganjam District Rice Millers Association – Berhampur.

Research Institutions Supporting Rice Mill Sector

In India, several national and state level universities and research institutes are engaged in the research areas like enhancing yield, quality and climate resilience of rice, enhancing the productivity, sustainability and resilience of rice based production system, among other rice production and processing areas. The research and work areas of few prominent and leading ones is described next.

Central Rice Research Institute (CRRI), Cuttack¹⁹

The Central Government, in the year 1944, decided to intensify research on all aspects of rice crop. In the following year, the Government decided to establish a Central Institute for Rice Research, and this culminated in the establishment of the Central Rice Research Institute (CRRI) on April 23, 1946 at Bidyadharpur, Cuttack, Odisha with an experimental farm land of 60 hectares provided by the Government of Odisha. Dr. K Ramiah, an eminent rice breeder, was its founder Director. Subsequently, in 1966, the administrative control of the Institute was transferred to the Indian Council of Agricultural Research (ICAR). CRRI is one of the institutes of ICAR under Crop Science Division. The Institute has two research stations, one at Hazaribag, Jharkhand for carrying out rice research on rainfed upland ecologies and the other at Gerua, Assam for carrying out rice research on flood prone rainfed lowland ecologies. Two Krishi Vigyan Kendras (KVKs) also function under the administrative control of CRRI. The KVKs are located at Santhapur, Cuttack, Odisha and Jainagar, Koderma, Jharkhand.

The institute has a strong force of well-experienced scientists and other researchers with expertise in diversified disciplines. The institute has been offering consultancies and advisory services to the public sectors all over the country and abroad on different technologies. The National Rice Research Institute (NRRI), Cuttack offers practical training to students as well as customized training programme for dissemination of modern rice production technology among farmers since its inception.

Odisha University of Agriculture and Technology (OUAT), Bhubaneswar²⁰

The OUAT was established as The Planning Commission Committee felt the inadequacy of trained personnel for substantial output in agricultural operations with the then set up of research, education and extension in Agriculture, Animal Husbandry and allied fields. The colleges under OUAT offer agriculture, agriculture engineering and technology, basic sciences, agro polytechnic, and other agriculture and forestry related academic programmes.

¹⁹ https://crii.icar.gov.in/crri_ag.php

²⁰ <https://www.ouat.nic.in/>

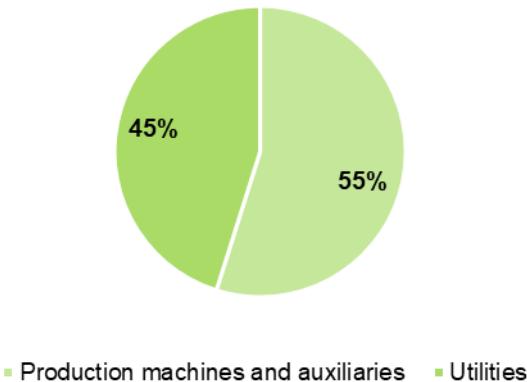
3.3. Energy Consumption and Benchmarking of Rice Mill Sector

3.3.1. Energy Consumption

Food processing industry is energy intensive and energy cost accounts for about 15²¹ per cent of total production cost. The primary process steps in food processing varies with the type of product processed.

In case of rice mills, the process steps include pre-cleaning and destoning, parboiling, drying, final cleaning, de-husking, husk separation, and whitening/polishing. Whereas in case of raw rice the process steps include cleaning, de-husking, un-husked paddy separation, polishing, and grading.

Energy Consumption in Raw Rice Mill



Energy Consumption in Parboiled Rice Mill

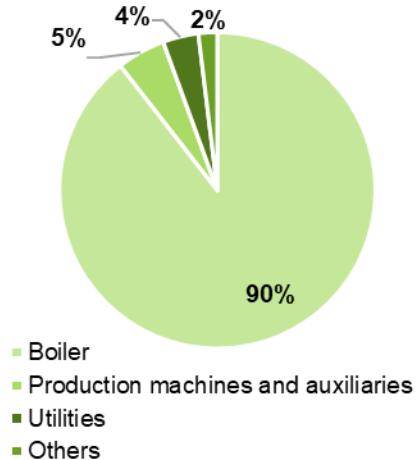


Figure 5: Typical energy consumption in raw rice mill

Figure 4: Typical energy consumption in parboiled rice mill

In case of parboiled rice mills, parboiling and drying accounts for 90% of the total energy. Figure 4 and Figure 5 showcases the share of energy consumption across process machineries, utilities and auxiliaries in a typical raw and parboiled rice mill.²²

consumption, and the balance energy is used in utilities and auxiliary operations.

- *Specific Energy Consumption (SEC)²³ for raw rice mills range between 1.5 to 3.5 kgoe per tonne of rice*
- *Specific Energy Consumption²³ for parboiled rice mills ranges between 81-124 kgoe per tonne of rice*

Boilers have a huge potential for energy conservation and energy can be saved by relining of surface wall and doors of combustion zone and deaerator, providing insulation to condensate return line, installing economizer, installing auto/semi-auto control systems for optimizing air supply, replacing old boilers with energy efficient boilers, among other interventions.

²¹ <https://www.centricabusinesssolutions.com/blogpost/energy-accounts-15-food-and-drink-manufacturers-costs-scope-ease-pressure-margins-clear#:~:text=Blogs-,Energy%20accounts%20for%2015%25%20of%20food%20and%20drink%20manufacturers%20costs,pressure%20on%20margins%20is%20clear>

²² The energy consumption values across process machines and auxiliaries, and utilities are from the energy audit studies conducted as part of the Energy and Resource Mapping project

²³ SEC is defined based upon the audits carried out by the team as part of this assignment and past audit experience

In Indian food processing context, some clusters are doing better than others. Within the clusters some food processing units are doing better than others. These units have identified and implemented energy efficient technologies and practices. Thus, there is need for benchmarking (SEC in kgoe/tonne of final product) and energy mapping. This shall further improve the efficiency and competitiveness of the Indian food processing industry.

3.3.2. Energy Benchmarking

The term benchmarking involves “comparing actual or planned practices, such as processes and operations, to those of comparable organizations to identify best practices, generate ideas for improvement”²⁴ which form the basis for measuring performance in an industry.

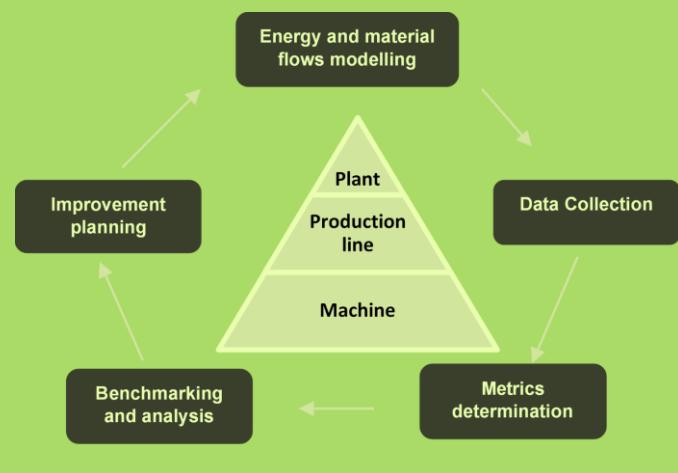
Energy efficiency (EE) benchmarking can be defined as the technique to identify the best practices and achievable EE improvement targets in companies and industries. The management in an industry can compare their baseline values with benchmark and take steps to ensure improvements in EE.

Energy efficiency benchmarking can be divided into internal (including SEC, historical trends of production, energy consumption inside plant boundary) and external benchmarking (benchmarking with industry best SEC level etc.). Internal benchmarking is the comparisons within one company to establish the baseline and best practice. External benchmarking is to compare companies in the same or similar industry sector to establish the best-in-class performance. Additionally, general benchmarking is the comparison of practices regardless of the industry field.

Benchmarking as defined above is the process of searching for best practices that lead to excellence in performance. Baseline can be established by comparing the best practices and subsequently, areas of potential improvement, and areas of focus can be identified. A variety of methods and studies have been carried across industry to come up with the best practices of energy efficiency benchmarking.

Example: A five step energy benchmarking method (E²BM method)

E²BM method can be applied at each individual process (e.g., machine), interrelated processes (e.g., production line), and a plant. This method relates energy consumption in manufacturing process to material flows to visualise the effectiveness and variations of energy usage. The inputs received from the prior step are used for developing strategies to improve energy efficiency. It consists of five steps and takes three levels of hierarchy into consideration i.e., plant, production line and machine.



Energy Performance Indicators (EnPIs) for the Sector

Key Performance Indicator (KPI) can be defined as a quantifiable/measurable value that demonstrates how effectively the industry or equipment or process is performing. KPIs can be financial and non-financial. A pictorial representation defining KPI's is presented next.

²⁴ Source: Guide to the project Management body of knowledge, PMBOK, 2013.



The four challenges in defining and maintaining KPIs are: (a) understanding industry's strategy and key objectives, (b) measure is deemed important to area/process of the industry, (c) targets of KPI improvement must be realistic and (d) in case, accurately measuring and reporting indicators is difficult, internal process or SOP should be defined.²⁵

Table 12 EnPI related terms and definitions

Term	Definition	Notes
Energy baseline	Quantitative reference(s) providing a basis for comparison of energy performance	An energy baseline reflects a specified period of time
Energy consumption	Quantity of energy consumed	-
Energy efficiency	Ratio or other quantitative relationship between an output of performance, service, goods or energy, and an input of energy	Conversion efficiency: energy required/energy used; output/input; theoretical energy used to operate/energy used to operate
Energy performance	Measurable results related to energy efficiency, energy use and energy consumption	Results can be measured against organization's energy targets and energy performance requirements
Energy performance indicator	Quantitative value or measure of energy performance, as defined by the organization	EnPIs could be expressed as a simple metric, ratio, or a more complex model ²⁶

EnPIs can be a simple parameter, a simple ratio, or a complex model. Examples of EnPIs can include energy consumption per time, energy consumption per unit of production, and multi-variable models. The organization can choose EnPIs that inform the energy performance of their operation and can update the EnPIs when business activities or baselines change that affect the relevance of the EnPI, as applicable.

Energy performance indicator of a food processing industry as a whole is represented as energy consumed per tonne of food produced (kgoe/tonne), the indicator can be further divided to arrive at sub-process/equipment-wise EnPI such as boiler (kgoe/tonne), air compressor (kW/cfm). The EnPI for any equipment varies depending on end application, usage pattern and a number of variable parameters.

EnPIs can further be classified as direct or indirect. Direct EnPIs are the internal factors for comparison within an industry to come up with best practices and establish baselines. Indirect EnPIs is comparison of companies or industries in a similar sector to establish best in class practice.

²⁵ Source: The Basics of Key Performance Indicators, <https://www.thebalancecareers.com/key-performance-indicators-2275156>

²⁶ Source: International Standard, ISO 50001 - Energy Management Systems - Requirements with guidance for use, 1st edition 2011-06-15

3.3.3. SEC Comparison Among Various Rice Mill Clusters in India

The specific energy consumption (SEC) of any food processing unit varies considerably depending on the type of product (raw rice/parboiled rice) and the degree of mechanization used. For example, raw rice mills consume in the range of 1.5 to 3.5 kgoe per tonne of rice, whereas parboiled rice mills consume in the range of 81-124 kgoe per tonne of rice.²⁷ In case of parboiled rice mills, parboiling and drying accounts for 90% of the total energy consumption, and the balance energy is used in utilities and auxiliary operations. The geographic location of the prominent clusters along with the share of type of rice processed is presented in the Figure 6²⁸ below.

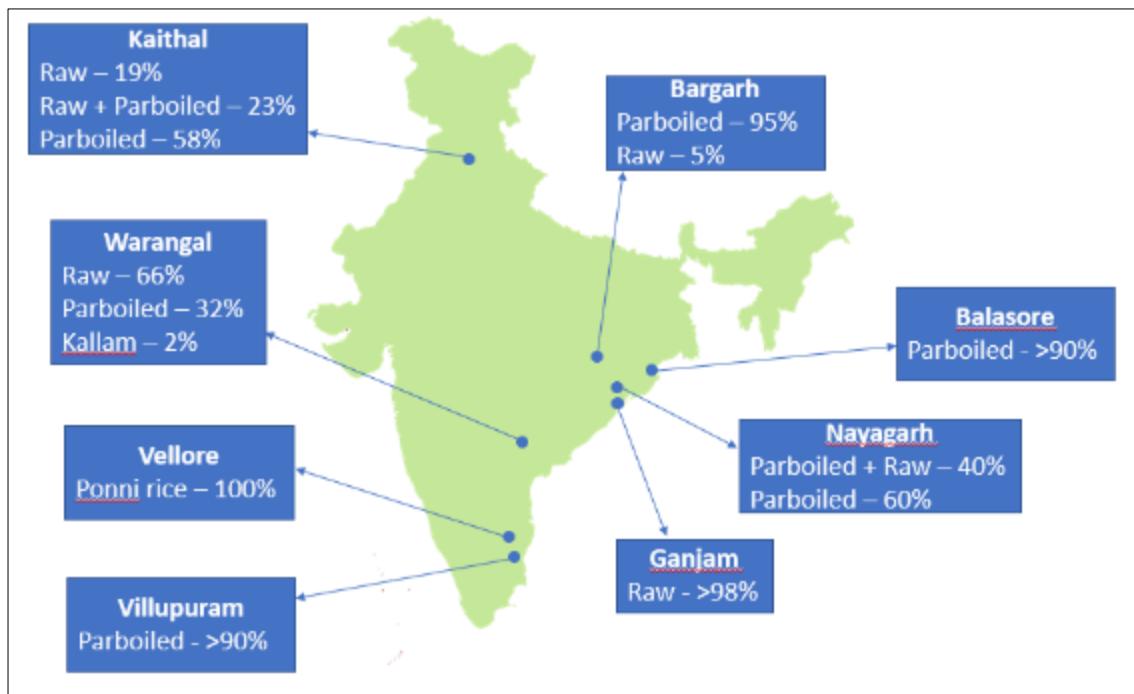


Figure 6: Product mix in prominent rice mill clusters

Average SECs of rice mills in some of the prominent clusters are represented in the bar graph below.

²⁷ SEC is defined based upon the audits carried out by the team as part of this assignment and past audit experience

²⁸ SAMEEKSHA, Energy Audit Studies Conducted as part of the BEE Energy and Resource Mapping Assignment

The Figure 7²⁹ above showcases the variation in the SECs across the several rice mill clusters in

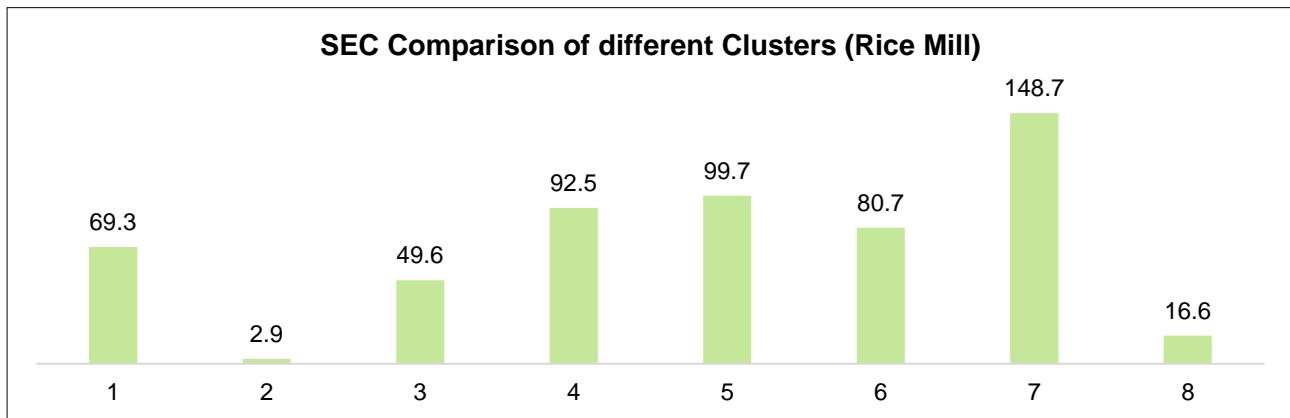


Figure 7: SEC benchmarks for different rice mill clusters across the country

the country. The variation in SECs is primarily due to the type of rice processed i.e., raw rice or parboiled rice. The clusters such as Berhampur and Warangal have lower SEC values compared to other clusters because the units in Berhampur and Warangal majorly processes raw rice. Further variation in SECs across clusters is due to the level of energy efficient practices implemented by the units in the cluster. In parboiling units, the boiler is the major energy consumer and hence the level of best operating practices for boilers followed by these units greatly affect the cluster level SEC values.

In order to carry out the better comparison the SEC should be monitored on the basis of the type of product processed. Variation of the SEC for different products processed is presented in Table 13.

Table 13: SEC benchmark data for Indian MSME rice mill units

Product Category	Product Sub-category	SEC (kgoe/tonne of final product)		
		Minimum	Maximum	Median
Rice	Raw rice	1.52	3.53	1.99
	Parboiled rice	81.6	124.7	92.6

Variation in the SEC can be broadly classified in the two main parameters –

- **Type of product processed**
- **Best Operating Practices (BOPs)**

Details of each category mentioned above is presented in subsequent sections-

Type of product processed

Rice mill sector has two major categories including raw rice, parboiled rice, among others. The type of rice processed in a particular rice mill unit has a major role to play in its energy consumption. The process flow and technologies used vary a lot with the type of rice processed and hence the energy intensity.

- In case of raw rice, the processing operations performed are cleaning, de-husking, unhusked paddy separation, polishing and grading. And the energy form used for

²⁹ SAMEEKSHA, Energy Audit Studies Conducted as part of the BEE Energy and Resource Mapping Assignment

³⁰ Most widely adopted technology based on the survey and EA carried out during the BEE energy and resource mapping assignment

performing these operations is entirely electrical energy. Whereas in case of parboiled rice mills there are additional processes like parboiling and drying of parboiled paddy. These processes need thermal energy and hence the units processing parboiled paddy use majorly rice husk fired boilers for meeting the thermal demand from process. As a result, the specific energy consumption value for raw rice is lower compared to parboiled rice due to the absence of few processes in the case of raw rice.

Best operating practices and EE technologies for the different processes used in rice mills play a vital role in optimization of the energy consumption in the units. Summary of key BOP's and technologies is presented in Table 14

Table 14: Summary of BoPs and EE technologies for different food processing sub-sectors³¹

Particulars	Best (Efficiency/SEC) ³²	Major Area of Improvement Required to meet the Benchmark values	Best operating practices
Rice husk / Cane straw fired boiler	77%	<ul style="list-style-type: none"> Reduce the heat losses from the Boiler surface and Header Gate by relining and providing ceramic blanket to doors & curtain. Reduce the heat losses from the Condensate return pipeline by providing insulation to pipeline. Fine tuning of air fuel ratio for reducing the dry flue gas losses Waste heat recovery from boiler flue gas for heating combustion air 	<ul style="list-style-type: none"> Maintain stack temperature between 120 – 130 °C by recovering heat to preheat combustion air or boiler feedwater Maintain excess air between 30 – 40% using PLC based control/IoT based automation Automatic blowdown control based on boiler water conductivity and pH. Regular removal of soot build up on tubes and scaling on water side. Optimization of steam pressure based on process demand. Variable speed control for ID and FD fans if the boiler load characteristics are variable. Maintaining boiler loading at two-thirds of full load.

³¹ Elaborative details of ah technology and BOP is presented in technology compendium section

³² Based on studies carried out in food processing clusters

Particulars	Best (Efficiency/SEC) ³²	Major Area of Improvement Required to meet the Benchmark values	Best operating practices
Compressed Air system	<ul style="list-style-type: none"> • Reciprocating – 0.22 kWh/cfm • Screw single stage – 0.19 kWh/cfm 	<ul style="list-style-type: none"> • Technology shift to the more efficient screw compressors with efficient permanent magnet motors, and other EE features based on application requirements like integrated speed control systems (VFDs), Waste Heat Recovery (WHR) from hot compressed air, all result in significant SEC reduction when appropriately applied. • Optimum size of the air compressors • Compressed air distribution system improvements like appropriately sized low friction coefficient piping, appropriately sized air receivers at appropriate locations in the system, use of the more efficient refrigeration based, or desiccant based air dryers where required etc. can also contribute to lower SECs in compressed air systems. 	<ul style="list-style-type: none"> • Operate the compressor at the optimal pressure requirement • Limit the compressed air leakage within 3% to 10%. • Maintain operating SPC within the design range as provided by the OEMs. • Periodic cleaning of the suction filters • Ensure the optimal dryer operation • Maintain specified air temperature after intercooler
Motors and Drives	<ul style="list-style-type: none"> • Refer Efficiency of Motor as per catalogue of motor manufacturer • Efficiency varies in range of 75%-95% for different rating of the motors from 0.3 kW- 500 kW 	<ul style="list-style-type: none"> • Replacement of rewound motor with efficient IE4 motors 	<ul style="list-style-type: none"> • Use IE3 or higher rating motors • Use BLDC motors for fans, blowers etc. • Maintain voltage and current imbalance as low as possible as prescribed by IEEE • Replace the motor after rewinding once

Particulars	Best (Efficiency/SEC) ³²	Major Area of Improvement Required to meet the Benchmark values	Best operating practices
Lighting	120 watt/lumen ³³	<ul style="list-style-type: none"> • Use of higher efficient Star rated LEDs, use of adequate lux level in different areas 	<ul style="list-style-type: none"> • Use of the motion sensors and automatic switching of lights

3.4. Energy Efficiency Potential in Rice Mill Sector

Rice mills are one of the energy intensive subsectors in food processing with the majority of the energy being consumed in operations like parboiling and drying.

Energy saving potential is a function of the present efficiency levels, type of fuel used, energy efficiency measures applicable for rice mill clusters, and readiness of the clusters in adopting the new state of art technologies. Details of the present fuel mix, penetration level of different technologies, EE potential for the rice mill clusters and national level projections is presented in this section.

The Rice mill sector mainly uses rice husk, electricity and diesel for meeting the energy requirements. Rice husk is a by-product obtained in rice mills and hence is majorly used by the rice mills cluster. The choice of fuels used varies with the type of rice processed in the rice mill unit. The units processing raw rice majorly use electricity and the units involved in processing parboiled rice are dependent on rice husk for major portion of their energy consumption. Major applications of the different fuels is presented next.



Electricity

For Driving Primemovers (majorly Motors)



Rice husk/Cane straw

Boilers, Dryers



Diesel

DG set for Back-up Power

During the BEE-“Energy and resource mapping assignment” detailed primary survey (EOI forms 189+) and secondary stakeholder consultations (200+), field visits (55+), energy audits (50), review of the past reports and interventions carried out across food processing clusters, discussion with IA (13+) and technology providers - were carried out to evaluate the penetration level of different technologies and share of the different fuels etc.

Summary of the cluster level and sector level findings based on the elaborative and extensive study is presented in section next.

³³ BEE Star rated appliances - https://www.beestarlabel.com/Content/Files/LED_schedule.pdf Accessed during April 2023

3.4.1. Energy consumption at Cluster Level

Based on the products processed (raw rice, parboiled rice) the forms of the energy used by the sector include electricity, rice husk/cane straw, diesel. Share of the energy varies for the different rice mill clusters based upon the type of the rice processed.

During the BEE energy and resource mapping study, the share of the fuel mix for the rice mill clusters (**Kaithal and Ganjam-Nayagarh**) is calculated based on the energy audits and stakeholder consultations with industries and multiple industries associations in these clusters (physical meetings, workshops, webinars).

Findings for these clusters have been thoroughly discussed with prominent industry associations and industries through workshops / physical meetings and one-one interactions with multiple industries.

*Cluster level workshops were conducted across – **Kaithal, Ganjam - Nayagarh** rice mill clusters to validate the findings. Regional consultations across the prominent rice mill clusters were also conducted to validate the findings.*

Summary of the different forms of energy used in different rice mill clusters is presented in Table 15.

Table 15: Energy share of different fuels in rice mill clusters (Units - toe)³⁴

Energy type	Kaithal	Ganjam - Nayagarh
Electricity	8675.8	3,885.1
Rice husk / Cane straw	86,097.7	23,428.6
Diesel	6.404	105.8
Total	94,779.9	27,420

Share of electricity in fuel mix for the Kaithal and Ganjam-Nayagarh clusters are 9.2% and 14.2% respectively. Share of rice husk/cane straw in fuel mix for the Kaithal and Ganjam-Nayagarh clusters are 90.8% and 85.4% respectively. Share of diesel in fuel mix for Kaithal and Ganjam-Nayagarh clusters are <1%.

Rice husk is the prominent fuel in the two clusters (Kaithal, Ganjam-Nayagarh) accounts for around 90% of total energy demand in these clusters. Electricity is the second largest used fuel in these clusters and contributes 10% to energy pie. Diesel contributes to <1% share in these clusters.

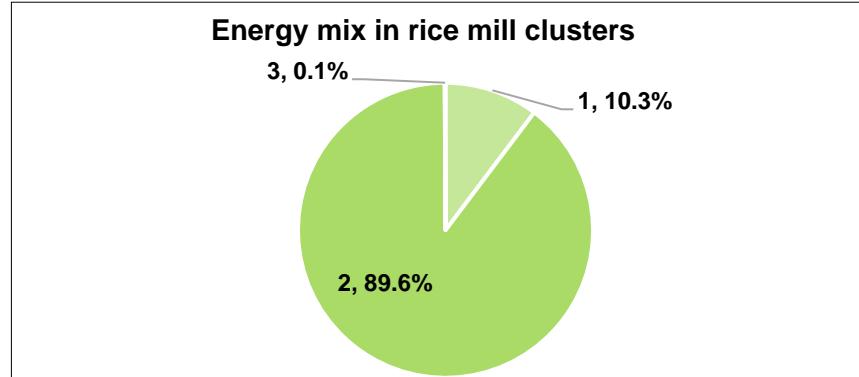


Figure 8: Share of different fuels across two rice mill clusters

³⁴ Appropriate GCV values of the different fuel based upon the discussion with Industries, review of the GCV reports at different audited units, across different clusters have been used to convert the different form of fuel to oil equivalent units.

3.4.2. Prominent Technologies being Adopted in Rice Mill Sector

The predominant technologies used in rice mills are described below.

1. Boiler

Most of the units use rice husk as a fuel for boiler, however, there are few units in the cluster which use cane straw as the boiler fuel. Most of the units use single pass technology for their boilers. The capacity of the rice husk fired boilers ranges from 0.75 - 12 tonnes per hour across the rice mill units in the cluster. The steam produced by these boilers is used to meet the demand from processes such as parboiling and drying. The direct efficiency of these boilers lies in the range of 60 – 77%. The common observations in the boilers across the rice mill units in cluster leading to energy loss were as below.

- Improper insulation on the surface walls of boiler and deaerator resulting in heat losses
- No insulation on condensate recovery pipeline
- Excess air used in combustion leading to dry flue gas losses
- Non recovery of waste heat from boiler flue gas

2. Air compressor

The units have installed air compressor mainly of screw type for meeting the compressed air requirement of instrumentation and service air. The capacities of these installed air compressors ranges from 7 to 258 cubic feet per minute (CFM). The operational specific power consumption of the screw type air compressors in the units in cluster was in the range of 0.16 to 0.37 kW/CFM. Some of the common observations in the compressed air system in the units resulting in increased power consumption are as below:

- Insufficient receiver capacity which results in increased loading on compressor leading to higher power consumption
- VFD is not installed on air compressor resulting in unload power consumption
- The surrounding temperature of compressor was observed to be 55 - 60°C, which is extremely high as compared to normal temperature

3. Blowers and Fans

Units are running motor driven applications for all the process machines. The process machines which contribute to motor-based loads include strainer machine, husk separator, destoner blower, FD fan, ID fan, vacuum blowers, silky blower, among others. The common observations resulting in higher power consumption in the units were

- It was observed during audit that the blower motors, ID fan motors, among others are driven using flat V-belt with pulleys. The disadvantage with belt drives are the high slippage, high maintenance and increased power consumption due to losses in transmission.
- It has been observed that there exist IE1 or IE2 standard motors in operation for process machines like destoner, separators, etc. in the plant.

3.4.3. Sector Level Rice Production and SEC Details

Production data for rice is taken from the Ministry of Agriculture and Farmers Welfare's "Second Advance Estimates of Production of Foodgrains for 2022-23". SEC data for rice processing is calculated from the multiple energy audits carried out under the BEE energy and resource mapping

assignment, SEC data has been validated thought multiple consultations carried out in different food processing clusters. Details of the present level production, SEC are presented in

Table 16: Production data for the FY 23³⁵

Product	Sub-category (capacity)	Production (Mn tonnes)	SEC (toe/tonne)
Rice	Raw Rice (< 2 tph)	39.251	0.003
	Raw Rice (> 2 tph)	26.167	0.003
	Parboiled rice (< 2 tph)	19.442	0.077
	Parboiled rice (> 2 tph)	45.976	0.080
	Overall	130.837	0.041

Rice production projections

Firstly, a correlation was obtained between India's historical GDP and historical rice production taken from the Ministry of Agriculture and Farmers Welfare's "Second Advance Estimates of Production of Foodgrains for 2022-23". Secondly, India's GDP was projected for the next decade based on several studies and projections related to GDP by International Monetary Fund (IMF) and India Energy Security Scenarios (IESS). Further, based on the correlation factor between GDP and rice production in past and the GDP projection values up to FY 2033, the rice production was projected till FY 2033. The sub-category mix until FY 2033 was considered the same as the sub-category mix in FY 2023.

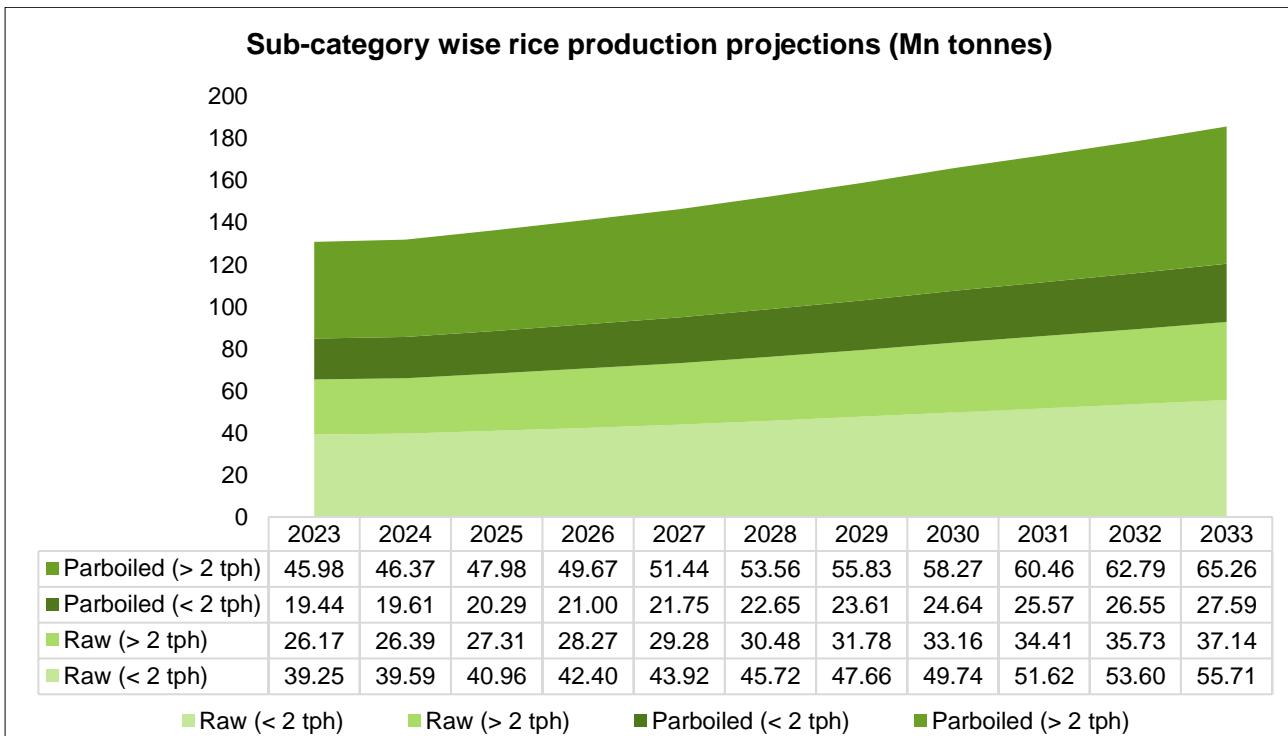


Figure 9: Sub-category wise rice production projections

³⁵ The sub-category wise production is estimated based on the share of raw rice and parboiled rice processed in the country, share of unregistered units in the total rice mill units, and inputs received during stakeholder consultations. The sub-category wise SEC values are calculated based on the energy audit studies conducted as part of this assignment.

3.4.4. Sector Level Energy Consumption

Benchmark SEC data for the different type of rice processed in rice mill sector validated through multiple consultations is used for calculating the sector level energy consumption data. Energy consumption for different type of rice processed is calculated by multiplying the SEC and production volume. Summary of the sector level energy consumption for different type of rice is presented in Table 17.

Table 17: Sector level energy consumption for the different products (FY 23)

Product	Sub-category	Energy consumption (Mn toe)
Rice	Raw (< 2 tph)	0.126
	Raw (> 2 tph)	0.068
	Parboiled (< 2 tph)	1.498
	Parboiled (> 2 tph)	3.676
Total energy consumption (Sector level - Rice)	Mn toe	5.367

The share of different fuels at sectoral level for rice processing remains same as showcased in Figure 8.

Rice husk has the highest share (90%) among the different forms of the energy. Rice husk is followed by electricity (10%) and diesel has an exceedingly small share of <1% in the total energy use.

3.4.5. Projections of Energy Saving Potential

In order to evaluate the energy saving potential at the sector level, mapping of energy efficient technologies, state of art technologies, EE technologies for utilities is required along with energy saving potential.

Mapping of the technologies for the different rice mill clusters were done through field studies, primarily survey, discussion with IA and technology vendors. Long list of the technologies was mapped during multiple tasks and activities under BEE energy and resource mapping study.

Replication potential for different technologies in short term and long term is evaluated in closed consultations with multiple stakeholders across different leading rice mill clusters – **Kaithal** rice mill cluster, **Ganjam-Nayagarh** rice mill cluster, **Vellore** rice mill cluster.

Summary of different energy efficient and state of art technologies is presented in Table 19 and Table 20.

Team has segregated the EE technologies in two categories based on their applicability in the short-term (next 5 years) and long-term (next 10 years). For all identified EETs replication potential is estimated and segregated into four categories.

Table 18: Methodology for segregating EETs

	Low Potential	Less than 10% MSMEs in cluster have replication potential
	Medium Potential	10%-30% MSMEs in cluster have replication potential
	High Potential	30%-60% MSMEs in cluster have replication potential
	Saturation	More than 60% MSMEs in the cluster have implemented EET

Potential of technology penetration levels across³⁶

Table 19: Process specific replication potential of technologies across rice mill clusters

S. No	Technologies	Energy savings potential	Replication potential in short- term (till 2028)			Replication potential in long-term (till 2033)		
			Micro	Small	Medium	Micro	Small	Medium
1.	Installation of Internet of Things (IoT) based energy monitoring system	1%	Low	Medium	High	Medium	Saturation	Saturation
2.	Installation of Energy Efficient Paddy Cleaner	45%	Low	Medium	Medium	Saturation	Saturation	Saturation
3.	Installation of Energy Efficient Separators	45%	Medium	Medium	Saturation	Saturation	Saturation	Saturation
4.	Installation of Plastic bucket for elevators	7%	Medium	High	Saturation	Saturation	Saturation	Saturation
State of Art Technologies³⁷								
5.	AI based Paddy Dryer	8%	Low	Medium	Medium	Low	High	High
6.	Water Recycle System	5%	Low	Medium	High	Medium	Medium	Saturation
7.	Online Moisture Meter - PLC controlled	0.5%	Low	High	High	High	Saturation	Saturation
8.	Semi-Automation System for soaking tanks - PLC controlled	5%	Low	High	High	High	Saturation	Saturation

³⁶ Indicative list not comprehensive, saving envisaged in the table only represents the energy saving, productivity saving from different technologies is not factored in this table. Most of the units globally having best SEC level had already implemented the ECMs indicated in point 1-7.

³⁷ Apart from energy savings there are additional benefits with respect to quality and productivity enhancement. More details on this are included in Annexure.

S. No	Technologies	Energy savings potential	Replication potential in short-term (till 2028)			Replication potential in long-term (till 2033)		
			Micro	Small	Medium	Micro	Small	Medium
9.	New Age Rice Whitener	10%	Low	Medium	High	Low	Saturation	Saturation
10.	New Age Rice Polisher	3%	Low	Medium	High	Medium	Saturation	Saturation
11.	Replacement of old boilers with energy efficient boilers	17%	Low	Medium	Medium	Low	Saturation	Saturation
12.	Replacement of old inefficient motors with energy efficient IE4 Motors	5 – 10%	Medium	High	High	Low	Saturation	Saturation
13.	Hot air generator for paddy drying	22%	Low	Medium	Medium	Low	Saturation	Saturation
Product quality enhancement / Renewable energy measures								
14.	Mechanized Soaking and Cooking unit	-	Medium	Medium	Saturation	Saturation	Saturation	Saturation
15.	Replacement of Cone Polishers with Whitener.	-	Low	High	Saturation	Saturation	Saturation	Saturation
16.	Optical Sorter	-	Low	Medium	High	Medium	High	Saturation
17.	Solar based paddy dryer	-	-	Medium	High	-	Low	Low
18.	Solar Water Heater	-	Low	High	High	Low	Medium	Medium
19.	Biomass gasifiers for power generation	-	Low	Medium	Medium	Low	Saturation	Saturation
20.	Installation of rooftop solar PV	-	High	High	High	Low	Saturation	Saturation

Energy conservation measures identified in cluster.

Table 20: Replication potential of energy conservation measures across rice mill clusters³⁸

S. No	Technologies	Energy savings potential	Replication Potential in short-term (till 2028)			Replication Potential in long-term (till 2033)		
			Micro	Small	Medium	Micro	Small	Medium
1.	Installation of additional receiver for Machine shop	4%	Low	High	High	Low	Low	Saturation

³⁸ Indicative list not comprehensive, saving envisaged in the table only represents the energy saving, productivity saving from different technologies is not factored in this table

S. No	Technologies	Energy savings potential	Replication Potential in short-term (till 2028)			Replication Potential in long-term (till 2033)		
			Micro	Small	Medium	Micro	Small	Medium
2.	Installation of VFD for existing air compressor to reduce the unload power consumption.	15%	Low	High	High	Low	Saturation	Saturation
3.	Use new air compressor with VFD to reduce the unload power consumption of the air compressor	42%	Low	Medium	Low	Low	Saturation	Saturation
4.	Reduce the heat losses from the Boiler surface and Header Gate by relining and providing ceramic blanket to doors & curtain.	2%	Low	High	High	Low	Saturation	Saturation
5.	Reduce the heat losses from the Condensate return line by providing insulation to line.	1%	Low	High	High	Low	Saturation	Saturation
6.	Economizer for boilers	7%	Low	High	Medium	Low	Saturation	Saturation
7.	Conversion of existing flat V belt to direct driven for ID Fan & Dryer Blowers	7%	Medium	High	High	Low	Saturation	Saturation
8.	Optimization of Excess air in the boiler	10%	Low	Medium	Medium	Low	Saturation	Saturation
9.	Reduction of surrounding temperature of the air compressor to reduce the power consumption.	7%	Low	Medium	Medium	Low	Saturation	Saturation
10.	Waste heat recovery from boiler flue gas for heating combustion air	7%	Low	Medium	Medium	Low	Saturation	Saturation

Implementation of the energy saving, and state of art technologies will help in reduction of the energy intensity eventually. This will help the rice mill units to become more energy efficient and competitive globally. Summary of the energy saving potential for the different types of rice processed is presented in Table 21

Table 21: Summary of the energy saving potential for different sub-categories in rice in Actual scenario

Product sub-category	Energy Saving potential (%)	Energy consumption (Mn toe) FY 22-23	Energy consumption BAU (Mn toe) FY 32-33	Estimated energy saving – Actual scenario (Mn toe) FY 32-33
Raw (< 2 tph)	12.8%	0.126	0.178	0.155
Raw (> 2 tph)	14.0%	0.068	0.097	0.083
Parboiled (< 2 tph)	11.3%	1.498	2.126	1.886
Parboiled (> 2 tph)	15.1%	3.676	5.217	4.431
<u>Total</u>		<u>5.367</u>	<u>7.618</u>	<u>6.556</u>

Projections of the different scenarios on account of the multiple interventions proposed for the rice mill sector are presented in Figure 10. The scenarios considered while projecting energy consumption are as below.

- Business as usual (BAU) scenario – In this case, the same level of energy efficiency is considered until 2033 as of 2023. There is no improvement considered in the specific energy consumption in the next ten years
- Actual scenario – Considering the energy savings potential mentioned in Table 21 is realized until 2033. These energy savings potential values are based on the detailed energy audit studies conducted in the Kaithal and Ganjam-Nayagarh cluster and considers energy efficiency technologies and measures and does not consider the implementation of the state-of-art technologies.
- Conservative scenario – Considering 75% of the energy savings potential as mentioned in Table 21 is realized until FY 2033
- Ambitious scenario – Considering 150% of the energy savings potential as mentioned in Table 21 is realized until FY 2033. The additional 50% energy savings are as a result of the adoption of the state-of-the-art technologies as mentioned in Table 19

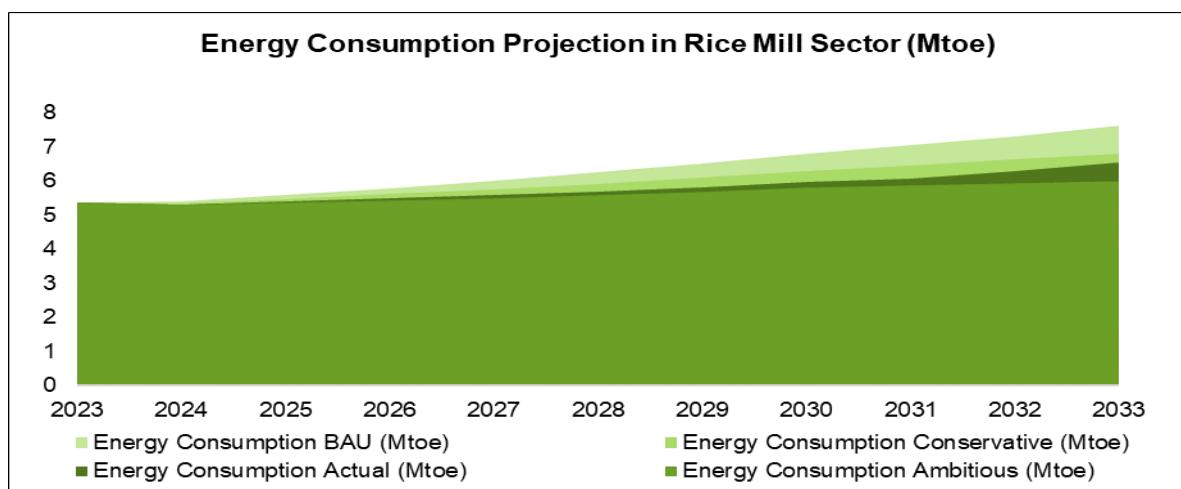


Figure 10: Projections of energy consumption and savings

Adoption of the new technologies will help the Indian rice mill units to reduce the SEC level by over 14% till FY 2033. Faster adoption of the interventions will further help the rice mill sector to achieve the saving and lower the emissions faster. List of challenges and proposed solutions to support the sustainable growth of the rice mill sector is presented in section 5.

Proposed sector level SEC for rice mills after implementation of EE and state of art technologies eventually reduces from 41.0 kgoe/tonne in FY23 to 35.8 kgoe/tonne in FY33 in the Actual scenario.

Proposed recommendations will help units in the rice mill sector to transit from conventional technologies to newer cleaner technologies for the production. Based on the consultations, the penetration level of the EE, state of the art technologies and other cross cutting technologies will not lead to change in the fuel mix of the sector. Rice husk will continue having the highest share (90%) among the different forms of the energy. Rice husk will be followed by electricity (10%) and diesel will have an exceedingly small share of <1% in the total energy use.

Rice mill sector will lower the carbon intensity in long run by adoption of the new EE technologies. And the development of the new state of the art technologies will further help in the reduction of the carbon intensity of the rice mill sector.

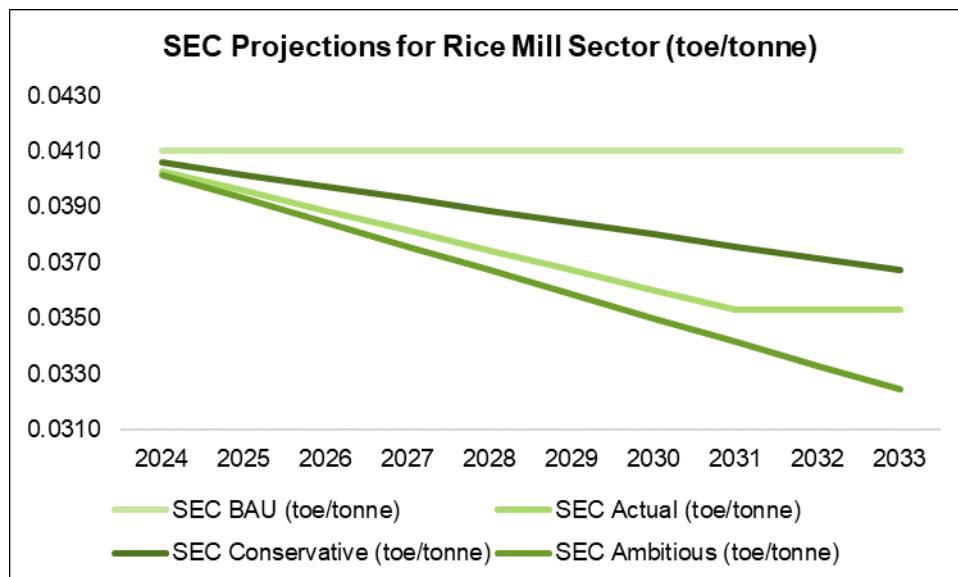


Figure 11: Change in SEC for the rice mill sector by implementation of EE and state of the art technologies

Adoption of the new technologies will help the rice mill sector during the transition to lower carbon emissions eventually. Rationale for the reduction in the SEC level considered are – EA recommendations will find faster adoption across the rice mill units and will be implemented by 2031 in the actual scenario and peer to peer learning will propagate the push for adoption of these technologies. State of art technologies are new and require the support and push from different stakeholders and demonstration projects, acceptance of these technologies will evolve over the time and penetration in MSME level will be completed by 2033. Projections carried out on the basis of adoption of new state of art technologies, advanced energy efficient technologies will help the rice mill sector to reduce the carbon intensity in long run.

3.4.6. ***Estimated co₂ Emission Reduction Potential***

Adoption of the energy efficient technologies and measures such as boiler revamping measures, etc., and other state of art technologies such as process automations and moisture level-based

controls, among others will help the rice mill sector to reduce the carbon emissions eventually. The change of the technology and adoption of the energy conservation and state of art technologies will help the rice mill sector in lowering their carbon emissions. Details of the emission reduction with respect to the base year (FY 2023) with BAU scenario is presented in Table 22. The fuel mix is considered same as that in the current scenario i.e., FY 2023.

Table 22: Fuel consumption and Emissions (BAU and proposed scenarios)

Year		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Energy Consumption and Emissions - BAU												
Raw (< 2 tph)	Mn toe	0.126	0.127	0.131	0.136	0.141	0.146	0.153	0.159	0.165	0.172	0.178
Raw (> 2 tph)		0.068	0.069	0.071	0.074	0.077	0.080	0.083	0.087	0.090	0.093	0.097
Parboiled (< 2 tph)		1.498	1.511	1.563	1.618	1.676	1.745	1.819	1.898	1.970	2.045	2.126
Parboiled (> 2 tph)		3.676	3.707	3.836	3.971	4.113	4.282	4.464	4.658	4.834	5.020	5.217
Total		5.367	5.413	5.601	5.799	6.006	6.253	6.518	6.802	7.058	7.330	7.618
Emissions	Mn tonne of CO ₂	6.101	6.153	6.366	6.591	6.826	7.107	7.408	7.731	8.022	8.331	8.659
Energy Consumption and Emissions – Actual scenario												
Raw (< 2 tph)	Mn toe	0.126	0.125	0.127	0.129	0.132	0.135	0.138	0.141	0.144	0.150	0.155
Raw (> 2 tph)		0.068	0.068	0.069	0.070	0.071	0.073	0.074	0.076	0.077	0.080	0.083
Parboiled (< 2 tph)		1.498	1.489	1.519	1.550	1.581	1.622	1.665	1.711	1.747	1.815	1.886
Parboiled (> 2 tph)		3.676	3.637	3.691	3.747	3.803	3.879	3.959	4.044	4.106	4.264	4.431
Total		5.367	5.319	5.406	5.495	5.587	5.708	5.836	5.972	6.074	6.308	6.556
Emissions	Mn tonne of CO ₂	6.101	6.048	6.148	6.252	6.359	6.499	6.647	6.805	6.924	7.190	7.473
Energy Consumption and Emissions – Conservative scenario												
Raw (< 2 tph)	Mn toe	0.126	0.125	0.129	0.132	0.135	0.139	0.144	0.149	0.153	0.157	0.161
Raw (> 2 tph)		0.068	0.068	0.070	0.072	0.073	0.075	0.078	0.080	0.082	0.085	0.087
Parboiled (< 2 tph)		1.498	1.498	1.536	1.577	1.619	1.671	1.726	1.786	1.836	1.890	1.946
Parboiled (> 2 tph)		3.676	3.665	3.749	3.836	3.927	4.040	4.161	4.290	4.397	4.509	4.628
Total		5.367	5.357	5.484	5.617	5.755	5.926	6.109	6.304	6.468	6.640	6.822
Emissions	Mn tonne of CO ₂	6.101	6.090	6.236	6.388	6.546	6.742	6.952	7.176	7.363	7.561	7.770
Energy Consumption and Emissions – Ambitious scenario												
Raw (< 2 tph)	Mn toe	0.126	0.124	0.126	0.128	0.130	0.132	0.135	0.138	0.140	0.142	0.144

Year		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Raw (> 2 tph)		0.068	0.068	0.068	0.069	0.070	0.071	0.073	0.074	0.075	0.076	0.077
Parboiled (< 2 tph)		1.498	1.485	1.510	1.536	1.562	1.597	1.634	1.673	1.703	1.734	1.766
Parboiled (> 2 tph)		3.676	3.624	3.663	3.702	3.741	3.798	3.859	3.922	3.960	3.999	4.039
Total		5.367	5.300	5.367	5.435	5.503	5.599	5.700	5.807	5.878	5.950	6.025
Emissions	Mn tonne of CO ₂	6.101	6.027	6.105	6.185	6.265	6.377	6.495	6.620	6.704	6.791	6.881

Adoption of the energy efficient technologies and measures and state of the art technologies will help in the reduction of 1.062 Mtoe during the FY 33 in Actual scenario. This reduction in the energy consumption will help the rice mill sector to reduce its carbon emissions by 1.185 Mn tCO₂ by FY 2033 in the Actual scenario. These transformations and adoption of new technologies will also help the rice mill sector to reduce the SEC level by over 14%.

Additionally, technical and financial barriers along with regulatory support required for the transition along with recommendations required to achieve the projections are presented in the next section.



4. Ready-to-Cook (RTC) and Ready-to-Eat (RTE): Sector Overview and Energy Saving Potential

4. Ready-to-Cook (RTC) and Ready-to-Eat (RTE)

4.1. Overview of RTC and RTE Industry

In India, the convenience food market comprising of the RTE and RTC products is dominated by domestic companies, but global players have also entered the space with vivid flavors and varieties. Organic food companies are also offering RTE/RTC foods to cater to health-conscious consumers. The RTE/RTC market has seen a significant growth in the past years due to increasing preference of the working population for RTE and RTC food. The production of RTE/RTC food products is projected to grow at a CAGR of 13% till FY30 starting from FY20 and reach around INR 9600 crore of market size or 4.6 Lac MT of production volume by FY30.³⁹ The growth of the RTE/RTC sector is attributed to factors like busy lifestyle, higher disposable income, growing number of nuclear families, among other factors.³⁹

The RTE/RTC market in India covers an extensive range of products like breakfast cereals, baked items, wafers, nuts, ready to cook frozen food items like frozen meat, samosa, sweet corn, pickles, jams, sauces, drinks, pasta, noodles, ready to cook mixes like desert, poha, upma, spice and other mixes, among others.

A detailed overview about region wise presence of these sector is provided as below:

4.1.1. Northern Region⁴⁰

Ludhiana has about 200 RTE food processing units operating in the cluster which are scattered across the city. About 72% of the units are engaged in the production of bakery products, savoury snacks and other ready-to-eat products. The remaining units are engaged in the production of jam, pickle and savoury snacks. The total estimated production at cluster level is 164,835 tonnes per year. Ludhiana bread industry enjoys the distinction of supplying bread to the entire north region comprising Punjab, Haryana, Himachal Pradesh, Chandigarh, parts of Rajasthan, Uttaranchal and Uttar Pradesh.

The units in Ludhiana cluster use raw materials like flour (besan, maida, wheat flour, suji), dry fruits (almond, cashew, raisins, dates, etc.), fruits and vegetables (potato, gooseberry, tomato, onion, garlic, tamarind), ghee, milk, salt, sugar, refined oil, yeast, among others. Most of these raw materials are available locally.

Almost 87% of the cluster's energy requirement comes in the form of thermal energy from burning LPG, diesel and wood. The remaining energy requirement comes from grid electricity. Most of the units in the cluster utilize electricity as a secondary source of energy for process machines and utilities. The units use LPG for Thermopac and Ovens, Wood for Boilers and Thermic Fluid Heaters, and Diesel is presently used in DG Set, Ovens, and Heater (Bhatti).

Associations including the Chamber of Industrial and Commercial Undertaking (CICU) - Ludhiana, Small Scale Industries Association – Ludhiana have presence in the cluster.

³⁹ https://worldfoodindia.gov.in/public/pdf/1691752912_1095741203.pdf

⁴⁰ SAMEEKSHA, Energy audit studies done as part of the BEE Energy and Resource Mapping Assignment

Table 23: Details of Ludhiana RTC-RTE cluster

Description	Details
Location	Punjab
Number of RTC-RTE units	~200
Major products	Bakery products, savoury snacks, jam, pickle, and other ready-to-eat products
Type of fuel used in cluster	LPG, Wood, Diesel, Electricity
Prominent Technologies used	Thermic Fluid Heater, Ovens, Boilers, Heater (Bhatti), Air compressor, Motor driven applications
Prominent Industry association	<ul style="list-style-type: none"> Chamber of Industrial and Commercial Undertaking (CICU) – Ludhiana Small Scale Industries Association – Ludhiana
Prominent Institutes	<ul style="list-style-type: none"> District Industries Centre (DIC) – Ludhiana MSME-DI Ludhiana
SDA	Punjab Energy Development Agency (PEDA)

Allahabad bakeries cluster has around 130 operating units scattered across the city. Around 60% of the units are engaged in the production of biscuit and pastry, 25% in the production of rusk and cake, and remaining 15% in the production of pav. A major share of these bakery products cater to the local market.

The units use ingredients like maida, sugar, ghee/ vegetable oils. The units rely on wood, electricity and diesel for meeting their energy demand. Wood and diesel are mostly used in the baking ovens. Electricity is used to drive motor-based loads like mixing, among others. Diesel is also used in DG sets in case of power failure. About 74% of the energy comes from burning wood in the cluster. 77% of the units use wood based conventional baking oven, followed by diesel based rotary ovens in 19% of the units and wood-based hanging ovens in 4% of units.

The Naini Industries Association have a presence in the cluster of which bakery units are members.

Table 24: Details of Allahabad Bakeries Cluster

Description	Details
Location	Uttar Pradesh
Number of RTC-RTE units	~130
Major products	Biscuit, bakery, rusk, cake, paav
Type of fuel used in cluster	Wood, Electricity, Diesel
Prominent Technologies used	Wood and diesel based baking ovens, Mixers
Prominent Industry association	<ul style="list-style-type: none"> Naini Industries Association
Prominent Institutes	<ul style="list-style-type: none"> District Industries Centre (DIC) MSME-DI Allahabad
SDA	Uttar Pradesh New & Renewable Energy Development Agency (UPNEDA)

4.1.2. Western Region

Pune RTC-RTE cluster has around 40 units engaged in the production of frozen sweet corn item, frozen samosa, frozen fruits and fruit items, frozen vegetables, frozen kala jamun, and other frozen ready-to-eat items. The estimated production at cluster level is around 29,260 tonnes per year.

The cluster relies on electricity for a major portion of its energy use with electricity having a share of 72% in the cluster's total energy consumption. Wood also is used significantly and has a 24% share in the total energy use. The remaining small share is through LPG and diesel at 4% and 1% respectively. The cluster uses wood in boilers for heating purposes, electricity for refrigeration system (comprising of compressors, condensers, accumulators, evaporators and cooling towers) and motor drives, and diesel for DG sets.

Maha Cold storage Association has an active presence in the cluster.

Table 25: Details of Pune RTC-RTE Cluster

Description	Details
Location	Maharashtra
Number of RTC-RTE units	~40
Major products	Frozen food items
Type of fuel used in cluster	Electricity, Wood, LPG, diesel (a small share)
Prominent Technologies used	Boilers, Refrigeration system, Motor drives
Prominent Industry association	<ul style="list-style-type: none">Maha Cold storage Association - Pune
Prominent Institutes	<ul style="list-style-type: none">District Industries Centre (DIC) – PuneMSME-DI Mumbai
SDA	Maharashtra Energy Development Agency (MEDA)

4.1.3. Southern Region⁴¹

Coimbatore bakery industries cluster has around 700 bakeries with 370 bakeries located within the city. The cluster produces several bakery items like bread, bun, biscuits, toasts, puffs and cakes. Micro and small units have a share of about 95% in the cluster. Mostly “retail bakeries” are present in the cluster which bakes at the back and sell through the front. The cluster mainly caters to the demand of the local market for bakery food products.

The unit wise production varies across the units and also within the units throughout the year depending on the consumer demand. The raw materials used by bakeries include maida, ghee, sugar, oils, sweeteners and colors. The cluster relies on electricity, diesel oil, wood and LPG for meeting its energy need. Diesel, wood and electricity are used in ovens. Electricity is also used to drive the motor-based loads like mixers, among others. Wood has a major share at 47% in the total energy consumption in cluster, followed by LPG at 24%, HSD at 19% and electricity at 10%.

The Coimbatore District Bakery Owners' Welfare Association is the most proactive association in the cluster with more than 300 members.

Table 26: Details of Coimbatore Bakeries Cluster

Description	Details
Location	Tamil Nadu

⁴¹ <http://www.sameeksha.org/pdf/clusterprofile/coimbatore-bakery-industries.pdf>

Description	Details
Number of RTC-RTE units	~700
Major products	Bread, bun, biscuits, toasts, puffs and cakes
Type of fuel used in cluster	Electricity, diesel oil, wood and LPG
Prominent Technologies used	Baking ovens, motor drives
Prominent Industry association	<ul style="list-style-type: none"> Coimbatore District Bakery Owners' Welfare Association
Prominent Institutes	<ul style="list-style-type: none"> District Industries Centre (DIC) – Coimbatore MSME-DI Coimbatore
SDA	Tamil Nadu Energy Development Agency (TEDA)

4.2. Sector Level Stakeholders

In context of our existing working relationships in a number of MSME clusters, the local level stakeholders show great interest and enthusiasm for energy efficiency initiatives and technical cooperation activities. These stakeholders can be positioned as opinion influencers among the local industrial community during project activities in any particular cluster.

The primary stakeholders in the cluster are the industry associations, individual RTC-RTE food processing units and MSME DI/DIC. The other stakeholders include the technology suppliers, government agencies, financial institutions, and academic/training institutes.

Industry Association

Industry Associations are increasingly becoming more professionally managed with dedicated staff for day-to-day operations. These associations serve as the first avenue to understand cluster dynamics such as energy efficiency technology needs, disseminate best practices among member units and also assist in organizing various cluster level awareness programmes on EE. Leveraging these industry associations from the initial stage of the study would be quite valuable in:

- Understand the membership profile of MSMEs in the cluster
- Cluster profile of Industrial association including number of MSMEs, size of MSME units
- Present business scenario, barriers for energy efficiency
- Support in reaching out to member industries for project activities

The major industry associations in the Indian RTC-RTE food processing sector are presented next.

Table 27 List of key industry associations

Organization	Contact Details
Federation of Sweets and Namkeen Manufacturers, Mumbai	sweetsandnamkeen@gmail.com (+91) 8850480553
Federation of Biscuit Manufacturer of India, New Delhi	kanchanzutshi@phdcci.in
All India Bread Manufacturers' Association, New Delhi	09818778399
Chamber of Industrial & Commercial Undertakings, Ludhiana	CHAMBER@CICUINDIA.ORG 0161-2530551, 2540551
Small Scale Industries Association – Ludhiana	
Coimbatore District Bakery Owners Welfare Association	
Naini Industries Association, Allahabad	
Maha Cold storage Association - Pune	mhcoldassociation@gmail.com (+91) 9225622145

Government Institutes:

There are government support bodies, such as District Industries Centre (DIC) – Ludhiana, DIC – Pune, DIC – Coimbatore among others in the clusters which also work towards the development of the cluster particularly the MSME industries. MSME-DI has offices in Ludhiana, Allahabad, Mumbai, Coimbatore, among other places and support the execution and implementation of the schemes from MoMSME. The agency functions for development of programmes on EE and RE in the region.

Key national and regional stakeholders associated with RTC-RTE food processing sector are presented next-

Federation of Sweets and Namkeen Manufacturers⁴²

Federation of Sweets and Namkeen Manufacturers (FSNM) is the topmost body of the Indian sweets, namkeen and snacks industry. It is one of the powerful voices in the food industry with all the small, medium and large players in mithai and namkeen manufacturing part of it and a number of other associations attached from all over the country. FSNM coordinates with the several ministries working for the growth of the food industry like Ministry of Food Processing Industries, Ministry of Animal Husbandry and Dairy, Ministry of Consumer Affairs, Ministry of MSME, among others and departments like Departments like FSSAI, APEDA and DHI who are involved in providing inputs key to the industry's benefit on a regular basis.

Their mission is to become the mithai, namkeen and snack manufacturer's voice and encouraging cooperation among the trade and industry sector's different components. FSNM's vision is to create an environment for its members to sustain, modernize, expand, and grow their business.

The association provides a platform to facilitate cross-industry co-operation, aligns industry players through wide self-regulation, and works with legislators and regulators.

Federation of Biscuit Manufacturer of India

The Federation of Biscuit Manufacturers of India (FBMI) was established in the year 1950 with the main objective to protect and promote the interest and development of biscuit industry. FBMI consists of the organized biscuit manufacturing segment including small scale, medium and large-scale biscuit manufacturers. The FBMI has a crucial role in the unprecedented growth and development of the biscuit industry making it reach into all the huge domestic markets and also the export markets.

The FBMI disseminates the latest relevant information and data to its members via Circulars on legislations Acts/Rules etc. relating to PFA, Weights & Measures Packaged Commodities Rules amendments/proposals for changes on such Acts/Rules particularly those adversely affecting manufacturers of Biscuits. FBMI represents the industry while interacting with the Central and State government to seek solutions on problems faced by its members regarding Taxation, Food Laws, finance, infrastructure, industrial relations, environment/pollution and other grey areas viz. wages, electricity tariff, availability and cost escalation on wheat flour, vegetable oil, sugar, fuel, packaging and other raw materials as well as ingredients.

All India Bread Manufacturer's Association⁴³

⁴² <https://fsnm.in/>

⁴³ <https://www.aibma.com/>

The All-India Bread Manufacturer's Association (AIBMA) was established in 1978 and has members from large- and small-scale bread manufacturing units in India. The AIBMA holds interaction with the government to promote the bread industry. It acts as a voice of the industry for discussing issues related to raw materials, quality aspects and promoting popularity of bread as nutritious wheat-based food.

AIBMA is associated with other important organizations through its affiliation to the PhD Chamber of Commerce and Industry and being member of organizations like Confederation of Indian Food Trade and Industry (CIFTI), All India Food Processors' Association (AIFPA), Wheat Products Promotion Society (WPPS).

Chamber of Industrial & Commercial Undertakings, Ludhiana⁴⁴

The Chamber of Industrial & Commercial Undertakings (CICU) was established in 1968 and represents the Industry and Trade sector of the Punjab State. CICU has more than 1200 direct members and 13,000 indirect members through 34 associations affiliated to CICU as Associate Members.

CICU works with an aim to make the business community's voice considered while shaping the economic policies of the country. CICU actively interacts with various government agencies to boost the industry's development to make it compete with the world class industries.

CICU has been National / State Level Winner as Responsible BMO by Foundation for MSME Cluster, New Delhi. It also has been accredited as Silver Standard by Quality Council of India, New Delhi and National Accreditation Board for Education & Training (NABET). CICU is also recognized by the Ministry of Commerce & Exports (Govt. of India).

Central Food Technological Research Institute (CFTRI)⁴⁵

CFTRI is a constituent laboratory of Council of Scientific and Industrial Research (CSIR), New Delhi and came into existence for pursuing in-depth research and development in the areas of food science and technology. Research areas of CSIR-CFTRI includes Engineering Sciences, Technology Development, Translational Research, and Food Protection and Safety. It has Resource Centers at Hyderabad, Lucknow and Mumbai. The academic programmes provided by the institute are M.Sc. Food Technology, Integrated M. Sc – Ph. D Program (Nutrition Biology), Flour Milling Technology Course, in addition to PhD programmes in Biochemistry, Bioscience, Biotechnology, Chemistry, Food Science, Food Technology, Food Science & Nutrition and Microbiology.

National Institute of Food Technology, Entrepreneurship and Management, Thanjavur (NIFTEM-T)⁴⁶

NIFTEM-T is a pioneer Research and Educational Institution under the Ministry of Food Processing Industries, Government of India. Through its intensive research and development activities, the institute provides solutions to all the food processing areas including Fish, meat and dairy products processing, among others. The institute is equipped with modern laboratories having hi-tech instruments through which it is engaged in the R&D of food grain processing, value addition, by-product utilization through bioprocessing, process and product development. They have a hi-tech and cottage level food processing incubation cum training center wherein hands-on-training on different food processing technologies, renting facilities and other supports are offered all

⁴⁴ <http://www.cicuindia.org/>

⁴⁵ <https://cftri.res.in/>

⁴⁶ <http://www.iifpt.edu.in/index.php>

throughout the year to help the entrepreneurs to put in their innovative ideas for the development of new products. The institute offers B.Tech., M.Tech. and Ph.D. programs in Food Process Engineering and M.Tech. programs in Food Science and Technology and Ph.D. in Biotechnology.

Central Institute of Post-Harvest Engineering and Technology (CIPHET)⁴⁷

The ICAR – Central Institute of Post-Harvest Engineering and Technology (CIPHET) undertakes research in the areas of the post-harvest engineering and value addition technologies appropriate to agricultural production catchments and agro-processing industries. In addition, the institute is engaged in empowering the rural community through human resource and entrepreneurship development activities related to post-harvest operations performed on-farm as well as off-farm in order to minimize the post-harvest losses. With its multidisciplinary scientific base, expertise in engineering and allied technology, the institute carries out research, provides technical and knowledge services, and generates information required for formulating national level policies on post-harvest agriculture sector. The institute is currently operating with five divisions equipped with appropriate laboratories and some state-of-the-art instruments, equipment, pilot plants etc. These divisions include Food Grain & Oilseed Processing Division, Agricultural Structures & Environment Control Division, Automation and Sensor Technology Division and Transfer of Technology Division at Ludhiana and Horticultural Crop Processing Division regional station at Abohar.

4.3. Energy Consumption and Benchmarking of RTC and RTE Sector

4.3.1. Energy Consumption

Food processing industry is energy intensive and energy cost accounts for about 15⁴⁸ per cent of total production cost. The primary process steps in food processing varies with the type of product processed.

In case of RTC or RTE food products, the production processes varies depending upon on the type of RTC/RTE food product produced. The table below lists the processes followed for producing some of the RTC or RTE food products.

Table 28: RTE/RTC product wise brief process flow

RTC or RTE Food Product	Process flow
Bakery (Biscuits/Cookies/Puff/Cake/Son papdi/Baklawa/Sweets)	Mining- Cutting-Baking-Storage-Packing
Rusk	Mining-Cutting-Profing-1 st Baking- Cooling-Cutting-2 nd Baking- Cooling-Packing
Murabba	Sorting-Aging-Keading-Boiling-Soaking-Mining-Cooking- Holding-Cooking-Holding-Storage-Packing
Pickles	Cutting-Soaking (Turmeric+Salt+Acid)-Soaking (Water)-Water Removal-Spicing-Packing
Sauces	Mining-Cooking-Holding-Cooling-Packing

⁴⁷ <https://ciphet.icar.gov.in/about-us/profile/>

⁴⁸ <https://www.centricabusinesssolutions.com/blogpost/energy-accounts-15-food-and-drink-manufacturers-costs-scope-ease-pressure-margins-clear#:~:text=Blogs>, Energy%20accounts%20for%2015%25%20of%20food%20and%20drink%20manufacturers'%20costs,pressure%20on%20margins%20is%20clear

RTC or RTE Food Product	Process flow
Frozen Sweet Corn	Washing-Blanching-Cooling-Vibrator-Blast Storage-Dispatch
Frozen Fruits or Vegetables	Peeling-Cleaning-Draining-Cold Storage
Frozen Mango Pulp	Pulp Removal-Cooking-Cooling-Packing-Blast Freezing-Cold Storage
Samosa	Grinding-Mixing-Cutting-Dipping in Batter-Draining-Prefrying-Freezing- Thawing-Final Frying
Breads	Mining-Profing-Oven Cooking-Cooling-Cutting-Packing
Puffs	Mining-Lister-Holding-Filling-Holding-Oven Cooking-Cooling-Packing

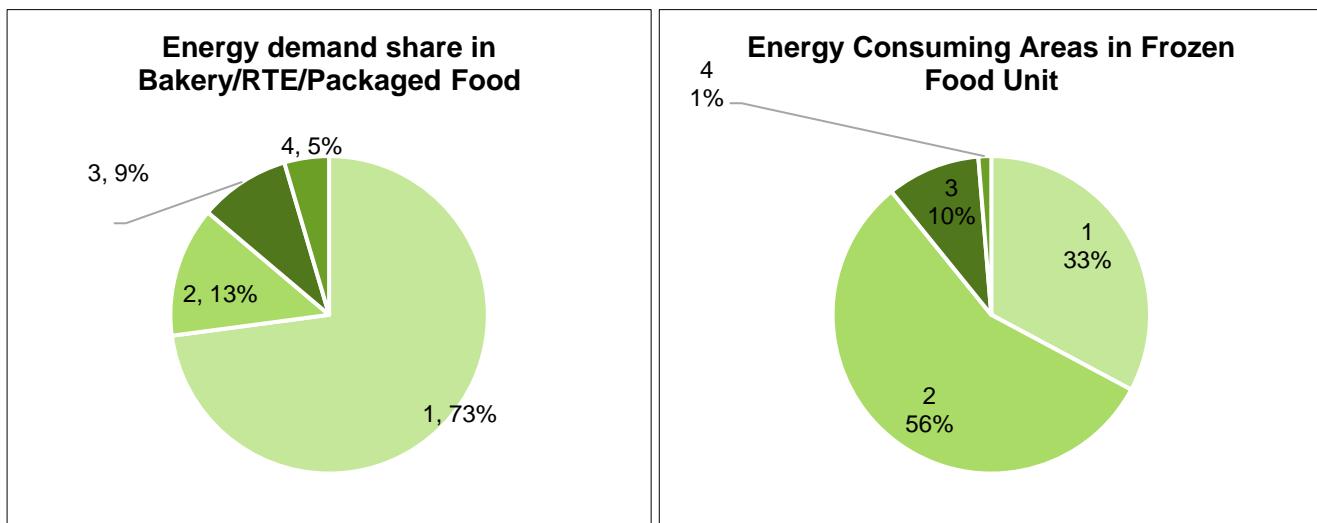


Figure 14: Energy consumption in RTE food manufacturing unit

Figure 13: Energy consumption in RTC food manufacturing unit

In case of Bakery and other RTE/Packaged food products, the thermal energy demand for heating or cooking accounts for more than 70% of the energy consumption. Whereas in case of frozen food units, the refrigeration system accounts for a major share in the energy use.

- *Specific Energy Consumption for (SEC) for bakery and other RTE/packaged food products range between 30 – 411 kgoe/tonne*
- *Specific Energy Consumption (SEC)^{Error! Bookmark not defined.} for frozen food products range between 39 – 80 kgoe/tonne*

In case of Bakery units, the ovens have a maximum potential for energy conservation. Interventions like thyristor-based control, use of recuperative type burners, use of insulation to reduce heat losses, maintaining air to fuel ratio, recovering waste heat from ovens, replacing diesel-based ovens by LPG based ovens, use of rotary rack type baking oven, reduction of weight of the baking fixtures, among others can be implemented for energy conservation in the baking ovens.

In case of other RTE/packaged food product units, equipment supplying thermal energy like thermic fluid heater, electric heater, diesel heater, boilers have the maximum potential for energy saving. Energy conservation measures like fine tuning the burner of thermopac, waste heat

recovery from thermopac, relining of thermopac surface to reduce heat losses, insulating the reserve oil tanks of thermopac, insulating the heaters to reduce heat losses, relining of combustion zone surface walls in boiler, insulating the condensate return line in boiler, among others can be implemented.

In case of frozen food product units, the refrigeration system comprising of chilling unit, cold storage, blast storage, and others have a maximum potential for energy conservation. Interventions which can be implemented to reduce the energy demand from the refrigeration system include insulating the accumulator piping to reduce the radiation heat losses, installation of air curtains to reduce the heat loss during air infiltration, installation of automatic ON-OFF control for evaporator FCUs based on cold room temperature, cleaning condenser tubes to improve performance of refrigeration system, among others.

In Indian food processing context, some clusters are doing better than others. Within the clusters some food processing units are doing better than others. These units have identified and implemented energy efficient technologies and practices. Thus, there is need for benchmarking (SEC in kgOE/tonne of final product) and energy mapping. This shall further improve the efficiency and competitiveness of the Indian food processing industry.

4.3.2. Energy Benchmarking

The term benchmarking involves “comparing actual or planned practices, such as processes and operations, to those of comparable organizations to identify best practices, generate ideas for improvement” which form the basis for measuring performance in an industry.

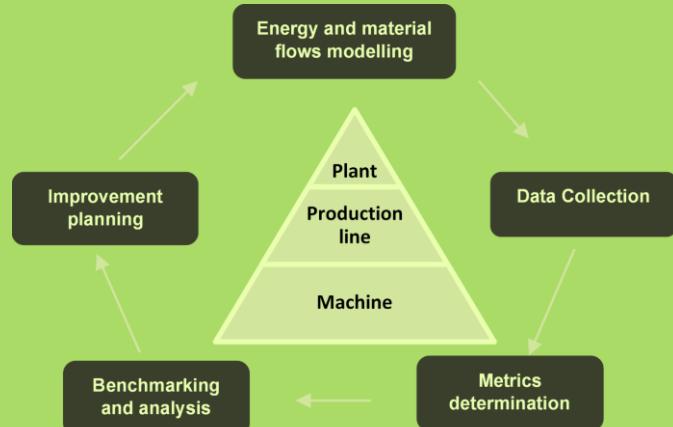
Energy efficiency (EE) benchmarking can be defined as the technique to identify the best practices and achievable EE improvement targets in companies and industries. The management in an industry can compare their baseline values with benchmark and take steps to ensure improvements in EE.

Energy efficiency benchmarking can be divided into internal (including SEC, historical trends of production, energy consumption inside plant boundary) and external benchmarking (benchmarking with industry best SEC level etc.). Internal benchmarking is the comparisons within one company to establish the baseline and best practice. External benchmarking is to compare companies in the same or similar industry sector to establish the best-in-class performance. Additionally, general benchmarking is the comparison of practices regardless of the industry field.

Benchmarking as defined above is the process of searching for best practices that lead to excellence in performance. Baseline can be established by comparing the best practices and subsequently, areas of potential improvement, and areas of focus can be identified. A variety of methods and studies have been carried across industry to come up with the best practices of energy efficiency benchmarking.

Example: A five step energy benchmarking method (E²BM method)

E²BM method can be applied at each individual process (e.g., machine), interrelated processes (e.g., production line), and a plant. This method relates energy consumption in manufacturing process to material flows to visualise the effectiveness and variations of energy usage. The inputs received from the prior step are used for developing strategies to improve energy efficiency. It consists of five steps and takes three levels of hierarchy into consideration i.e., plant, production line and machine.



Energy Performance Indicators (EnPIs) for the Sector

Key Performance Indicator (KPI) can be defined as a quantifiable/measurable value that demonstrates how effectively the industry or equipment or process is performing. KPIs can be financial and non-financial. A pictorial representation defining KPI's is presented next.



The four challenges in defining and maintaining KPIs are: (a) understanding industry's strategy and key objectives, (b) measure is deemed important to area/process of the industry, (c) targets of KPI improvement must be realistic and (d) in case, accurately measuring and reporting indicators is difficult, internal process or SOP should be defined.⁴⁹

Table 29 EnPI related terms and definitions

Term	Definition	Notes
Energy baseline	Quantitative reference(s) providing a basis for comparison of energy performance	An energy baseline reflects a specified period
Energy consumption	Quantity of energy consumed	-
Energy efficiency	Ratio or other quantitative relationship between an output of performance, service, goods or energy, and an input of energy	Conversion efficiency: energy required/energy used; output/input; theoretical energy used to operate/energy used to operate
Energy performance	Measurable results related to energy efficiency, energy use and energy consumption	Results can be measured against organization's energy targets and energy performance requirements

⁴⁹ Source: The Basics of Key Performance Indicators, <https://www.thebalancecareers.com/key-performance-indicators-2275156>

Term	Definition	Notes
Energy performance indicator	Quantitative value or measure of energy performance, as defined by the organization	EnPIs could be expressed as a simple metric, ratio, or a more complex model ⁵⁰

EnPIs can be a simple parameter, a simple ratio, or a complex model. Examples of EnPIs can include energy consumption per time, energy consumption per unit of production, and multi-variable models. The organization can choose EnPIs that inform the energy performance of their operation and can update the EnPIs when business activities or baselines change that affect the relevance of the EnPI, as applicable.

Energy performance indicator of a food processing industry is represented as energy consumed per tonne of food produced (kgoe/tonne), the indicator can be further divided to arrive at sub-process/equipment-wise EnPI such as boiler (kgoe/tonne), air compressor (kW/cfm). The EnPI for any equipment varies depending on end application, usage pattern and several variable parameters.

EnPIs can further be classified as direct or indirect. Direct EnPIs are the internal factors for comparison within an industry to come up with best practices and establish baselines. Indirect EnPIs is comparison of companies or industries in a similar sector to establish best in class practice.

4.3.3. SEC comparison across various clusters across India⁵¹

The specific energy consumption (SEC) of any RTC/RTE unit varies considerably depending on the type of product (baked food, frozen food, among others) and the degree of mechanization used. For example, units engaged in the production of baked and other RTE/packaged food products like rusk, cookies, puffs, breads, sweets, namkeen, samosa, jams, sauces, murabba, among others consume energy in the range of 20 – 316 kgOE/tonne, wherein the product wise variation is given in Table 30. And units producing frozen food products like frozen sweet corn, frozen fruits/vegetables, and others consume energy in the range of 39 – 80 kgOE/tonne. The geographic location of the prominent clusters is presented in the figure below.

⁵⁰ Source: International Standard, ISO 50001 - Energy Management Systems - Requirements with guidance for use, 1st edition 2011-06-15

⁵¹ The SEC values are based on the energy audits carried out as part of this assignment and past programmes by BEE on MSME Energy Efficiency Enhancement

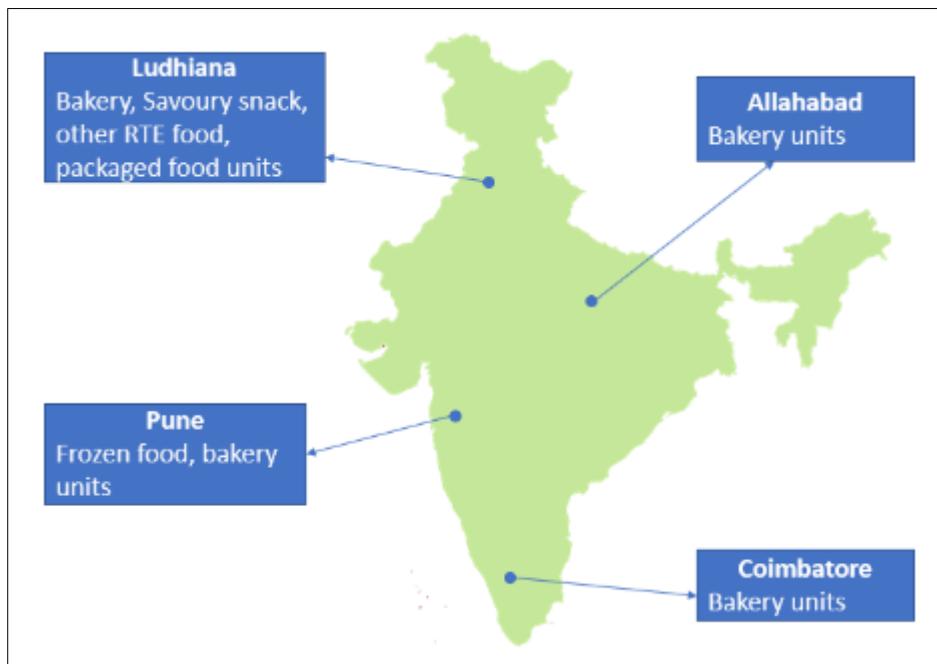


Figure 15: Geographic spread of prominent RTC-RTE clusters

Table 30: SEC benchmark data for Indian MSME RTC-RTE food processing units⁵²

Product Category	Product Sub-category	SEC (kgoe/tonne of final product)
RTC-RTE	Bakery items	316
	Sweets	296
	Bakery items, sweets and namkeen	304
	Pickles, sauce, murabba	268
	Namkeen	44
	Candies and jellies	20
	Frozen foods	40-420 ⁵⁴

Variation in the SEC can be broadly classified in the two main parameters –

- **Type of product processed**
- **Best Operating Practices (BOPs)**

Details of each category mentioned above is presented next-

Type of product processed

The RTC-RTE food products sector has multiple products covering ready-to-cook (frozen food), baked food (rusk, cookies, puffs, breads), and other RTE/packaged food (namkeen, samosa, jams, pickles, ketchup, murabba), among others. The type of products processed in a particular food processing unit has a major role to play in its energy consumption. The process flow and technologies used vary a lot with the product processed and hence the energy intensity.

⁵² SEC values are based on energy audit studies conducted as part of the Energy and Resource Mapping Assignment

⁵³ Most widely adopted technology based on the survey and EA carried out during the BEE energy and resource mapping assignment

⁵⁴ The huge variation in the SEC values is attributed to the huge variation in the production levels in the units

- In case of bakery units, the production process involve steps like mining, cutting, baking, storing and packing, among others. The units in the cluster have installed ovens for baking of biscuits, cookies, rusk, bread, cake, murabba, etc. which use LPG and diesel fuel. The baking oven is the highest energy consumer in a bakery.
- Producing other RTE/packaged food items include steps like boiling and cooking which needs thermal energy supplied by equipment like boilers, ovens, and others. The other steps involved are grading/sorting, kneading/breaking, etc. for which electricity is used.
- Frozen food items like frozen sweet corn, frozen fruits or vegetables, among others have refrigeration as one of the main and the most energy consuming processes. This refrigeration system comprising of the cold storage, blast storage, includes components like compressors, condensers, accumulators, evaporators and cooling towers. The refrigeration system uses electricity. The other processes include blanching, cooking, for which the units use boiler which is wood fired. Additionally, equipment like vibrator, peeler, among others are used by the units which are powered by electricity.

Best operating practices and EE technologies for the different processes used in RTC-RTE food processing play a vital role in optimization of the energy consumption in the units. Summary of key BOP's and technologies is presented in Table 31

Table 31: Summary of BoPs and EE technologies for different RTC-RTE food processing sub-sectors⁵⁵

Equipment	Best (Efficiency/SEC) ⁵⁶	Major Area of Improvement Required to meet the Benchmark values ⁵⁶	Best operating practices ⁵⁷
Ovens	-	<ul style="list-style-type: none"> • Thyristor control for Electric Ovens • Using Recuperative Type Burner • Reducing heat losses from oven by providing proper insulation • Recovering waste heat from Ovens • Maintaining air to fuel ratio in oven • Replacing diesel-based ovens by LPG based ovens • Using Rotary Rack Type Baking Oven • Reduction of the weight of baking fixtures 	<ul style="list-style-type: none"> • Provide adequate insulation to ovens. • Ensure optimum loading of ovens. • For LPG combustion maintain the oxygen level in flue gas between 4 – 5%. • Maintain stack temperature between 120 – 130 °C by recovering heat to vaporise LPG

⁵⁵ Elaborative details of the technology and BOP is presented in technology compendium section

⁵⁶ Based on studies carried out in RTC-RTE food processing clusters

⁵⁷ <https://beeindia.gov.in/sites/default/files/Annexure%202.pdf>

Based on energy audit studies in the RTC-RTE food processing cluster

Equipment	Best (Efficiency/SE C) ⁵⁶	Major Area of Improvement Required to meet the Benchmark values ⁵⁶	Best operating practices ⁵⁷
Thermic Fluid Heater	81%	<ul style="list-style-type: none"> • Fine Tuning of Burner • Waste heat recovery from Thermopac • Reducing the heat losses from the Thermopac surface by relining of surface walls and doors of combustion zone • Reducing the heat losses from the reserve oil tanks by providing insulation 	<ul style="list-style-type: none"> • Maintain air ratio for LPG between 1.12-1.15 and for wood between 1.32-1.39 • Maintain average external skin temperatures up to Ambient temperature + 20 °C. • Undertake thermal insulation work according to the industrial standard practices for thermal insulation works and equivalent standards
Wood fired boiler	74%	<ul style="list-style-type: none"> • Relining of combustion zone surface walls to reduce the heat losses • Reducing the heat loss from condensate return line by providing insulation to line 	<ul style="list-style-type: none"> • Maintain stack temperature between 120 – 130 °C by recovering heat to preheat combustion air or boiler feedwater • Maintain air ratio between 1.32-1.39 • Automatic blowdown control based on boiler water conductivity and pH. • Regular removal of soot build up on tubes and scaling on water side. • Optimising steam pressure based on process demand. • Variable speed control for ID and FD fans if the boiler load characteristics are variable. • Maintaining boiler loading at two-thirds of full load

Equipment	Best (Efficiency/SEC) ⁵⁶	Major Area of Improvement Required to meet the Benchmark values ⁵⁶	Best operating practices ⁵⁷
Compressed Air system	<ul style="list-style-type: none"> • Reciprocating – 0.22 kWh/cfm • Screw single stage – 0.19 kWh/cfm • Screw multistage – 0.25 kWh/cfm 	<ul style="list-style-type: none"> • Decreasing compressor pressure as per requirement • Replacement of old reciprocating air compressor with new VSD based screw air compressor with proper piping 	<ul style="list-style-type: none"> • Operate the compressor at the optimal pressure requirement • Limit the compressed air leakage within 3% to 10% • Maintain operating SPC within the design range as provided by the OEMs • Periodic cleaning of the suction filters • Ensure the optimal dryer operation • Maintain specified air temperature after intercooler
Refrigeration system	<ul style="list-style-type: none"> • COP – 1.470 	<ul style="list-style-type: none"> • Insulating the accumulator piping to reduce the radiation losses. • Installation of air curtains to reduce the heat loss during air infiltration. • Installation of automatic ON-OFF control for evaporator FCUs based on cold room temperature. • Cleaning of condenser tubes to improve performance of refrigeration system. 	<ul style="list-style-type: none"> • Avoiding the entry of warm air from outside into the cold room area by properly sealing the cold room chamber • Providing insulation of appropriate type, size and thickness to reduce the energy losses from uninsulated or defective insulation portions of the refrigeration system. • Providing thickness for insulation so as to maintain the surface temperature above the dew point temperature of ambient air • Minimising the corrosion on cold piping, ducts, chillers, etc. • Cleaning the condenser coils on monthly basis • Using regular watch glass to inspect, observe and maintain refrigerant and recharge up to the essential level • Minimising refrigeration loads with energy efficient measures like window shades, low thermal mass wall, etc. • Seasonal variations shall be considered while choosing the operational parameters like temperatures of cooling water, chilled water and return water without affecting system

Equipment	Best (Efficiency/SEC) ⁵⁶	Major Area of Improvement Required to meet the Benchmark values ⁵⁶	Best operating practices ⁵⁷
Electric Motors	<ul style="list-style-type: none"> Refer Efficiency of Motor as per catalogue of motor manufacturer Efficiency varies in range of 75%-95% for different rating of the motors from 0.3 kW- 500 kW 	<ul style="list-style-type: none"> Conversion of existing flat V belt to direct driven for motors Replacement of existing old inefficient motors with energy efficient IE4 motors 	<ul style="list-style-type: none"> Use IE4 rating motors Use BLDC motors for fans, blowers etc. Maintain voltage and current imbalance as low as possible as prescribed by IEEE Replace the motor after rewinding once
Pump and Pumping System	38%	<ul style="list-style-type: none"> Replacement of ETP pumps with new EE pumps 	<ul style="list-style-type: none"> Operate pumps close to the best operating point as specified by the OEMs. Install variable frequency drive (VFD) for fluctuating loads instead of throttling Use on-line monitoring for centralized large system and periodical measurement for decentralized smaller pumps Replace worn-out pumps with energy efficient pumps. Maintain a minimum Net Positive Suction Head (NPSH) of pumps as prescribed by the manufacturer.
Lighting System	120 watt/lumen ⁵⁸	<ul style="list-style-type: none"> Replacement of fluorescent Tubes with LED tubes 	<p>Maintain the appropriate lux levels</p> <ul style="list-style-type: none"> Administrative building 50–400 Administrative corridor 100 Shop floor lighting (process) 150–300 Workshop 150–300 Warehouse storage area 100–150 Use 3-5 star rated LED lights

⁵⁸ BEE Star rated appliances - https://www.beestarlabel.com/Content/Files/LED_schedule.pdf Accessed during April 2023

4.4. Energy Efficiency Potential in RTC-RTE Food Processing sector

RTC-RTE food processing is one of the energy intensive subsectors in food processing with most of the energy being consumed in operations like baking, cooking, refrigeration, among others.

Energy saving potential is a function of the present efficiency levels, type of fuel used, energy efficiency measures applicable for RTC-RTE food processing clusters, and readiness of the clusters in adopting the new state of art technologies. Details of the present fuel mix, penetration level of different technologies, EE potential for the RTC-RTE food processing clusters and national level projections is presented in this section.

The RTC-RTE food processing sector mainly uses electricity, wood, LPG, and diesel for meeting the energy requirements. The choice of fuels used varies with the type of RTC-RTE food processed in the unit. The units processing bakery, RTE and packaged food products majorly use thermal energy from fuels like wood, LPG and diesel for meeting their energy needs and the units involved in producing frozen food products rely on electricity for majority of their energy needs. Major applications of the different fuels is presented next.



Electricity

Majorly to drive primemovers (motors) and refrigeration systems (mainly freezers, cold storages, chillers)



LPG

Thermopacs, Ovens



Wood

Boilers, thermic fluid heaters



Diesel

DG set for back-up power, ovens, heater (bhatti)

During the BEE- “Energy and resource mapping assignment” detailed primary survey (EOI forms 189+) and secondary stakeholder consultations (200+), field visits (55+), energy audits (50), review of the past reports and interventions carried out across food processing clusters, discussion with IA (13+) and technology providers – were carried out to evaluate the penetration level of different technologies and share of the different fuels etc.

Summary of the cluster level and sector level findings based on the elaborative and extensive study is presented in section next.

4.4.1. Energy Consumption at Cluster Level

Based on the products processed (baked/RTE/packaged/frozen food) the forms of the energy used by the sector include electricity, wood, LPG, and diesel. Share of the energy varies for the different RTC-RTE food processing clusters based upon the type of the product processed.

During the BEE energy and resource mapping study, the share of the fuel mix for the RTC-RTE food processing clusters (Ludhiana, Pune) is calculated based on the energy audits and stakeholder consultations with industries and multiple industries associations in these clusters (physical meetings, workshops, webinars).

Findings for these clusters have been thoroughly discussed with prominent industry associations and industries through workshops / physical meetings and one-one interactions with multiple industries.

Cluster level workshops were conducted across – Ludhiana and Pune RTC-RTE food processing clusters to validate the findings. Regional consultations across the prominent RTC-RTE food processing clusters were also conducted to validate the findings.

Summary of the different forms of energy used in different RTC-RTE food processing clusters is presented in Table 32.

Table 32: Energy share of different fuels in RTC-RTE food processing clusters (Units – toe)⁵⁹

Energy type	Ludhiana	Pune
Electricity	2461	1245
LPG	6636	67
Diesel	3841	12
Wood	7230	416
Total	20168	1740

Share of electricity in fuel mix for the Ludhiana and Pune clusters are 12% and 72% respectively. Share of wood in fuel mix for the Ludhiana and Pune clusters are 36% and 24% respectively. Share of LPG in fuel mix for Ludhiana and Pune clusters are 33% and 4% respectively. Share of diesel in the fuel mix of Ludhiana and Pune clusters are 19% and 1% respectively.

Wood and LPG have a major share in the Ludhiana cluster together accounting for 69% of the total energy demand. In Pune cluster, electricity has a major share at 72% in the total energy use.

Energy mix in RTC-RTE Food Processing Clusters

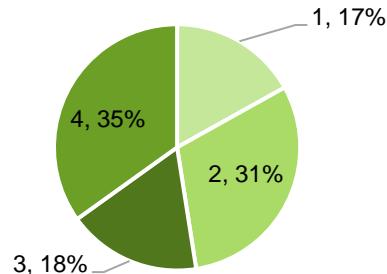


Figure 16: Share of different fuels across two RTC-RTE Food Processing clusters

4.4.2. Prominent Technologies Adopted in RTC-RTE Food Processing Sector

The predominant technologies used in RTC-RTE food processing are described below.

a) Thermic Fluid Heater (TFH)

The units in the cluster operate Thermopac having capacity in the range of 6,00,000 to 10,00,000 kcal for heating operation in the units. The Thermopacs are of Horizontal and Vertical 2 Pass type. The Thermopacs operated are LPG and wood fired. In some units the excess air in the flue gas of TFH was measured to be 123.4%, the flue gas temperature exiting the TFH system was measured at 238.5 °C and the surface temperature was measured around 115 °C. The direct efficiency of

⁵⁹ Appropriate GCV values of the different fuel based upon the discussion with Industries, review of the GCV reports at different audited units, across different clusters have been used to convert the different form of fuel to oil equivalent units.

TFH is in the range of 72 to 81%. The common observations in the TFH system resulting in energy losses are as below.

- Air to fuel ratio is not optimised in the combustion zone of the TFH system
- Waste heat from flue gas is not recovered
- Improper insulation at Thermopac surface (surface walls and door of combustion zone)
- The Reserve Oil Tanks from which the hot return oil is circulated are without insulation
- The condensate return lines are observed to be without insulation

b) Ovens

The units in the cluster have installed ovens for baking of biscuits, cookies, rusk, bread, cake, murabba, etc. The ovens are of Monoblock type and use LPG and diesel fuel. The temperature in the oven is maintained in the range of 65 to 210 °C and the required cycle time ranges from 12 to 50 minutes. The common observations in the oven leading to high heat losses are mentioned below.

- Improper insulation on the surface walls and door of Oven's combustion zone
- Air to fuel ratio in the Oven's combustion zone is not optimized
- Waste heat from the flue gas of Ovens is not recovered

c) Boiler

Some of the units operate boiler having capacity ranging from 0.3 – 4 TPH for meeting heating and cooking demand of the unit. The boiler uses wood blocks as its fuel. The steam generated in boiler is used for cooking the murabba and sauces, drying the laddoos, cooking mango pulp, blanching sweet corn, and other processes. The direct efficiency of these boilers ranges from 34 – 74%. The common observations in the boilers across the units in cluster leading to energy loss were as below.

- Improper insulation on the surface walls and door of boiler combustion zone and steam drum resulting in heat losses
- No insulation on condensate recovery pipeline
- Excess air used in combustion leading to dry flue gas losses
- Non recovery of waste heat from boiler flue gas

d) Air compressor

The units have installed air compressors of reciprocating type for meeting the compressed air requirement of boiler and other pneumatic utilities, instrumentation and service air for processes. The capacities of these installed air compressors ranges from 18 to 68 cubic feet per minute (CFM). The operational specific power consumption of the reciprocating type air compressors in the units in cluster was in the range of 0.17 to 0.21 kW/CFM. Several typical observations in the compressed air systems within the units, leading to higher power consumption, included

- Supply of compressed air at higher pressure than the requirement
- Use of old inefficient compressors with zig zag piping for compressed air supply
- VFD is not installed on air compressor resulting in unload power consumption

e) Motor Loadings

Units are running motor driven applications for the process machines like boiler circulation pumps, ID and FD fans, chiller, blowers, mixing motor, air compressor cooling, oven blowers and motors, rolling/cutting/rounder machines, ETP/oil circulation/borewell pumps, cooling tower fan and pump, among others. The common observations resulting in higher power consumption in the units were

- It was observed during audit that the ID and FD fan motors, feed water pump motors, blower motors for ETP plant, mixing motors and ball cutting motors, among others are driven using flat V-belt with pulleys. The disadvantage with belt drives are the high slippage, high maintenance and increased power consumption due to losses in transmission.
- It has been observed that there exist IE1 or IE2 standard motors in operation for process machines like ID Fan, pumps, blower, pumps, etc. in the plant.

f) Pumps

The units in the cluster have installed pumps for applications including ETP, etc. The efficiency of these pumps is in the range of 30 to 38%. The input power to these pumps is in the range of 1.9 to 2.1 kW. The common observation with respect to the pumping system is as below.

- Efficiency of the pumps was low compared to the EE pumps available on the market

g) Refrigeration system

The units engaged in producing frozen food products have installed refrigeration system for cold rooms and blast storages and this system includes arrangement of compressors, condensers, accumulators, evaporators and cooling towers. The refrigeration system includes cold storages, blast storages as well as spiral freezers and is installed for storing the food products like sweet corn, packed samosa, baby corn, mango pulp, ice making, etc. The temperature in cold storage is kept at around -20 °C. The COP of the overall refrigeration system ranges from 1.217 to 1.423 and the COP of the compressor ranges from 1.551 to 1.96. The cooling tower which is part of the refrigeration system has effectiveness in the range of 35 – 70%. Some of the common observations in the refrigeration system installed at RTC-RTE food processing units are-

- The surface temperature of accumulator was observed to be -3 °C
- There is air infiltration when the door is opened and there is a transfer of heat to the space through the air
- The FCUs installed for cooling purpose continues to run even when the temperature is attained
- The condenser tubes in the refrigeration system are not cleaned

4.4.3. Sector Level Production and SEC Details

Production data for the RTC and RTE food processing sector is estimated by applying a 13% CAGR on FY20 production data.⁶⁰ Within the RTC-RTE sector, RTE has a share of 65% and RTC has a share of 35% in the total exports from the RTC-RTE.⁶¹ This same split between RTC and RTE is considered in the total production volume of the RTC-RTE sector. SEC data for RTC-RTE food processing is calculated from the multiple energy audits carried out under the BEE energy and

⁶⁰ The values for FY20 production data for RTE and RTC sector and CAGR between FY20 and FY30 are sourced from MoFPI's Sector Profile on Ready to Eat /Ready to Cook /Ready to Drink

⁶¹ https://worldfoodindia.gov.in/public/pdf/1691752912_1095741203.pdf

resource mapping assignment. Also, the SEC data has been validated through multiple consultations carried out in different food processing clusters.

Table 33: Production data for the FY 23

Product	Sub-category (capacity)	Production (Mn tonnes)	SEC (toe/tonne)
RTC-RTE	RTE	126	0.346
	RTC	68	0.059
	Overall	195	0.245

RTC-RTE production projections

The production was projected till FY30 by applying the CAGR value of 13% on the FY20 production volume. The CAGR between FY30 and FY33 was considered as an average of domestic CAGR between FY20 and FY30, and global CAGR between FY23 and FY28.⁶² As mentioned above the share of RTE and RTC categories in cumulative production of RTC-RTE sector was considered same as the share of RTC and RTE in the total exports from RTC-RTE sector in FY 20. The subcategory wise projection of the production volume between FY23 and FY33 is shown in the Figure 17.

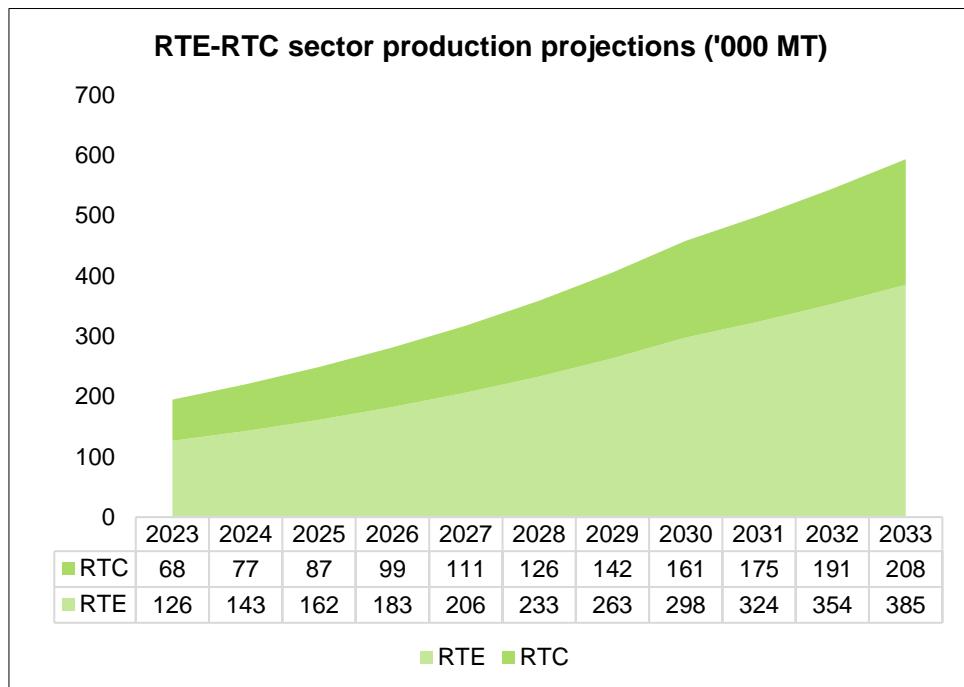


Figure 17: Sub-category wise RTC-RTE production projections

4.4.4. Sector Level Energy Consumption

Benchmark SEC data for the RTE and RTC subsector validated though multiple consultations is used for calculating the sector level energy consumption data. Energy consumption for the RTE and RTC subsectors is calculated by multiplying the SEC and production volume. Summary of the sector level energy consumption for the RTC and RTE subsector is presented in Table 34.

⁶² The values for domestic CAGR between FY20 and FY30 and the Global CAGR between FY23 and FY28 are taken from MoFPI's Sector Profile on Ready to Eat /Ready to Cook /Ready to Drink

Table 34: Sector level energy consumption for RTE and RTC products (FY 23)

Product	Sub-category	Energy consumption (Mn toe)
RTC-RTE	RTE	0.044
	RTC	0.004
<u>Total energy consumption (Sector level – RTC-RTE)</u>		0.048

The share of different fuels at sectoral level for RTC-RTE food processing remains same as showcased in Figure 16.

The fuel mix varies with the type of RTC or RTE product processed. The share of thermal energy is more in case of baked items, snacks, etc. whereas in case of frozen items the share of electricity is more due to refrigeration requirement.

4.4.5. Projections of Energy Saving potential

In order to evaluate the energy saving potential at the sector level, mapping of energy efficient technologies, state of art technologies, EE technologies for utilities is required along with energy saving potential.

Mapping of the technologies for the different RTC-RTE food processing clusters were done through field studies, primarily survey, discussion with IA and technology vendors. Long list of the technologies was mapped during multiple tasks and activities under BEE energy and resource mapping study.

Replication potential for different technologies in short term and long term is evaluated in closed consultation with multiple stakeholders across different leading RTC-RTE food processing clusters – **Ludhiana** RTE cluster, **Pune** RTC cluster, **Kanpur** RTE cluster, **Indore** RTE cluster.

Summary of different energy efficient and state of art technologies is presented in Table 36 and Energy conservation measures identified in cluster.

Table 37.

Team has segregated the EE technologies in two categories based on their applicability in the short-term (next 5 years) and long-term (next 10 years). For all identified EETs replication potential is estimated and segregated into four categories.

Table 35: Methodology for segregating EETs

	Low Potential	Less than 10% MSMEs in cluster have replication potential
	Medium Potential	10%-30% MSMEs in cluster have replication potential
	High Potential	30%-60% MSMEs in cluster have replication potential
	Saturation	More than 60% MSMEs in the cluster have implemented EET

Potential of technology penetration levels across cluster⁶³

Table 36: Process specific replication potential of technologies across RTE & RTC clusters

S. No	Technologies	Energy savings potential	Replication Potential in short-term (till 2028)			Replication Potential in long-term (till 2033)		
			Micro	Small	Medium	Micro	Small	Medium
1.	Recuperative Type Burner for Ovens	3% ⁶⁴	High	High	High	Medium	Medium	Medium
2.	Thyristor control for Electric Ovens	10% ⁶⁵	High	High	Medium	Medium	Medium	Low
3.	Reduction of the weight of baking fixtures	7% ⁶⁵	High	High	Medium	Medium	Medium	Low
State of Art Technologies⁶⁶								
4.	Individual Quick Freezer	30%	Low	Medium	High	Saturation	Low	Low
5.	Rotary Rack Baking Oven	5%	High	High	Medium	Medium	Medium	Low
6.	Turbo Drop Cookie Depositors	3%	High	High	Medium	Medium	Medium	Low
7.	Replacement of old reciprocating air compressor with new VSD based screw air compressor with proper piping	20%	Medium	Medium	Medium	Low	Low	Low

⁶³ Indicative list not comprehensive, saving envisaged in the table only represents the energy saving, productivity saving from different technologies is not factored in this table. Most of the units globally having best SEC level had already implemented the ECMs indicated in point 1-7.

⁶⁴ Energy savings potential is estimated based on PwC's past experience of conducting energy saving studies in MSME units

⁶⁵ <http://www.sameeksha.org/pdf/clusterprofile/ludhiana-bakeries-Punjab.pdf>

⁶⁶ Apart from energy savings there are additional benefits with respect to quality and productivity enhancement. More details on this are included in Annexure.

S. No	Technologies	Energy savings potential	Replication Potential in short-term (till 2028)			Replication Potential in long-term (till 2033)		
			Micro	Small	Medium	Micro	Small	Medium
8.	Replacement of existing old inefficient motors with energy efficient IE4 motors	5%	Low	Low	High	High	Saturation	Saturation
9.	Replacement of ETP pumps with new EE pumps	20%	Medium	Medium	Low	Low	Low	Saturation
10.	Installation of IoT based energy monitoring system	1%	Low	Low	Medium	Low	High	High
Cleaner energy measures								
11.	Replacing diesel based ovens by LPG based ovens	-	Medium	Medium	Medium	Low	Low	Low
12.	Biogas Generation	-	Low	Low	Medium	Low	Low	Medium
13.	Rooftop Solar	-	Low	Medium	High	Saturation	Saturation	Saturation

Energy conservation measures identified in cluster.

Table 37: Replication potential of energy saving measures across RTE & RTC clusters⁶⁷

S. No	Technologies	Energy savings potential	Replication Potential in short-term (till 2025)			Replication Potential in long-term (till 2030)		
			Micro	Small	Medium	Micro	Small	Medium
1.	Reducing heat losses from oven by providing proper insulation	12%	High	High	High	Medium	Medium	Medium
2.	Optimization of Excess air in oven	1.5%	Medium	Medium	Low	Low	Low	Saturation
3.	Removal of LPG vaporizer by recovering waste heat from Ovens	1%	Medium	Medium	Medium	Low	Low	Low
4.	Optimization of Excess air in Thermopac	4%	Medium	Medium	Low	Low	Low	Saturation
5.	Waste heat recovery from Thermopac to replace LPG vaporizer	1%	Medium	Medium	Medium	Low	Low	Low

⁶⁷ Indicative list not comprehensive, saving envisaged in the table only represents the energy saving, productivity saving from different technologies is not factored in this table

S. No	Technologies	Energy savings potential	Replication Potential in short-term (till 2025)			Replication Potential in long-term (till 2030)		
			Micro	Small	Medium	Micro	Small	Medium
6.	Reduce the heat loss from the Thermopac surface by relining of surface walls and doors of combustion zone	6%	Medium	Medium	Medium	Low	Low	Low
7.	Reduce the heat losses from the reserve oil tanks of Thermopac by providing insulation	1%	Medium	Medium	Low	Low	Low	Saturation
8.	Reducing heat losses from electric heater by providing proper insulation	10%	Medium	Medium	Low	Low	Low	Saturation
9.	Reducing heat losses from diesel heater by providing proper insulation	10%	Medium	Medium	Low	Low	Low	Saturation
10.	Reduction in heat losses from surface of boiler and steam drum	6%	Medium	High	High	High	Saturation	Saturation
11.	Reduce the heat loss from condensate return line to boiler by providing insulation to line	3%	Medium	Medium	Medium	Low	Low	Low
12.	Decrease compressor pressure as per requirement	10%	High	High	Medium	Medium	Medium	Low
13.	Conversion of existing flat V belt to direct driven for motors	4%	High	Medium	Low	Low	Low	Saturation
14.	Replacement of fluorescent Tubes with LED tubes	50%	Medium	Medium	Medium	Low	Low	Low
15.	Replacement of traditional fans with BLDC fans	40%	High	High	High	Medium	Medium	Medium
16.	Use high efficiency air conditioner	15%	Medium	Medium	Medium	Low	Low	Low
17.	Reduce the radiation losses from the accumulator pipe	3%	Medium	High	High	High	Saturation	Saturation
18.	Installation of air curtains to reduce the heat loss during air infiltration	3%	Low	Medium	High	Low	Medium	High
19.	Installation of automatic ON-OFF control with respect to temperature for evaporator FCU	3%	Low	Low	Medium	High	Saturation	Saturation
20.	Improve performance of refrigeration system by cleaning condenser tubes.	4%	High	Saturation	Saturation	Saturation	Saturation	Saturation
21.	Installation air curtains at the inlet and outlet of the spiral freezer to reduce the heat loss due to air infiltration	3%	Low	Medium	High	Saturation	Low	Low

Implementation of the energy saving, and state of art technologies will help in reduction of the energy intensity eventually. This will help the RTC-RTE food processing units to become more energy efficient and competitive globally. Summary of the energy saving potential for the RTE and RTC subsectors is presented in *Table 38*

Table 38: Summary of the energy saving potential for different sub-categories in RTE-RTC in Actual scenario⁶⁸

Product sub-category	Energy Saving potential (%)	Energy consumption ('000 toe) FY 22-23	Energy consumption BAU ('000 toe) FY 32-33	Estimated energy saving – Actual scenario ('000 toe) FY 32-33
RTE	10.60%	43.73	133.22	14.12
RTC	9.20%	4.06	12.37	1.14
Total	<u>10.5%</u>	<u>47.79</u>	<u>145.59</u>	<u>15.26</u>

Projections of the different scenarios on account of the multiple interventions proposed for the RTC-RTE food processing sector are presented in Figure 18. The scenarios considered while projecting energy consumption are as below.

- Actual scenario – Considering the energy savings potential as mentioned in the table above is realized until FY 2033
- Conservative scenario – Considering 75% of the energy savings potential is realized until FY 2033
- Ambitious scenario – Considering 150% of the energy savings potential is realized until FY 2033. The additional energy savings are as a result of the adoption of the state of the art technologies as mentioned in Table 19

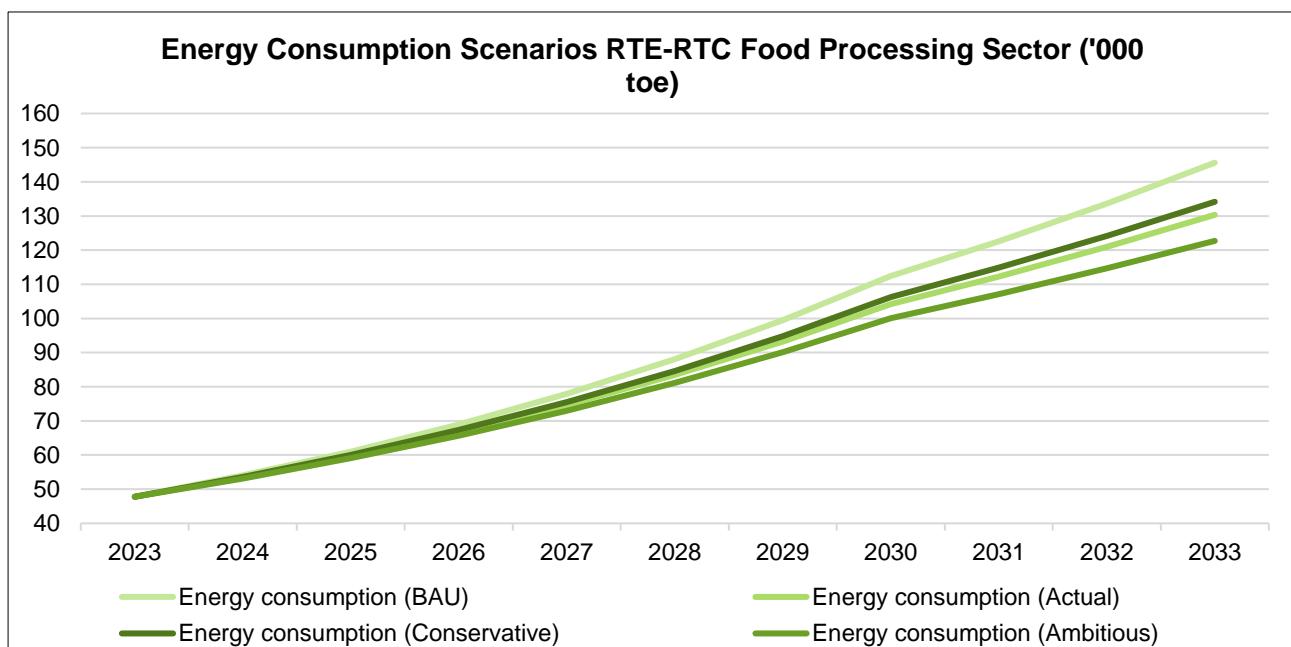


Figure 18: Energy consumption scenarios RTE-RTC

⁶⁸ The energy savings potential in the Actual scenario is considered based on the findings of the energy audit studies conducted as part of the BEE Energy and Resource Mapping Assignment

Adoption of the new technologies will help the Indian RTE and RTC food processing units to reduce the SEC level by over 10% and 9% respectively till FY 2033. Faster adoption of the interventions will further help the RTE-RTC food processing sector to achieve the savings and lower the emissions faster. List of challenges and proposed solutions to support the sustainable growth of the RTE-RTC food processing sector is presented in section 5.

Proposed sector level SEC for RTE-RTC sector after implementation of EE technologies eventually till FY-2033 is presented in Table 39.

Table 39: Proposed long term Sector level SEC – RTE-RTC (Actual scenario)

Overall sector level SEC – RTE-RTC Food kgoe/tonne	FY 22-23	FY 27-28	FY 32-33
	245	232	220

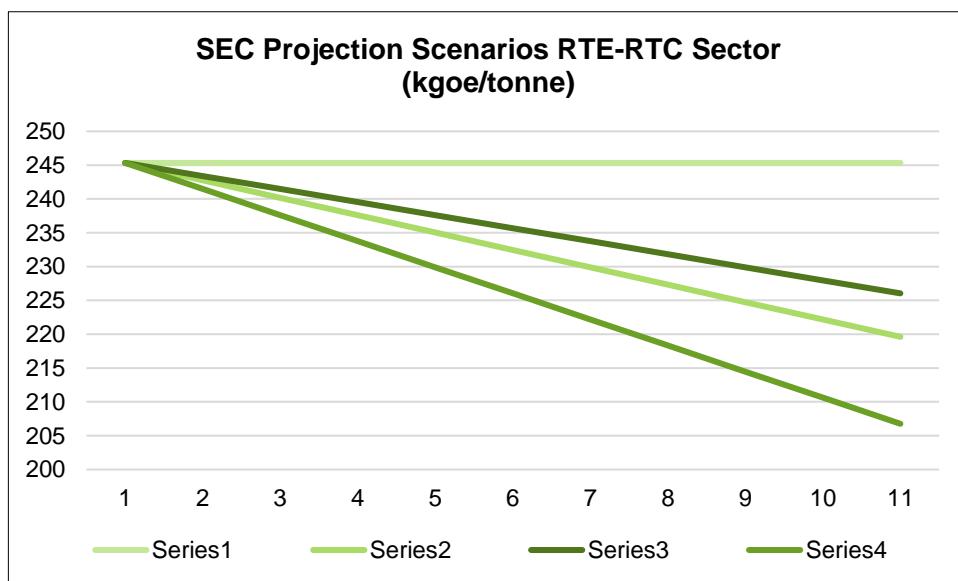


Figure 19: SEC projection under various scenarios for RTE-RTC sector

Proposed recommendations will help units in the RTE-RTC food processing sector to transit from conventional technologies to newer cleaner technologies for the production. Based on the consultations, the penetration level of the EE, state of the art technologies and other cross cutting technologies will not lead to change in the fuel mix of the sector.

RTE-RTC food processing sector will lower the carbon intensity in long run by adoption of the new EE technologies. And the development of the new state of the art technologies will further help in the reduction of the carbon intensity of the RTE-RTC food processing sector.

Adoption of the new technologies will help the RTE-RTC food processing sector during the transition to lower carbon emissions eventually. Rationale for the reduction in the SEC level considered are – EA recommendations will find faster adoption across the RTE-RTC food processing units and will be implemented by 2033 in the actual scenario and peer to peer learning will propagate the push for adoption of these technologies. State of art technologies are new and require the support and push from different stakeholders and demonstration. Acceptance of these technologies will evolve over the time and penetration in MSME level will be completed by 2033. Projections carried out on the basis of adoption of new state of art technologies, advanced energy efficient technologies will help the RTE-RTC food processing sector to reduce the carbon intensity in long run.

4.4.6. *Estimated co₂ Emission Reduction Potential*

Adoption of the energy efficient technologies and measures such as revamping measures for boilers, ovens, heaters, etc., and other state of art technologies such as turbo drop cookie depositors, rotary rack baking oven, among others will help the RTE-RTC food processing sector to reduce the carbon emissions eventually. Details of the emission reduction with respect to the base year (FY 2023) in BAU and other scenarios is presented in Table 40. The fuel mix is considered same as that in the current scenario i.e., FY 2023.

Table 40: Fuel consumption and Emissions – RTE-RTC Sector (BAU and proposed scenarios)

Year		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Energy Consumption and Emissions – BAU												
RTE		43.73	49.41	55.84	63.09	71.30	80.56	91.04	102.87	112.13	122.22	133.22
RTC	'000 toe	4.06	4.59	5.19	5.86	6.62	7.48	8.45	9.55	10.41	11.35	12.37
Total		47.79	54.00	61.02	68.95	77.92	88.05	99.49	112.4	122.5	133.6	145.6
Emissions	'000 tCO ₂	65.76	74.31	83.97	94.88	107.2	121.2	136.9	154.7	168.6	183.8	200.3
Energy Consumption and Emissions – Actual scenario												
RTE		43.73	48.89	54.65	61.09	68.27	76.29	85.25	95.24	102.6	110.6	119.1
RTC	'000 toe	4.06	4.55	5.09	5.70	6.38	7.14	7.99	8.94	9.65	10.41	11.23
Total		47.79	53.43	59.74	66.78	74.65	83.43	93.24	104.2	112.3	121.0	130.3
Emissions	'000 tCO ₂	65.76	73.56	82.29	92.04	102.9	115.1	128.7	143.9	155.1	167.3	180.3
Energy Consumption and Emissions – Conservative scenario												
RTE		43.73	49.02	54.95	61.59	69.03	77.36	86.70	97.15	105.0	113.5	122.6
RTC	'000 toe	4.06	4.56	5.11	5.74	6.44	7.22	8.10	9.09	9.84	10.65	11.52
Total		47.79	53.58	60.06	67.33	75.47	84.59	94.80	106.2	114.8	124.1	134.2
Emissions	'000 tCO ₂	65.76	73.75	82.71	92.75	104.0	116.6	130.7	146.6	158.5	171.4	185.3
Energy Consumption and Emissions – Ambitious scenario												
RTE		43.73	48.63	54.06	60.08	66.76	74.16	82.35	91.42	97.87	104.7	112.0
RTC	'000 toe	4.06	4.53	5.04	5.62	6.26	6.97	7.75	8.63	9.26	9.94	10.66
Total		47.79	53.15	59.10	65.70	73.02	81.12	90.11	100.1	107.1	114.7	122.7
Emissions	'000 tCO ₂	65.76	73.19	81.45	90.61	100.8	112.1	124.6	138.5	148.4	159.0	170.3

Adoption of the energy efficient technologies and measures and state of the art technologies will help in the reduction of 15.26 '000 toe during the FY 33 in Actual scenario. This reduction in the energy consumption will help the RTE-RTC food processing sector to reduce its carbon emissions by 20.05 '000 tCO₂ by FY 2033 in the Actual scenario. These transformations and adoption of new technologies will also help the RTE-RTC food processing sector to reduce the SEC level by over 10%.

Additionally, technical and financial barriers along with regulatory support required for the transition along with recommendations required to achieve the projections are presented in the next section.



5. Seafood Processing: Sector Overview and Energy Saving Potential

5. Seafood Processing Sector

5.1. Overview of Seafood Processing Industry⁶⁹

India has a coastline of more than 8118 kilometers making it a suitable geography for seafood processing industries. The seafood processing industry of India supplies quality products to more than 100 countries. This industry exported products worth 7.76 billion US\$ during FY 22. The world class seafood processing facilities and compliance to international regulatory requirement with respect to stringent quality control has resulted in the growth of the seafood processing industry in India. India is third largest fish producer and fourth largest seafood producer in the world.

5.1.1. Western Region⁷⁰

Veraval seafood processing cluster has around 60 processing units. These units are majorly engaged in the processing of Mackerel and Ribbon fish products. The total estimated production at cluster level is 108,000 tonnes. The units in the cluster have seasonal operation with May to December as the “season” and January to early April as the “off season.” The capacity utilisation remains 100% during the peak season and drops down to 50% during the off season. The units engaged in cold storage operation remain operational throughout the year with only cold storage operation being performed during the off season at the facility.

Major share of the input costs in seafood processing is attributed to the raw material i.e. fish contributes to 70% in the total input costs, followed by labour cost at 15%, packaging and transportation cost at 13% and energy cost at 2%. Energy has an extremely low share in the total input costs as due to low labour cost, manual operation is preferred over automated processes.

More than 96% of the cluster’s energy demand is met from electricity with remaining share being contributed by diesel. The technologies deployed in the cluster include blast freezer, IQF freezer, and other refrigeration system related equipment (reciprocating compressor, ammonia pump, atmospheric/ evaporative condenser and fan coil units), among others.

The Seafood Exporters Association of India and Veraval GIDC Association are the active associations with presence in the cluster.

Table 41: Details of Veraval Seafood Cluster

Description	Details
Location	Gujarat
Number of RTC-RTE units	~60
Major products	Mackerel fish, Ribbon fish
Type of fuel used in cluster	Electricity, diesel
Prominent Technologies used	Blast freezer, IQF freezer, reciprocating compressor, ammonia pump, atmospheric/ evaporative condenser and fan coil units
Prominent Industry association	<ul style="list-style-type: none">Seafood Exporters Association of IndiaVeraval GIDC Association
Prominent Institutes	<ul style="list-style-type: none">District Industries Centre (DIC) – Gir Somnath

⁶⁹ <https://www.indianseafoodexpo.com/indian-seafood-industry/>

⁷⁰ <https://www.sameeksha.org/pdf/clusterprofile/Veraval-Seafood-Processing-Gujarat.pdf>

Description	Details
	<ul style="list-style-type: none"> MSME DFO - Ahmedabad
SDA	Gujarat Energy Development Agency (GEDA)

5.1.2. Eastern Region⁷¹

Bhubaneshwar seafood processing cluster has around 21 processing units of which 16 remain active throughout the year and 5 only during the peak season. The total production from this cluster is ~33,600 tonnes per annum of processed food. The major products processed in the cluster include fish and tiger shrimp. The products from this cluster are exported to Japan, USA, Thailand, Vietnam, European Union, among others. The raw material used by these units is fish or shrimp and it accounts for 70% of the total input cost. Energy accounts for only 2% of the total input costs.

The cluster meets its energy demand by using electricity and diesel in which electricity has a major share of 83% and remaining contributed by diesel. The capacity utilisation of the units varies from 20% during the off season to 100% during the peak season with average capacity utilisation in the range of 40-60%. The prominent technologies used in the cluster are blast freezers, plate freezers, IQF freezers, and refrigeration system related equipment consisting of reciprocating compressor, ammonia pump, atmospheric/evaporative condenser and fan coil units.

The Seafood Exporters Association of India is active in this region and works for the promotion of exports from this region.

Table 42: Details of Bhubaneshwar Seafood Cluster

Description	Details
Location	Odisha
Number of RTC-RTE units	~21
Major products	Tiger shrimp, fish
Type of fuel used in cluster	Electricity, diesel
Prominent Technologies used	Blast freezer, plate freezer, IQF freezer, reciprocating compressor, ammonia pump, atmospheric/ evaporative condenser and fan coil units
Prominent Industry association	<ul style="list-style-type: none"> Seafood Exporters Association of India
Prominent Institutes	<ul style="list-style-type: none"> District Industries Centre (DIC) – Bhubaneshwar MSME DI - Cuttack
SDA	Odisha Renewable Energy Development Agency (OREDA)

5.1.3. Southern Region

Kochi seafood processing cluster has around 35 active units engaged in the processing of seafood. The availability of fish products and skilled labour locally in addition to the accessibility to the Kochi port has made the Kochi cluster pioneer in seafood exports from India since 1953. The major product processed in the cluster is shrimp along with other kinds of fish and cephalopods like squid, cuttlefish, octopus, crab, clams, mussels, etc. The estimated production from this cluster is around 146,876 tonnes.

⁷¹ <https://www.sameeksha.org/pdf/clusterprofile/bhubaneshwar-seafood-processing-odisha.pdf>

The cluster meets its energy demand by using electricity, wood and diesel fuel with electricity contributing to 69% and wood contributing to 29% in the total energy mix. The capacity utilisation of the units in Kochi cluster varies between 16 – 91% due to the seasonal nature of this industry. The prominent technologies used in this cluster are refrigeration compressors, evaporative condenser, IQF freezer, blast freezer, spiral freezer, plate freezer, tunnel freezer, freeze dryer, wood fired boiler, among others.

The Seafood Exporters Association of India is a prominent association in the seafood sector with presence in the Kochi cluster.

Table 43: Details of Kochi Seafood Cluster

Description	Details
Location	Kerala
Number of RTC-RTE units	~35
Major products	Shrimp and fish products
Type of fuel used in cluster	Electricity, wood, diesel
Prominent Technologies used	Refrigeration compressors, evaporative condenser, IQF freezer, blast freezer, spiral freezer, plate freezer, tunnel freezer, freeze dryer, wood fired boiler
Prominent Industry association	<ul style="list-style-type: none"> Seafood Exporters Association of India
Prominent Institutes	<ul style="list-style-type: none"> District Industries Centre (DIC) – Kakkanad MSME DFO - Thrissur
SDA	Energy Management Centre (EMC) Kerala

5.2. Sector Level Stakeholders

In context of our existing working relationships in a number of MSME clusters, the local level stakeholders show great interest and enthusiasm for energy efficiency initiatives and technical cooperation activities. These stakeholders can be positioned as opinion influencers among the local industrial community during project activities in any particular cluster.

The primary stakeholders in the cluster are the industry associations, individual seafood processing units and MSME DI/DIC. The other stakeholders include the technology suppliers, government agencies, financial institutions, and academic/training institutes.

Industry Association

Industry Associations are increasingly becoming more professionally managed with dedicated staff for day-to-day operations. These associations serve as the first avenue to understand cluster dynamics such as energy efficiency technology needs, disseminate best practices among member units and also assist in organizing various cluster level awareness programmes on EE. Leveraging these industry associations from the initial stage of the study would be quite valuable in:

- Understand the membership profile of MSMEs in the cluster
- Cluster profile of Industrial association including number of MSMEs, size of MSME units
- Present business scenario, barriers for energy efficiency
- Support in reaching out to member industries for project activities

Seafood Exporters Association of India (SEAI)⁷²

The Seafood Exporters Association of India was established in the year 1973 with an aim to safeguard and promote the interest of seafood industry and members of the industry by promoting cooperation. SEAI has around 90% of the seafood industries as its members. The association is engaged in activities aimed at increasing the seafood exports from India.

Government Institutes:

There are government support bodies, such as District Industries Centre (DIC) – Kakkanad, DIC – Bhubaneshwar, DIC – Gir Somnath among others in the clusters which also work towards the development of the cluster particularly the MSME industries. MSME-DI/DFO has offices in Ahmedabad, Cuttack, Thrissur, among other places and support the execution of the schemes from MoMSME. The agency functions for development of programmes on EE and RE in the region.

Key national and regional stakeholders associated with seafood processing sector are presented next-

Marine Products Export Development Authority (MPEDA)⁷³

The Marine Products Export Development Authority (MPEDA) was established in 1972 under the Marine Products Export Development Authority Act 1972. According to the Act, MPEDA has the mandate to take actions for developing the necessary resources for promoting the exports for all fishery products like shrimp, prawn, lobster, crab, fish, shell-fish, other aquatic animals or plants, among others. The Act allows MPEDA to regulate the seafood exports from the country with respect to quality parameters and ensuring sustenance. MPEDA holds the authority to enhance the seafood products quality by ensuring the quality of marine products and raw material through inspection, standards and specification, training and others for meeting the requirement of the international seafood products market. MPEDA reserves the right to take necessary steps for safeguarding and developing the exports from the country.

Based on MPEDA's recommendations, the government has notified new standards for fishing vessels, storage premises, processing plants and conveyances. MPEDA focusses on the below mentioned activities for augmenting the seafood export market of India

- Market Promotion
- Capture Fisheries
- Culture Fisheries
- Processing Infrastructure & Value addition
- Quality Control
- Research and Development

⁷² <https://www.indianseafoodexpo.com/mpeda-seai/>

⁷³ <https://mpeda.gov.in/>

5.3. Energy Consumption and Benchmarking of Seafood Processing Sector

5.3.1. Energy Consumption

Food processing industry is energy intensive and energy cost accounts for about 15⁷⁴ per cent of total production cost. The primary process steps in food processing varies with the type of product processed.

In case of seafood processing, the main steps followed are washing, grading, packing, freezing, cold storage, along with some additional processes depending on the type of product processed. In case of dried fish products, a drying operation is performed which increases the specific energy consumption of this type of product significantly.

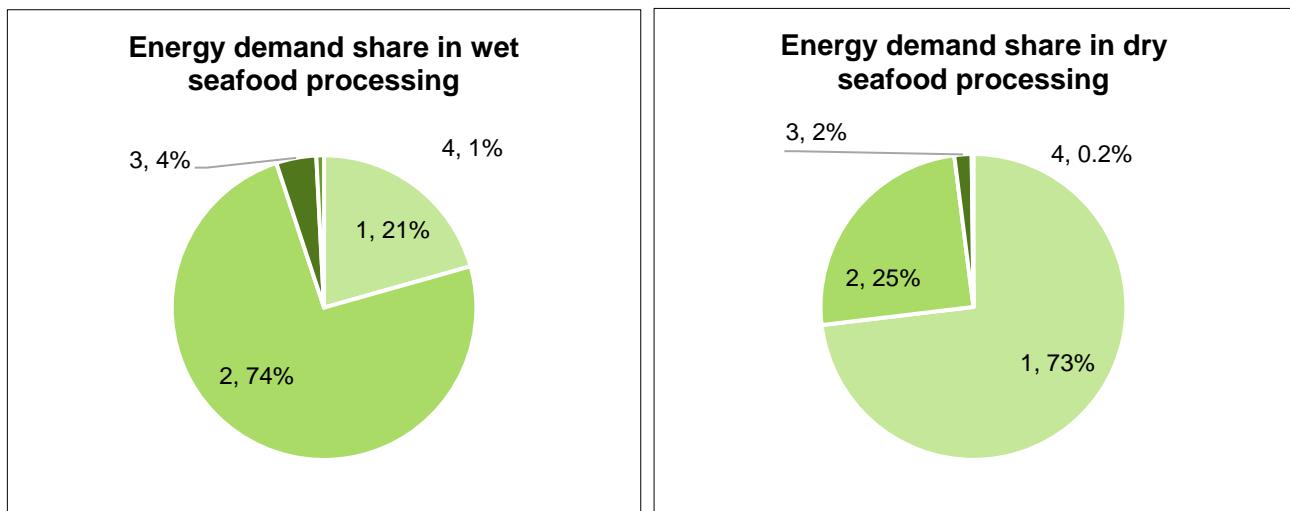


Figure 21: Energy consumption in wet seafood processing

Figure 20: Energy consumption in dry seafood processing

In case of seafood products, electricity which is majorly used for refrigeration, freezing, process auxiliaries and utilities, among others account for a major share in the energy consumption (~90%).

- *Specific Energy Consumption for (SEC)⁷⁵ for wet seafood products range between 27 - 76 kgoe/tonne*
- *Specific Energy Consumption (SEC)^{Error! Bookmark not defined.} for dried seafood products is around 2922 kgoe/tonne*

In case of seafood processing units, the refrigeration system has a major potential for energy conservation. Interventions like replacement of ammonia based reciprocating compressors with VFD based screw compressors, defrosting with hot gas instead of electric heating system, cleaning of condenser tubes, installation of air curtains, installation of FRP blades, installation of automatic ON-OFF control with respect to temperature for evaporator FCUs, reducing heat losses from boiler surface and condensate return line, use of energy efficient IE4 Motors, conversion of existing flat V belt to cogged v-belt in motor drive system, installation of Internet of Things (IoT) based energy monitoring system are some of the interventions which can be implemented for reducing the energy consumption.

⁷⁴ <https://www.centricabusinesssolutions.com/blogpost/energy-accounts-15-food-and-drink-manufacturers-costs-scope-ease-pressure-margins-clear#:~:text=Blogs-,.Energy%20accounts%20for%202015%25%20of%20food%20and%20drink%20manufacturers%20costs,pressure%20on%20margins%20is%20clear>

⁷⁵ SEC is defined based upon the audits carried out by the team as part of this assignment

In Indian food processing context, some clusters are doing better than others. Within the clusters some food processing units are doing better than others. These units have identified and implemented energy efficient technologies and practices. Thus, there is need for benchmarking (SEC in kgoe/tonne of final product) and energy mapping. This shall further improve the efficiency and competitiveness of the Indian food processing industry.

5.3.2. Energy Benchmarking

The term benchmarking involves “comparing actual or planned practices, such as processes and operations, to those of comparable organizations to identify best practices, generate ideas for improvement” which form the basis for measuring performance in an industry.

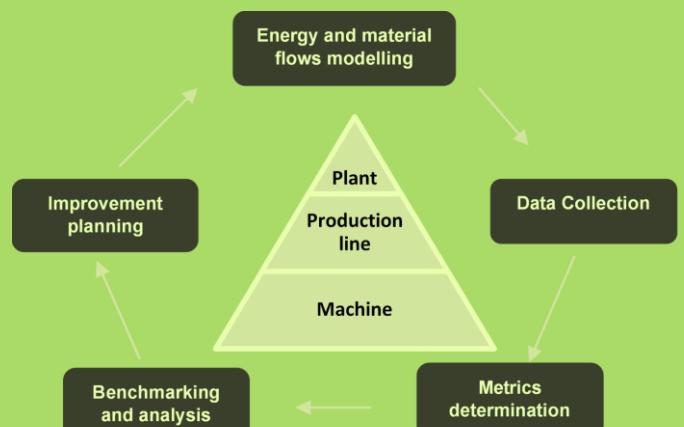
Energy efficiency (EE) benchmarking can be defined as the technique to identify the best practices and achievable EE improvement targets in companies and industries. The management in an industry can compare their baseline values with benchmark and take steps to ensure improvements in EE.

Energy efficiency benchmarking can be divided into internal (including SEC, historical trends of production, energy consumption inside plant boundary) and external benchmarking (benchmarking with industry best SEC level etc.). Internal benchmarking is the comparisons within one company to establish the baseline and best practice. External benchmarking is to compare companies in the same or similar industry sector to establish the best-in-class performance. Additionally, general benchmarking is the comparison of practices regardless of the industry field.

Benchmarking as defined above is the process of searching for best practices that lead to excellence in performance. Baseline can be established by comparing the best practices and subsequently, areas of potential improvement, and areas of focus can be identified. A variety of methods and studies have been carried across industry to come up with the best practices of energy efficiency benchmarking.

Example: A five step energy benchmarking method (E²BM method)

E²BM method can be applied at each individual process (e.g., machine), interrelated processes (e.g., production line), and a plant. This method relates energy consumption in manufacturing process to material flows to visualise the effectiveness and variations of energy usage. The inputs received from the prior step are used for developing strategies to improve energy efficiency. It consists of five steps and takes three levels of hierarchy into consideration i.e., plant, production line and machine.



Energy Performance Indicators (EnPIs) for the Sector

Key Performance Indicator (KPI) can be defined as a quantifiable/measurable value that demonstrates how effectively the industry or equipment or process is performing. KPIs can be financial and non-financial. A pictorial representation defining KPI's is presented next.



The four challenges in defining and maintaining KPIs are: (a) understanding industry's strategy and key objectives, (b) measure is deemed important to area/process of the industry, (c) targets of KPI improvement must be realistic and (d) in case, accurately measuring and reporting indicators is difficult, internal process or SOP should be defined.⁷⁶

Table 44: EnPI related terms and definitions

Term	Definition	Notes
Energy baseline	Quantitative reference(s) providing a basis for comparison of energy performance	An energy baseline reflects a specified period of time
Energy consumption	Quantity of energy consumed	-
Energy efficiency	Ratio or other quantitative relationship between an output of performance, service, goods or energy, and an input of energy	Conversion efficiency; energy required/energy used; output/input; theoretical energy used to operate/energy used to operate
Energy performance	Measurable results related to energy efficiency, energy use and energy consumption	Results can be measured against organization's energy targets and energy performance requirements
Energy performance indicator	Quantitative value or measure of energy performance, as defined by the organization	EnPIs could be expressed as a simple metric, ratio, or a more complex model ⁷⁷

EnPIs can be a simple parameter, a simple ratio, or a complex model. Examples of EnPIs can include energy consumption per time, energy consumption per unit of production, and multi-variable models. The organization can choose EnPIs that inform the energy performance of their operation and can update the EnPIs when business activities or baselines change that affect the relevance of the EnPI, as applicable.

Energy performance indicator of a food processing industry as a whole is represented as energy consumed per tonne of food produced (kgoe/tonne), the indicator can be further divided to arrive at sub-process/equipment-wise EnPI such as boiler (kgoe/tonne), air compressor (kW/cfm). The EnPI for any equipment varies depending on end application, usage pattern and a number of variable parameters.

EnPIs can further be classified as direct or indirect. Direct EnPIs are the internal factors for comparison within an industry to come up with best practices and establish baselines. Indirect EnPIs is comparison of companies or industries in a similar sector to establish best in class practice.

5.3.3. SEC comparison across various clusters across India⁷⁸

⁷⁶ Source: The Basics of Key Performance Indicators, <https://www.thebalancecareers.com/key-performance-indicators-2275156>

⁷⁷ Source: International Standard, ISO 50001 - Energy Management Systems - Requirements with guidance for use, 1st edition 2011-06-15

⁷⁸ The SEC values are based on the energy audits carried out as part of this assignment and past programmes by BEE on MSME Energy Efficiency Enhancement

The specific energy consumption (SEC) of any seafood unit varies considerably depending on the type of product (wet seafood or dry seafood) and the degree of mechanization used. For example, units engaged in the processing of wet seafood products consume energy in the range of 27 - 76 kgoe/tonne. And units processing dried seafood products has significantly higher energy consumption of around 2922 kgoe/tonne. The geographic location of the prominent clusters is presented in the figure below.

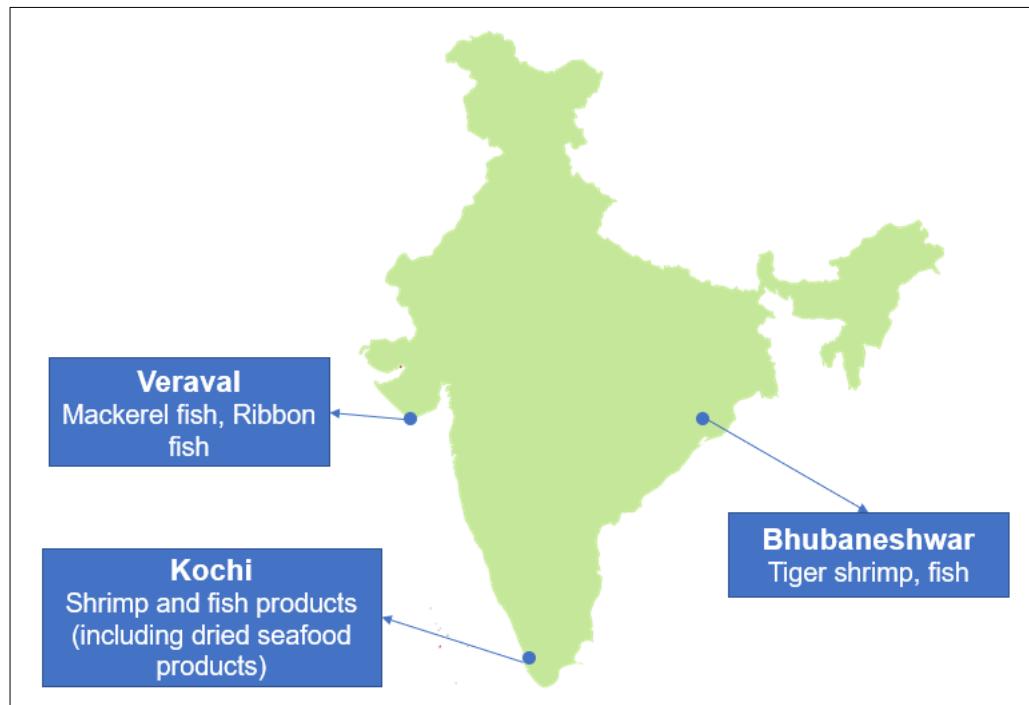


Figure 22: Geographic spread of prominent Seafood clusters

Table 45: SEC benchmark data for Indian MSME seafood processing units⁷⁹

Product Category	Product Sub-category	SEC (kgoe/tonne of final product)		
		Minimum	Maximum	Median
Seafood	Wet seafood	27	76	45.3
	Dry seafood		2922	

Variation in the SEC can be broadly classified in the two main parameters –

- **Type of product processed**
- **Best Operating Practices (BOPs)**

Details of each category mentioned above is presented next-

Type of product processed

The seafood processing sector processes majorly two types of products i.e., wet products and dried products. The type of products processed in a particular seafood processing unit has a major role to play in its energy consumption. The process flow and technologies used vary a lot with the product processed and hence the energy intensity.

⁷⁹ SEC values are based on energy audit studies conducted as part of the Energy and Resource Mapping Assignment

⁸⁰ Most widely adopted technology based on the survey and EA carried out during the BEE energy and resource mapping assignment

- In case of wet seafood processing, the processes involved are grading, packing, freezing, cold storage, among others. The units in the cluster use blast freezers, plate freezers, IQF freezers, refrigeration compressors, condensers, evaporators, evaporative condensers, and cooling towers, among other equipment for meeting the freezing and refrigeration demand of the units. The refrigeration and freezing processes are the highest energy consumers in a seafood unit.
- The units engaged in the processing of dried seafood products performs drying operation by reducing the pressure and adding heat to allow the frozen water in the material to change directly to vapor (sublimate), after the freezing process. This process of freezing and then drying is called “Freeze drying” (also known as lyophilization) typically used to preserve perishable materials, with the goal of extending their shelf life and/or preparing them for transport. These type of units install wood fired boilers and use the steam generated to heat oil which is then used in dryers for drying the products. This drying operation is the highest energy consumer in these type of units.

Best operating practices and EE technologies for the different processes used in seafood processing play a vital role in optimization of the energy consumption in the units. Summary of key BOP's and technologies is presented in Table 31

Table 46: Summary of BoPs and EE technologies for different seafood processing sub-sectors⁸¹

Equipment	Best (Efficiency/S EC) ⁸²	Major Area of Improvement Required to meet the Benchmark values ⁵⁶	Best operating practices ⁸³
Wood fired boiler	74%	<ul style="list-style-type: none"> • Relining of combustion zone surface walls to reduce the heat losses • Reducing the heat loss from condensate return line by providing insulation to line 	<ul style="list-style-type: none"> • Maintain stack temperature between 120 – 130 °C by recovering heat to preheat combustion air or boiler feedwater • Maintain air ratio between 1.32- 1.39 • Automatic blowdown control based on boiler water conductivity and pH. • Regular removal of soot build up on tubes and scaling on water side. • Optimising steam pressure based on process demand. • Variable speed control for ID and FD fans if the boiler load characteristics are variable. • Maintaining boiler loading at two-thirds of full load.
Refrigeration	<ul style="list-style-type: none"> • Water- 	<ul style="list-style-type: none"> • Insulating the 	<ul style="list-style-type: none"> • Avoiding the entry of warm air

⁸¹ Elaborative details of the technology and BOP is presented in technology compendium section

⁸² Based on studies carried out in seafood processing cluster

⁸³ <https://beeindia.gov.in/sites/default/files/Annexure%202.pdf>

Based on energy audit studies in the seafood processing cluster

Equipment	Best (Efficiency/SEC) ⁸²	Major Area of Improvement Required to meet the Benchmark values ⁵⁶	Best operating practices ⁸³
system	Cooled Refrigeration Compressors: COP - 2.042 • Air-Cooled Refrigeration Compressors: COP - 1.638	accumulator piping to reduce the radiation losses. <ul style="list-style-type: none"> Installation of air curtains to reduce the heat loss during air infiltration. Installation of automatic ON-OFF control for evaporator FCUs based on cold room temperature. Cleaning of condenser tubes to improve performance of refrigeration system. 	from outside into the cold room area by properly sealing the cold room chamber <ul style="list-style-type: none"> Providing insulation of appropriate type, size and thickness to reduce the energy losses from uninsulated or defective insulation portions of the refrigeration system. Providing thickness for insulation so as to maintain the surface temperature above the dew point temperature of ambient air Minimising the corrosion on cold piping, ducts, chillers, etc. Cleaning the condenser coils on monthly basis. Using regular watch glass to inspect, observe and maintain refrigerant and recharge up to the essential level Minimising refrigeration loads with energy efficient measures like window shades, low thermal mass wall, etc Seasonal variations shall be considered while choosing the operational parameters like temperatures of cooling water, chilled water and return water without affecting system performance.
Electric Motors	<ul style="list-style-type: none"> 96% 	<ul style="list-style-type: none"> Conversion of existing flat V belt to direct driven for motors Replacement of existing old inefficient motors with energy efficient IE4 motors 	<ul style="list-style-type: none"> Use IE4 rating motors Use BLDC motors for fans, blowers etc. Maintain voltage and current imbalance as low as possible as prescribed by IEEE Replace the motor after rewinding once

Equipment	Best (Efficiency/SEC) ⁸²	Major Area of Improvement Required to meet the Benchmark values ⁵⁶	Best operating practices ⁸³
Pump and Pumping System	68%	<ul style="list-style-type: none"> • Replacement of ETP pumps with new EE pumps 	<ul style="list-style-type: none"> • Operate pumps close to the best operating point as specified by the OEMs. • Install variable frequency drive (VFD) for fluctuating loads instead of throttling • Use on-line monitoring for centralized large system and periodical measurement for decentralized smaller pumps • Replace worn-out pumps with energy efficient pumps. • Maintain a minimum Net Positive Suction Head (NPSH) of pumps as prescribed by the manufacturer.
Lighting System	120 watt/lumen ⁸⁴	<ul style="list-style-type: none"> • Replacement of fluorescent Tubes with LED tubes 	<p>Maintain the appropriate lux levels</p> <ul style="list-style-type: none"> • Administrative building 50–400 • Administrative corridor 100 • Shop floor lighting (process) 150–300 • Workshop 150–300 • Warehouse storage area 100–150 • Use 3-5 star rated LED lights

5.4. Energy Efficiency Potential in Seafood Processing sector

Seafood processing is one of the energy intensive subsectors in food processing with the majority of the energy being consumed in operations like refrigeration and freezing.

Energy saving potential is a function of the present efficiency levels, type of fuel used, energy efficiency measures applicable for seafood processing clusters, and readiness of the clusters in adopting the new state of art technologies. Details of the present fuel mix, penetration level of different technologies, EE potential for the seafood processing clusters and national level projections is presented in this section.

The seafood processing sector mainly uses electricity, wood, and diesel for meeting the energy requirements. The choice of fuels used varies with the type of seafood processed in the unit i.e. wet seafood or dry seafood. The units engaged in processing dry seafood products use wood for meeting the thermal energy requirement of dryer whereas the units engaged in processing wet seafood products use electricity as a major fuel source. Major applications of the different fuels are presented next.

⁸⁴ BEE Star rated appliances - https://www.beestarlabel.com/Content/Files/LED_schedule.pdf Accessed during April 2023



Electricity

Majorly to drive refrigeration system, freezers, primemovers (motors), among other applications



Wood

Boilers



Diesel

DG set for back-up power

During the BEE- “Energy and resource mapping assignment” detailed primary survey (EOI forms 189+) and secondary stakeholder consultations (200+), field visits (55+), energy audits (50), review of the past reports and interventions carried out across food processing clusters, discussion with IA (13+) and technology providers – were carried out to evaluate the penetration level of different technologies and share of the different fuels etc.

Summary of the cluster level and sector level findings based on the elaborative and extensive study is presented in section next.

5.4.1. Energy Consumption at Cluster Level

Based on the products processed (wet seafood / dry seafood) the forms of the energy used by the sector include electricity, wood, and diesel. Share of the energy varies for the different seafood processing units based upon the type of the product processed.

During the BEE energy and resource mapping study, the share of the fuel mix for the Seafood processing cluster (**Kochi**) is calculated based on the energy audits and stakeholder consultations with industries and industry association in this cluster (physical meetings, workshops).

Findings for the Kochi cluster have been thoroughly discussed with prominent industry association for seafood processing i.e. SEAI and industries through workshops / physical meetings and one-one interactions with multiple industries.

Cluster level workshop was conducted in Kochi seafood processing cluster to validate the findings. Regional consultation in the other prominent seafood processing cluster was also conducted to validate the findings.

Summary of the different forms of energy used in Kochi seafood processing cluster is presented in Table 32.

Table 47: Energy share of different fuels in Kochi seafood processing cluster (Units – toe)⁸⁵

Energy type	Kochi
Electricity	5320
Wood	2228
Diesel	218
Total	7766

⁸⁵ Appropriate GCV values of the different fuel based upon the discussion with Industries, review of the GCV reports at different audited units have been used to convert the different form of fuel to oil equivalent units.

Electricity has a maximum share in the energy mix in Kochi cluster which stands at 68%, followed by wood at 29% and the remaining small portion is contributed by the diesel use. The wood consumption is attributed to the drying operation performed in the units engaged in processing dry seafood products which involve a step wherein the products are dried post the freezing operation. Diesel consumption is mainly because of DG set's use for backup power.

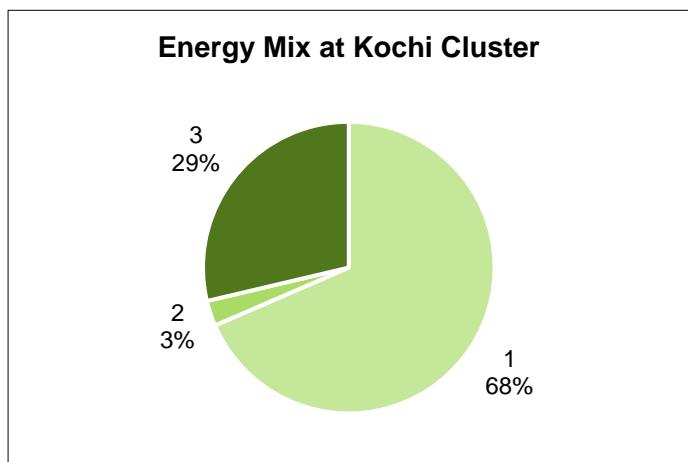


Figure 23: Share of different fuels in Kochi seafood cluster

5.4.2. Prominent Technologies Adopted in Seafood Processing Sector

The predominant technologies used in seafood processing are described below.

1. Refrigeration System

Refrigeration systems play a crucial role in the processing and supply of marine products due to their fundamental significance in preserving the quality, safety, and freshness of these perishable items. Marine products, such as seafood, are highly susceptible to rapid degradation if not properly handled. A refrigeration system effectively maintains the necessary low temperatures required to inhibit bacterial growth extending the shelf life of the products.

This system includes an arrangement of compressors, condensers, evaporators, evaporative condensers, and cooling towers. The plants have installed cold rooms, blast rooms, IQF, tunnel freezer, flake ice machine, tube ice machine, chill rooms, plate freezer, and a spiral freezer which uses reciprocating compressors for water cooled system and air cooled outdoor unit. The direct efficiency of the system ranges from COP 0.960 – 2.042. Some observations with respect to the refrigeration unit are:

- Uncleaned condenser tubes can negatively impact the performance of a refrigeration system, reducing its efficiency.
- Heat loss during air infiltration happens when outside air enters a building, causing temperature fluctuations.
- Manual controls for fans require operators to adjust fan settings manually instead of relying on automated systems.
- Defrosting with electric heaters in storage units is a time-consuming process.
- The ammonia reciprocating compressors have high specific energy consumption.
- VFD is not installed on air compressor resulting in unload power consumption.

2. Boiler

Boilers are crucial in the seafood processing industry for their role in providing the necessary steam and hot water required for various processes such as blanching, sterilization, and cooking of seafood products. Boilers generate the steam that heats water, which in turn helps cook ingredients, ensuring food safety and extending shelf life.

Some of the units operate boiler having capacity ranging from 0.6 - 4 TPH for meeting the heating demands of the unit. The boiler uses wood blocks as its fuel. The direct efficiency of these boilers

ranges from 44 – 74%. The common observations in the boilers across the units in cluster leading to energy loss were as below.

- Heat losses from combustion zone surface walls resulting from inefficient insulation or heat-resistant materials
- Heat losses from condensate return lines occur due to poorly insulated or improperly maintained system
- Dry flue gas losses stem from incomplete combustion or inefficient burner design
- Insufficient waste heat recovery from boiler flue gas represents a missed opportunity for energy efficiency and cost savings

3. Motors and Drives

Motors and drives facilitate the movement of conveyor belts, packaging machines, among others, allowing for efficient and precise automation in the plants. The current efficiency is in the range of 83 – 96%. During the audit, the observations with motors and drives are as follows:

- Certain motors are driven using flat V-belt with pulleys. The disadvantage with belt drives are the high slippage, high maintenance, and increased power consumption due to losses in transmission.
- IE1 or IE2 standard motors are used in operations for process machines like ID Fan, pumps, blower, pumps, etc. in the plant.

4. Pumps

Pumps are essential components in seafood processing facilities, serving critical roles in various applications. In cooling towers and evaporative condensers, pumps circulate water or refrigerants to dissipate heat, ensuring that the processing environment remains at optimal temperatures. Condenser pumps assist in the refrigeration process by facilitating the release of heat from the system. Ammonia pumps are specifically designed to handle ammonia, a common refrigerant in the seafood industry. The efficiency of these pumps is in the range of 23 - 75%.

- Efficiency of the pumps was low compared to the EE pumps available on the market

5.4.3. Sector Level Production and SEC Details

The production volume of processed seafood (including fish products) is sourced from a research study conducted by *statista* on Processed Fish & Seafood in India.⁸⁶ SEC data for the processed seafood subsector is calculated from the multiple energy audits carried out under the BEE energy and resource mapping assignment. Also, the SEC data has been validated through multiple consultations carried out in different food processing clusters.

The production of processed seafood products in FY23 was 2.4 million tonnes and the average SEC of the units engaged in seafood processing is 64.2 kgoe/tonne.

Processed seafood production projections

The production trend for processed seafood between FY19 to FY29 is sourced from a research study conducted by *statista*.⁸⁶ For projecting the production volumes until FY33 the CAGR between FY19 to FY29 is used.

⁸⁶ <https://www.statista.com/outlook/cmo/food/fish-seafood/processed-fish-seafood/india>

The projection of production volume of processed seafood products between FY23 to FY33 is shown in the Figure 24.

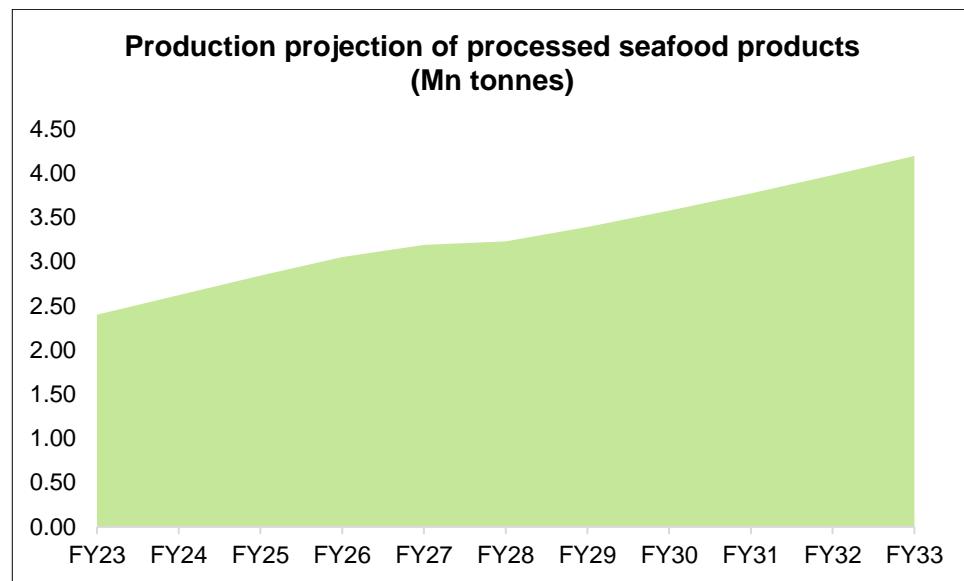


Figure 24: Production projection of processed seafood products

5.4.4. Sector Level Energy Consumption

Benchmark SEC data for the processed seafood subsector validated through multiple consultations is used for calculating the sector level energy consumption data. Energy consumption for the processed seafood subsector is calculated by multiplying the SEC and production volume.

The energy consumption of the processed seafood subsector in FY23 is estimated at 154 ktoe.

The share of different fuels at sectoral level for processed seafood subsector remains same as showcased in Figure 23.

The fuel mix in the units processing seafood products varies with the type of product processed i.e. wet seafood product or dry seafood product. In case of wet seafood products, the share of electricity is more whereas in case of dry seafood products the share of thermal energy is more because of the drying requirement.

5.4.5. Projections of Energy Saving potential

In order to evaluate the energy saving potential at the sector level, mapping of energy efficient technologies, state of art technologies, EE technologies for utilities is required along with energy saving potential.

Mapping of the technologies for the processed seafood cluster was done through field studies, primarily survey, discussion with IA and technology vendors. Long list of the technologies was mapped during multiple tasks and activities under BEE energy and resource mapping study.

Replication potential for different technologies in short term and long term is evaluated in closed consultation with multiple stakeholders across different leading seafood processing clusters – **Kochi** seafood processing cluster, **Khordha** seafood processing cluster.

Summary of different energy efficient and state of art technologies is presented in Table 36 and Energy conservation measures identified in cluster.

Table 37.

Team has segregated the EE technologies in two categories based on their applicability in the short-term (next 5 years) and long-term (next 10 years). For all identified EETs replication potential is estimated and segregated into four categories.

Table 48: Methodology for segregating EETs

	Low Potential	Less than 10% MSMEs in cluster have replication potential
	Medium Potential	10%-30% MSMEs in cluster have replication potential
	High Potential	30%-60% MSMEs in cluster have replication potential
	Saturation	More than 60% MSMEs in the cluster have implemented EET

Potential of technology penetration levels across⁸⁷

Table 49: Process specific replication potential of technologies across seafood processing clusters

S. No	Technologies	Energy savings potential	Replication Potential in short-term (till 2028)			Replication Potential in long-term (till 2033)		
			Micro	Small	Medium	Micro	Small	Medium
1	Replacement of Ammonia Reciprocating Compressors with VFD based Screw Compressors	13%	Low	Medium	High	Low	Low	Medium
2	Installation of FRP blades at evaporative side FCUs in cold storage and blast storage	1%	Low	Medium	High	Low	Medium	Medium
3	Replacement of existing old inefficient motors with energy efficient IE4 motors	3%	Low	Medium	High	Low	Medium	Medium
4	Installation of Internet of things-based Energy Monitoring system	1%	Low	Medium	High	Low	Medium	Medium
State of the art technology								
5	Use of brine freezers	30%	Low	Medium	High	Saturation	Low	Medium

⁸⁷ Indicative list not comprehensive, saving envisaged in the table only represents the energy saving, productivity saving from different technologies is not factored in this table. Most of the units globally having best SEC level had already implemented the ECMs indicated in point 1-10.

Energy conservation measures identified in cluster.

Table 50: Replication potential of energy saving practices across seafood processing clusters⁸⁸

S. No	Technologies	Energy savings potential	Replication Potential in short-term (till 2028)			Replication Potential in long-term (till 2033)		
			Micro	Small	Medium	Micro	Small	Medium
1	Improve performance of refrigeration system by cleaning condenser tubes	7%	Medium	High	High	Low	Medium	Medium
2	Installation air curtains to reduce the heat loss due to air infiltration	2%	Low	High	High	Low	Medium	Medium
3	Installation of automatic ON-OFF control with respect to temperature for evaporator FCUs	3%	Medium	High	High	Low	Medium	Medium
4	Defrosting with the help of hot gas instead of electric heating system in cold storage	1%	Low	Medium	High	Low	Medium	Medium
5	Installation of VFD for Screw Air compressor to reduce the unload power consumption.	1%	Low	Low	Low	Low	Low	Low
6	Conversion of existing flat V belt to cogged v-belt driven motor	5%	Low	Medium	High	Low	Low	Medium
7	Reduce the heat losses from the surface of the boiler	30%	Low	Medium	Medium	Low	Low	Low
8	Reduce the heat losses from the Condensate return line	30%	Low	Low	Low	Low	Low	Low
Renewable energy measures								
9	Installation of rooftop solar PV	-	Medium	High	High	Low	Medium	Low

⁸⁸ Indicative list not comprehensive, saving envisaged in the table only represents the energy saving, productivity saving from different technologies is not factored in this table.

Implementation of the energy saving, and state of art technologies will help in reduction of the energy intensity eventually. This will help the seafood processing units to become more energy efficient and competitive globally. Summary of the energy saving potential for the seafood processing subsector is presented in *Table 38*

Table 51: Summary of the energy saving potential for seafood processing subsector in Actual scenario⁸⁹

Product sub-category	Energy Saving potential (%)	Energy consumption (ktoe) FY 22-23	Energy consumption BAU (ktoe) FY 32-33	Estimated energy saving – Actual scenario (ktoe) FY 32-33
<u>Processed seafood</u>	<u>20.5%</u>	<u>154.0</u>	<u>269.1</u>	<u>55.1</u>

Projections of the different scenarios on account of the multiple interventions proposed for the seafood processing sector are presented in Figure 25. The scenarios considered while projecting energy consumption are as below.

- Actual scenario – Considering the energy savings potential as mentioned in the table above is realized until FY 2033. This savings potential is identified during the energy audit studies conducted in seafood processing units as part of the BEE Energy and Resource Mapping in MSME clusters for the Food Processing sector assignment. This savings potential will be realized by the implementation of the energy efficient technologies and measures mentioned in Table 36 and Table 50 and described in detail in Annexure.
- Conservative scenario – Considering 75% of the energy savings potential is realized until FY 2033
- Ambitious scenario – Considering 150% of the energy savings potential is realized until FY 2033. The additional energy savings are as a result of the adoption of the state of the art technologies as mentioned in Table 36.

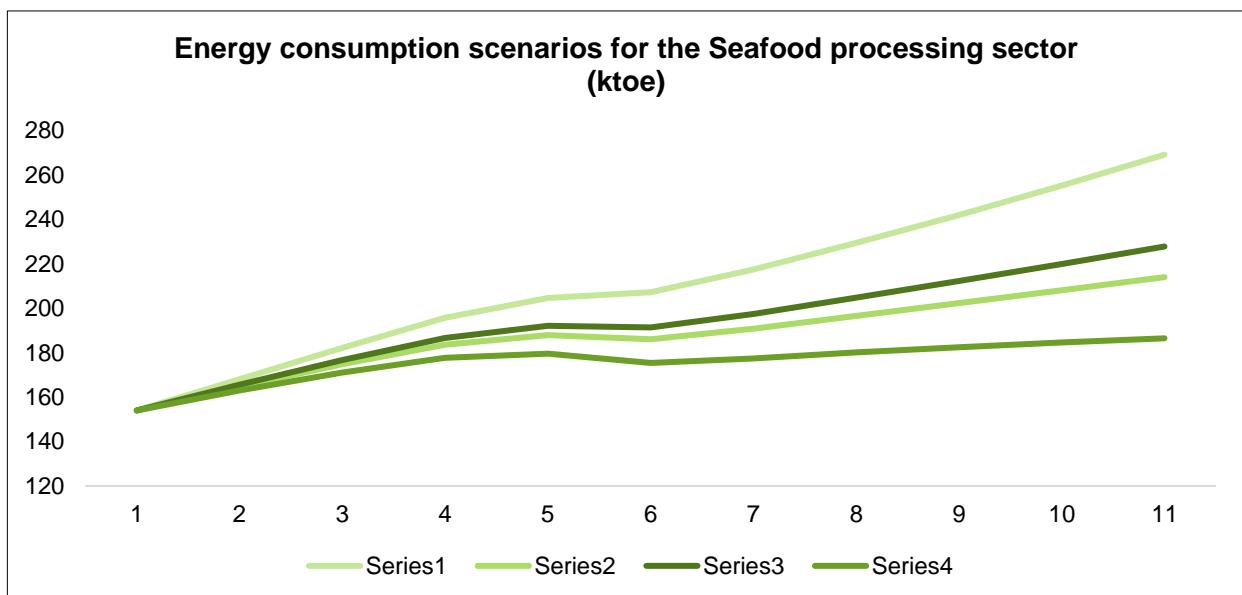


Figure 25: Energy consumption scenarios for seafood processing sector

⁸⁹ The energy savings potential in the Actual scenario is considered based on the findings of the energy audit studies conducted as part of the BEE Energy and Resource Mapping Assignment

Adoption of the new technologies will help the Indian seafood processing units to reduce the SEC level by over 20% till FY 2033. Faster adoption of the interventions will further help the seafood processing sector to achieve the savings and lower the emissions faster. List of challenges and proposed solutions to support the sustainable growth of the seafood processing sector is presented in section 5.

Proposed sector level SEC for seafood processing sector after implementation of EE technologies eventually till FY-2033 is presented in Table 39.

Table 52: Proposed long term Sector level SEC – Seafood processing (Actual scenario)

Overall sector level SEC – Seafood processing kgoe/tonne	FY 22-23	FY 27-28	FY 32-33
	64.2	57.6	51.0

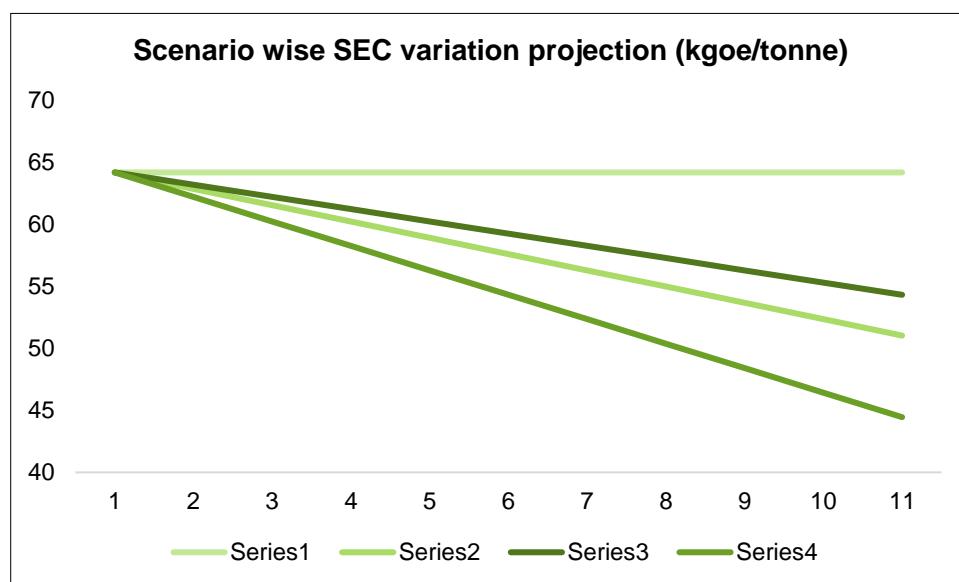


Figure 26: SEC projection under various scenarios for seafood processing sector

Proposed recommendations will help units engaged in seafood processing to transit from conventional technologies to newer cleaner technologies for the production. Based on the consultations, the penetration level of the EE, state of the art technologies and other cross cutting technologies will not lead to change in the fuel mix of the sector.

Seafood processing sector will lower the carbon intensity in long run by adoption of the new EE technologies. And the development of the new state of the art technologies will further help in the reduction of the carbon intensity of the seafood processing sector.

Adoption of the new technologies will help the seafood processing sector during the transition to lower carbon emissions eventually. Rationale for the reduction in the SEC level considered are – EA recommendations will find faster adoption across the seafood processing units and will be implemented by 2033 in the actual scenario and peer to peer learning will propagate the push for adoption of these technologies. State of art technologies are new and require the support and push from different stakeholders and demonstration. Acceptance of these technologies will evolve over the time and penetration in MSME level will be completed by 2033. Projections carried out on the basis of adoption of new state of art technologies, advanced energy efficient technologies will help the seafood processing sector to reduce the carbon intensity in long run.

5.4.6. *Estimated co₂ Emission Reduction Potential*

Adoption of the energy efficient technologies and measures such as replacing reciprocating compressors with screw compressors, cleaning of condenser tubes, automatic control for evaporator FCUs, FRP blades for evaporator FCUs, use of air curtains, among others, and other state of art technologies such as brine freezers, among others will help the seafood processing sector to reduce the carbon emissions eventually. Details of the emission reduction with respect to the base year (FY 2023) in BAU and other scenarios is presented in Table 40. The fuel mix is considered same as that in the current scenario i.e. in FY 2023.

Table 53: Fuel consumption and Emissions – Seafood Processing Sector (BAU and proposed scenarios)

Year		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Energy Consumption and Emissions – BAU												
Energy	ktoe	154.0	168.1	182.2	195.7	204.7	207.2	217.5	229.4	241.9	255.2	269.1
Emissions	Mn tCO ₂	0.606	0.661	0.717	0.770	0.805	0.815	0.856	0.903	0.952	1.004	1.059
Energy Consumption and Emissions – Actual scenario												
Energy	ktoe	154.0	164.6	174.7	183.7	187.9	186.0	190.8	196.5	202.3	208.1	214.0
Emissions	Mn tCO ₂	0.606	0.648	0.687	0.723	0.739	0.732	0.751	0.773	0.796	0.819	0.842
Energy Consumption and Emissions – Conservative scenario												
Energy	ktoe	154.0	165.5	176.6	186.7	192.1	191.3	197.4	204.7	212.2	219.9	227.8
Emissions	Mn tCO ₂	0.606	0.651	0.695	0.734	0.756	0.753	0.777	0.805	0.835	0.865	0.896
Energy Consumption and Emissions – Ambitious scenario												
Energy	ktoe	154.0	162.9	171.0	177.6	179.5	175.4	177.4	180.1	182.5	184.6	186.5
Emissions	Mn tCO ₂	0.606	0.641	0.673	0.699	0.706	0.690	0.698	0.708	0.718	0.726	0.734

Adoption of the energy efficient technologies and measures will help in the reduction of 55.1 ktoe during the FY 33 in Actual scenario. This reduction in the energy consumption will help the seafood processing sector to reduce its carbon emissions by 0.217 Mn tCO₂ by FY 2033 in the Actual scenario. These transformations and adoption of new technologies will also help the seafood processing sector to reduce the SEC level by over 20%.

Additionally, technical and financial barriers along with regulatory support required for the transition along with recommendations required to achieve the projections are presented in the next section.



6. Recommendations and Implementation Plan

6. Recommendations and Implementation Plan

6.1. Barriers and Challenges in Adoption of EE Technologies

MSME units in the cluster need to become more energy efficient to increase their competitiveness and maintain profits, however units face following challenges in adoption of EE technologies.

We have segregated those challenges and barriers mainly in 3 categories viz. a) technical (covers mainly lack of awareness and capacity building), b) financial (covers lack of financial capacities such as weaker balance sheets of MSMEs), and c) regulatory (covers mainly lack of support infrastructure and skills). In addition to this, we have highlighted barriers which are pertinent to MSMEs due to their small scale, unpredictability in demand, and wider spread across the clusters.

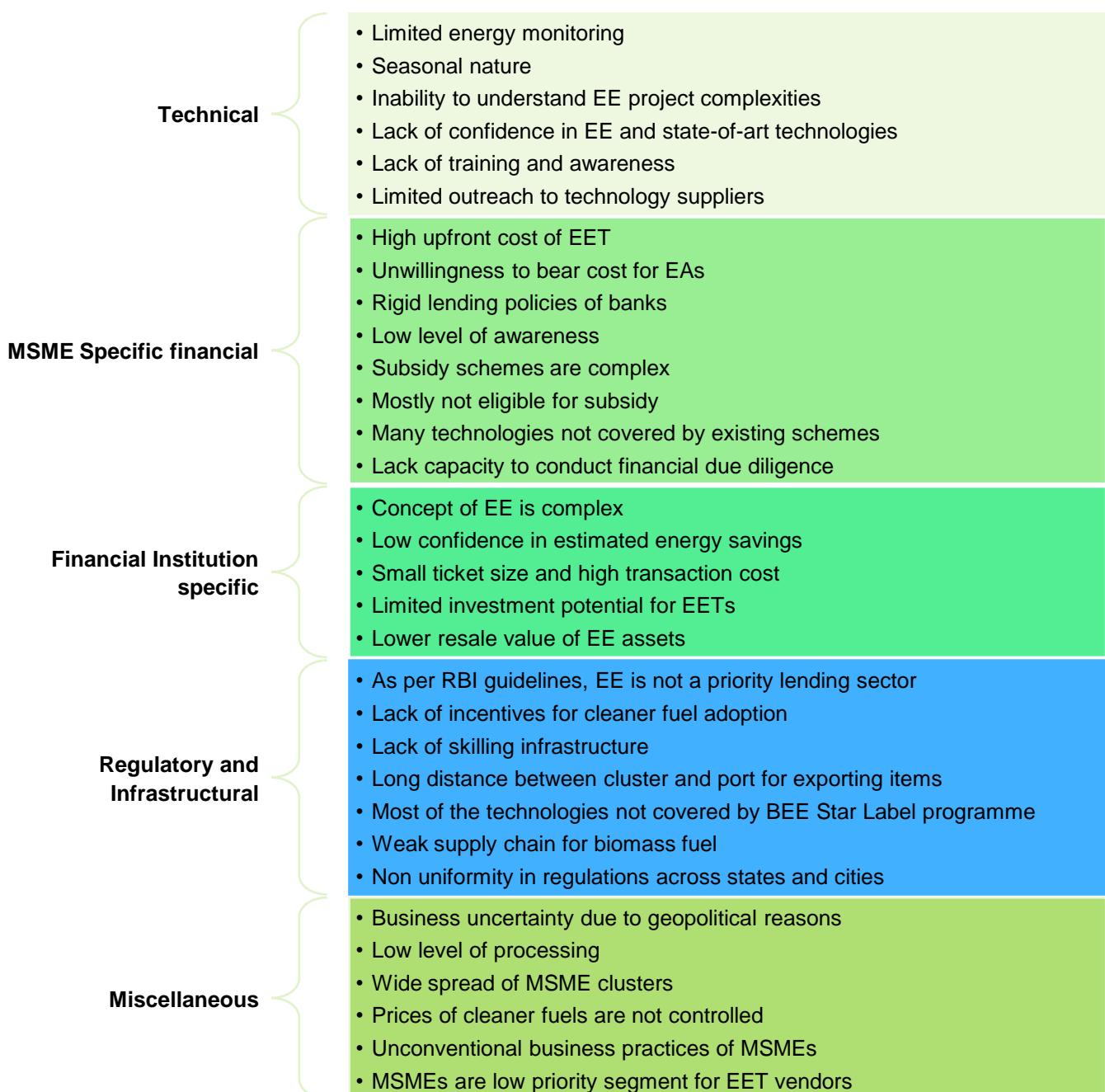


Figure 27: Barriers and challenges for EET implementation

6.1.1. Technical Barriers

The use of outdated and outmoded technologies is a major challenge in the MSME units in the cluster. Limited availability and weak linkages with suppliers, and low levels of knowledge on modern technologies are the main reasons for lack of technology up gradation in the cluster. MSME units in the cluster need to become more energy efficient to increase their competitiveness and maintain profits, however units face following technical barriers in adoption of EE technologies.

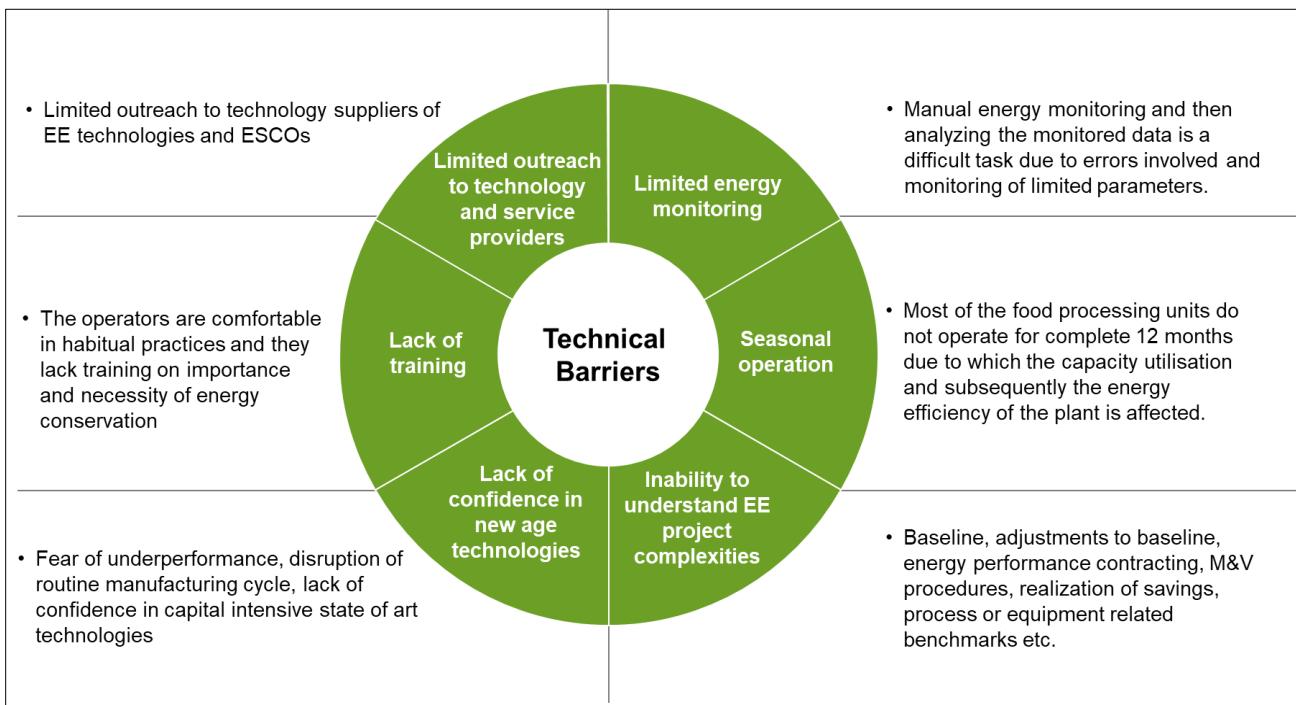


Figure 28: Technical Barriers

6.1.2. Financial Barriers

Implementation of potential energy conservation measures requires investments, either marginal or substantial in order to realize energy savings. Energy efficiency is generally perceived as a secondary aspect when compared to the core business activity or only considered when it directly links to increase in production/output. This perception is also there as a result of lack of awareness about EE.

6.1.2.1. MSME Specific Barriers in EE Financing:

The MSMEs face several barriers related to capital cost, low awareness on existing schemes, among others while implementing the energy efficient and renewable energy technologies. Some of the barriers faced by MSMEs are depicted in the figure below.

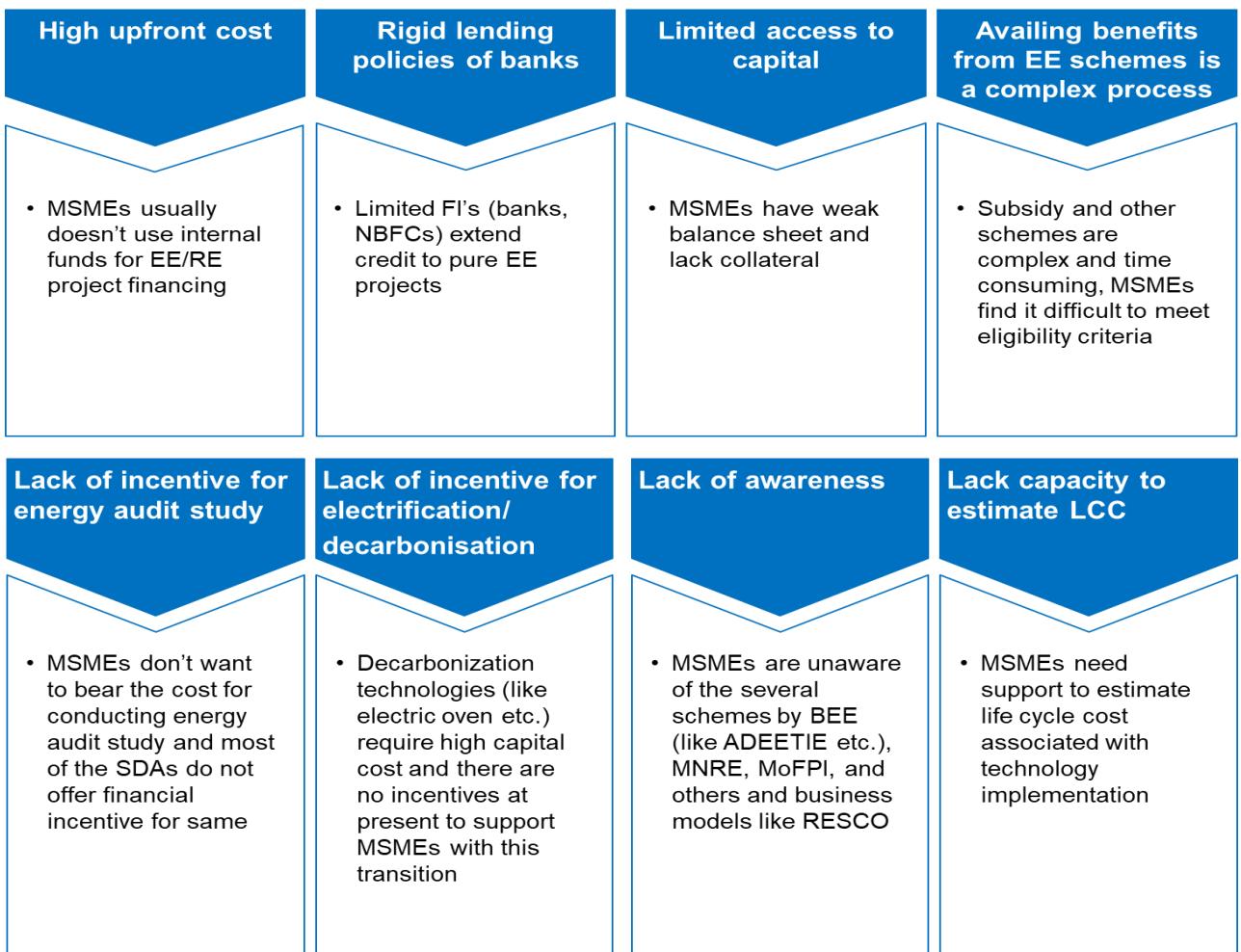


Figure 29: MSME specific financing barriers

Financial Institutes (Banks, NBFCs) Specific Barriers:

Energy efficiency investments usually do not generate additional tangible revenues, but rather contribute to the earnings through a reduction in energy expenditures. This can make it difficult for banks to identify and capture cash flows from such projects and treat energy savings as assets of sufficient market value to justify a loan, despite the overall benefits which will accrue if implemented.

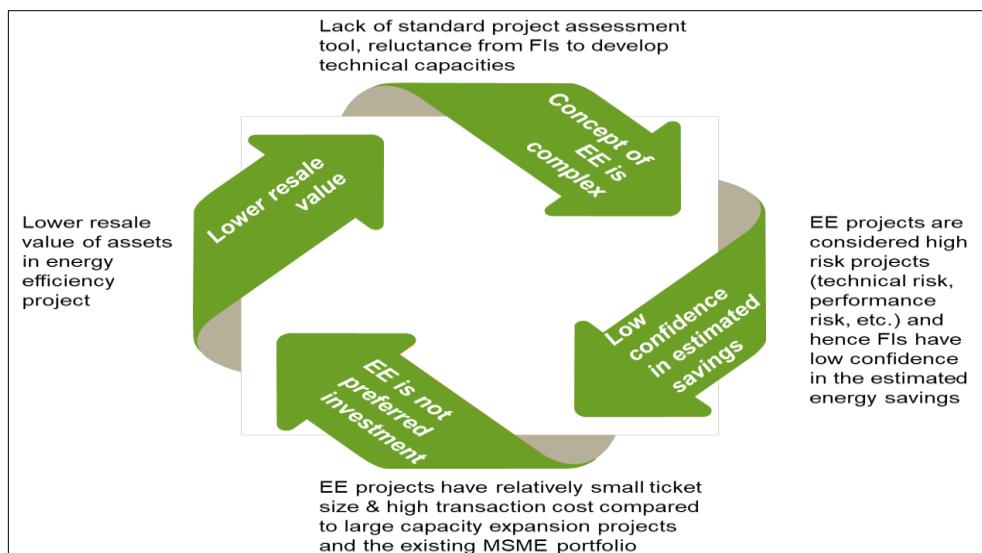


Figure 30: Financing institution specific barriers

6.1.3. Regulatory and Infrastructure Related Barriers:

In addition to technical and financial barriers lack of supporting infrastructure and regulatory interventions also limit the uptake of EE interventions in MSME clusters.

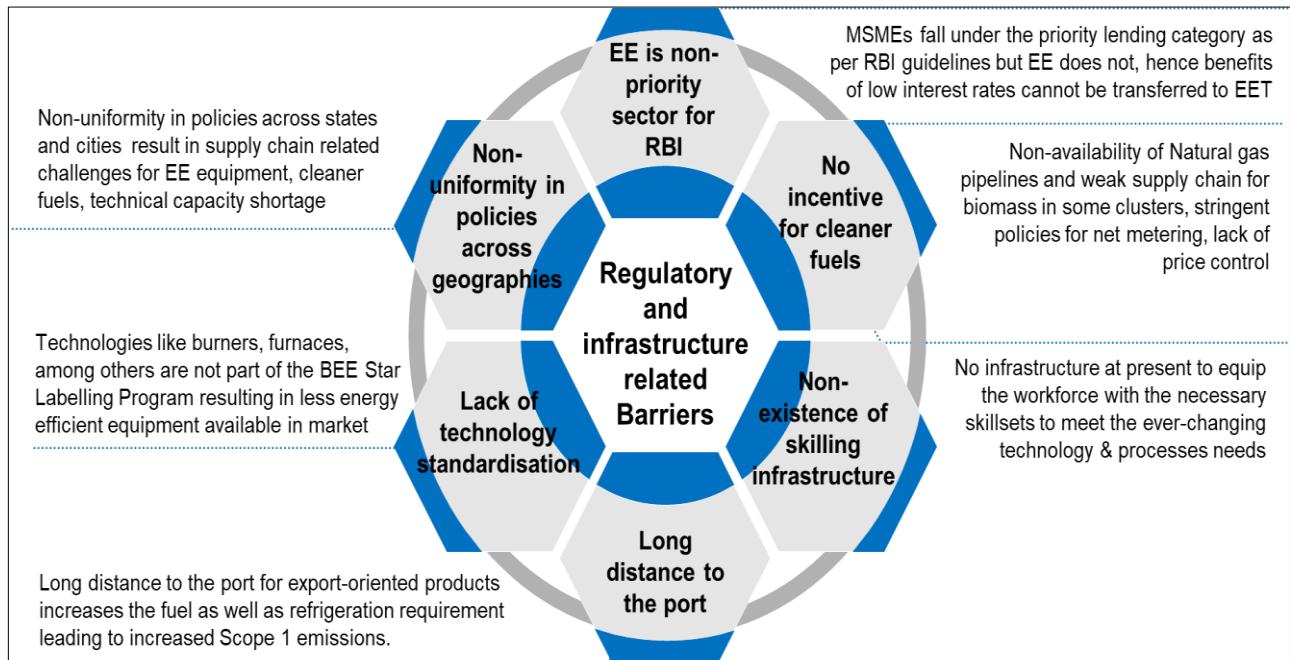


Figure 31: Regulatory and infrastructure related barriers

6.1.4. Miscellaneous

The above challenges have beleaguered the energy efficiency agenda in the cluster and limited its uptake. Now further when we look specifically at the MSME units in the cluster we see that it has its own challenges which has immensely restricted energy efficiency improvement in MSMEs even though there is a high potential.

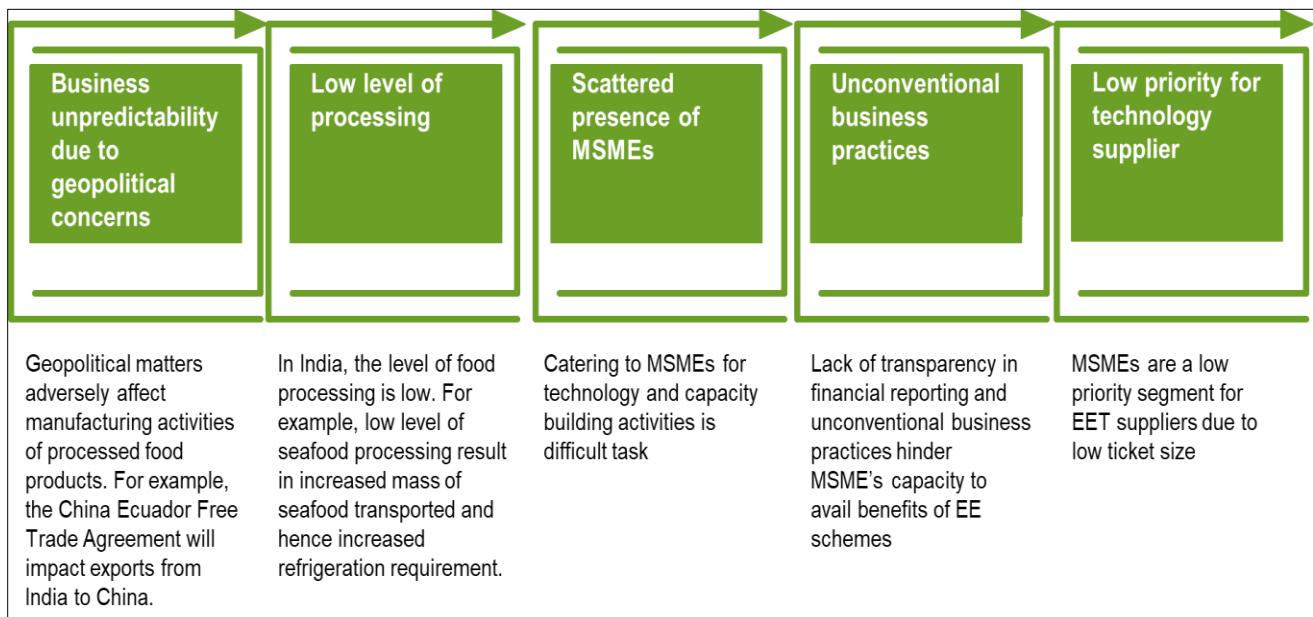


Figure 32: Other barriers for EE implementation

6.1.5. SWOT Analysis

A SWOT (Strength, Weakness, Opportunity, and Threat) analysis of the food processing industry is provided below. The units need to become more energy efficient to reduce their production costs, increase competitiveness and maintain profits. For this, the units have to adopt new and innovative technologies in their production processes. A detailed SWOT analysis for the food processing sector is depicted in the Figure 33.

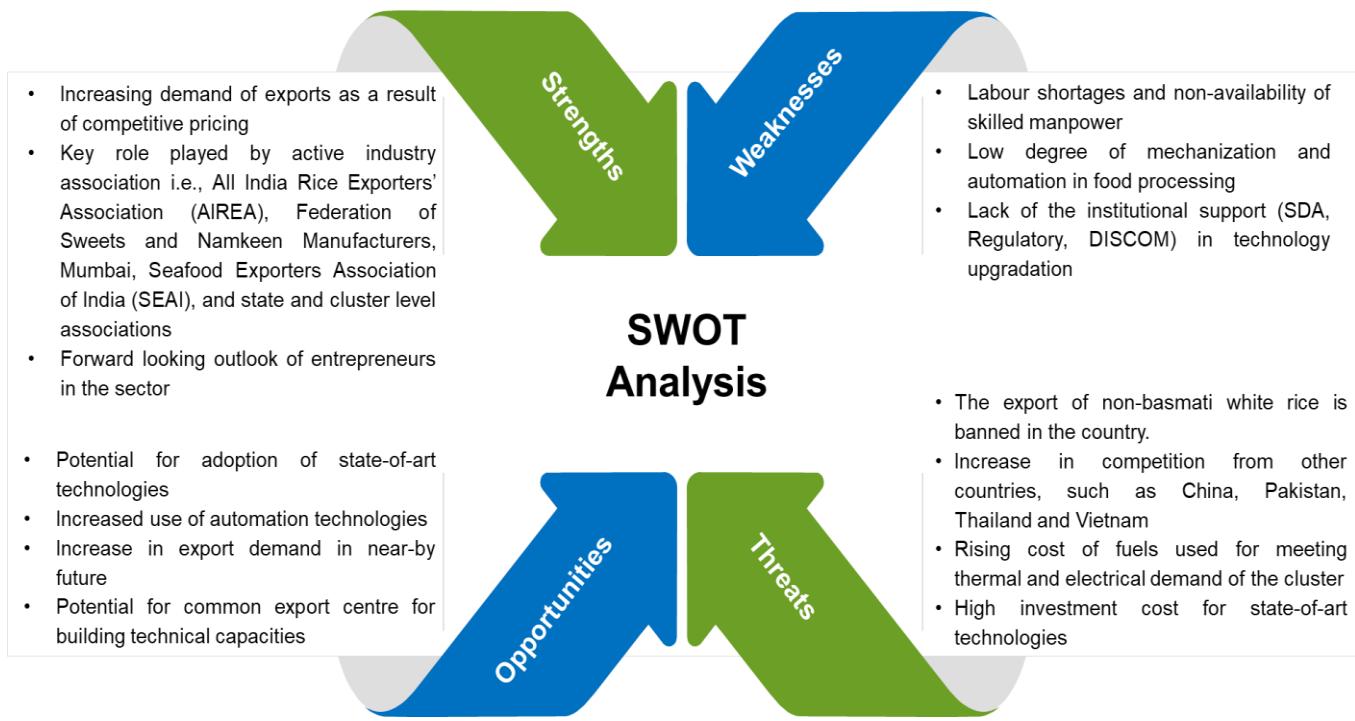


Figure 33: SWOT Analysis



7. Integrated Policy Roadmap

7. Integrated Policy Roadmap

Food processing sector in India offers immense potential for energy savings through technology upgradation, EE retrofits and adoption of operating practices. However, given the current levels of EE technology penetration and the overall health of the MSME sector, there is need of innovative measures and policy interventions to increase the adoption of EE solutions.

This BEE Energy mapping study" aims to generate a sector level energy efficiency policy roadmap for the Food Processing MSME sector, which is aligned with the country's energy & climate goals and also have high correlation with industry needs. Hence, based on analysis of the various identified barriers to energy efficiency, we have created and recommended an integrated policy roadmap to boost the adoption of EE technologies across the food processing industry.

Under the current assignment, multiple stakeholder consultations have been organized with a goal of establishing a shared agreement on the outcomes and gathering input from a wide range of stakeholders to draft recommendations. This study offers a valuable service by compiling insights from diverse stakeholders, discussing identified interventions, and evaluating their suitability and significance.

A long list of recommendations, prepared with in-depth consultations with multiple stakeholders such as, MSME food processing units, industry associations, industry specific institutes etc., in various food processing MSME clusters, is provided below. The actionable elements of the policy and implementation roadmap are integrated along five broad and parallel tracks as depicted in Figure 34 and Table 54 respectively.

- a) Technology capacity building
 - Awareness creation & B2B vendor interfacing platform
 - EE Assessment tool for food processing MSME sector
 - Technology demonstration platform
- b) Creating conducive environment for increasing EE adoption
 - Energy management Centre
 - Supporting ISO-50001 EnMS implementations and Promoting IoT Solutions
 - Skill enhancement support from NSIC, NSDC, OUAT - Bhubaneswar, CSIR – CFTRI, NIFTEM-T, CES - Pune University
 - Forming Industry Association at cluster level
- c) Financial Incentives
 - Capital subsidies on EE technology solutions
 - Lower interest rates on EE loans
 - Differential tax and other incentives for EETs
 - Financial incentives for energy audit studies
 - Innovative business models
- d) Collaborative efforts among different institutions and IDAs
 - Collaborative efforts among different institutions
 - Creating synergies with existing initiatives by IDAs
 - Creating supporting infrastructure
- e) Regulations
 - PAE Scheme
 - Eco Labelling Scheme
 - Uniform policies across states/cities

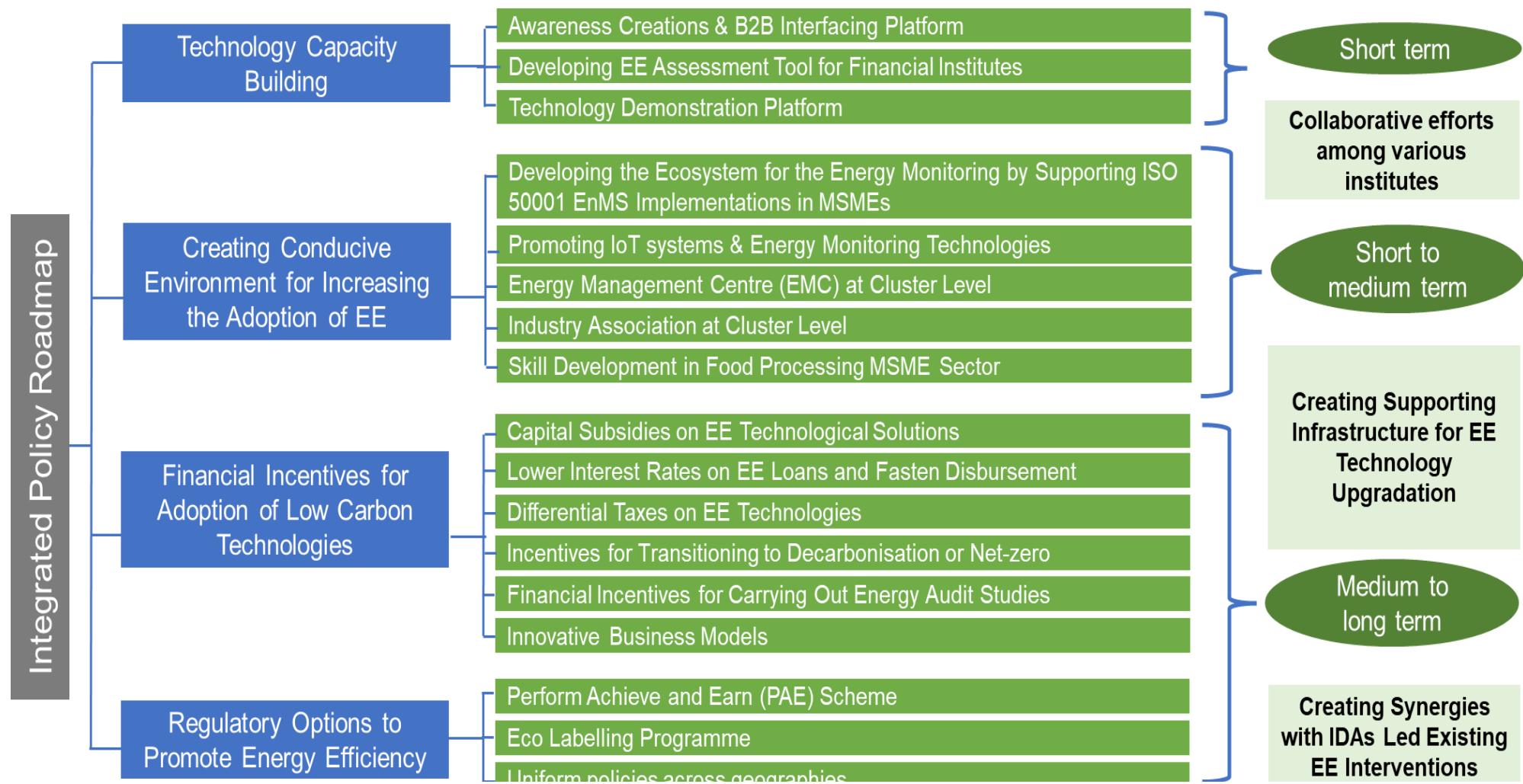


Figure 34: Integrated Policy Roadmap

Table 54: Implementation Roadmap

Proposed Interventions	Key Activities	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Technology Capacity Building											
Awareness Creations & B2B Interfacing Platform	<ul style="list-style-type: none"> Workshop on state-of-art technologies / schemes dissemination / other activities – 1 annual workshop in each of the 10 energy intensive clusters and at National level targeting participation from atleast 50% of the units and 3-4 technology vendors Establishment of Project Management Unit at SDAs corresponding to 10 key clusters Development of ready reckoners for estimating LCC of key technologies like boilers, ovens, thermic fluid heaters, freezers, air compressors, motors, pumps, among others Capacity development of atleast 2 vendors / LSPs / ESCOs / RESCOs per key identified cluster 	×	×	×	×	×	×	×	×	×	×
Developing EE Assessment Tool for Financial Institutes	<ul style="list-style-type: none"> Development of EE assessment tool for 3 sub-sectors (Rice mills, RTE/RTC, processed seafood) 4 regional capacity building workshops for FIs (banks/NBFCs) to promote wider and effective use of the tool 	×	×								
Technology Demonstration Platform	<ul style="list-style-type: none"> Feasibility analysis of 3-5 innovative / new age technologies per cluster among the 10 key clusters Technology mapping for shortlisting 3-5 prominent technologies for each of the 10 key clusters identified Technology demonstrations for 3-5 technologies in each of the 10 key identified clusters with involvement of atleast 2 Fis Identification of 2-3 vendors for each of the key technologies used in 10 key food processing clusters 			×	×	×	×				

Proposed Interventions	Key Activities	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Creating Conducive Environment for Increasing the Adoption of EE											
Supporting ISO 50001 EnMS and promoting IoT solutions	<ul style="list-style-type: none"> Launch workshop in each of the 10 key clusters Providing technical consulting services and support to 5 MSMEs in each of the 10 clusters for EnMS certification (including IoT system implementation) Building capacity of atleast 3 local service providers / consultants for conducting ISO 50001 internal audits, providing consulting for implementing ISO 50001 system (including IoT based solutions) Workshop in each of the 10 clusters for training on IoT based system and disseminating the findings of the EnMS implementation in MSMEs 1 National level dissemination workshop 				×	×	×				
Energy Management Centre and Industry Association at Cluster Level	<ul style="list-style-type: none"> Establishing EMC at each of the 10 key clusters Building capacity of atleast 3 local auditors for conducting energy audit study in food processing units Providing support in establishing local level association in 10 key clusters with no active association present Training of the existing and new local associations for enhancing their efforts towards EE transition in the cluster 			×	×	×	×				
Skill enhancement support	<ul style="list-style-type: none"> Identifying key institutes with close proximity to the MSME cluster for providing certification courses for energy conservation guidelines for food processing sub-sectors - 1 institute per key cluster among the 10 prominent clusters Developing certification course curriculum in collaboration with the identified institutes 				×	×	×				

Proposed Interventions	Key Activities	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Financial Incentives for Adoption of Low Carbon Technologies											
<ul style="list-style-type: none"> • Capital Subsidies on EE Technological Solutions, Lower Interest Rates on EE Loans, quick loan disbursement and differential taxes • Incentives for Transitioning to Decarbonisation or Net-zero 	<ul style="list-style-type: none"> • 1 consultation workshop in each of the 10 key clusters for the MSME related financing schemes, identifying 1-2 key technologies for each of the 10 key clusters basis minimum energy saving potential threshold and solutions for overall decarbonisation • Mapping of required investment for implementation of the key identified technologies and decarbonisation solutions for proposing revision to the minimum investment criteria under BEE – ADEETIE scheme and consideration of the technologies for reduced GST, reduced taxes, Accelerated Depreciation, among other schemes • 1 consultation workshop with MoMSME, GST Council, SIDBI and others for proposing recommendations to cover additional technologies supporting overall decarbonisation • Building capacity of FIs for cost-benefit analysis of EETs and other decarbonisation technologies (this activity can be combined with <i>Regional capacity building workshops for FIs under Developing EE Assessment Tool for FIs activity</i>) 	×	×	×							
Financial Incentives for Carrying Out Energy Audit Studies	<ul style="list-style-type: none"> • Designing subsidy scheme for SDAs corresponding to 10 key clusters and which do not have an existing subsidy scheme • Empanelling 5-10 local energy auditors/auditing firms for each of the 10 key clusters 					×	×	×			
Innovative Business Models	Aggregating demand for 1-2 prominent technologies for each of the 10 key clusters and leveraging RESCO / ESCO / and other business models for implementing the technologies					×	×	×	×		

Proposed Interventions	Key Activities	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Regulatory Options to Promote Energy Efficiency											
Perform Achieve and Earn (PAE) Scheme	<ul style="list-style-type: none"> Launch of voluntary energy savings programme in the key clusters processing rice, RTE/RTC and processed seafood products Launch of the mandatory energy savings programme in forward looking clusters across rice, RTE/RTC and seafood processing 					x	x	x	x	x	
Eco Labelling Programme	<ul style="list-style-type: none"> Designing energy consumption and GHG emission standards for 1-2 prominent technologies in each of the 10 key clusters in collaboration with the technology vendors Launch of the Eco Labelling programme for energy consumption and GHG emissions standardisation 					x	x	x	x	x	x
Uniform policies across geographies	<ul style="list-style-type: none"> Identification of geographical discrepancies in environmental regulations and associated problems Regional and National consultation workshops for addressing discrepancies 					x	x	x			

7.1.1. Technology Capacity Building

Need Assessment:

MSMEs usually have limited technical abilities to evaluate EE technologies and limited outreach to technology suppliers and service providers of EE technologies.

1. Limited technical capacities and weak linkages with suppliers are among the main reasons for lack of technology up gradation in the cluster.

This could be addressed by increasing the frequency of awareness workshops on EE technologies in presence of technology suppliers

2. EE investments are usually considered risky because of the uncertainties associated with the performance of technological interventions and the difficulty in demonstrating savings.

MSME's confidence can be enhanced by establishing replicable contracts for identified EE technologies and building the capacities of local FIs in evaluating EE proposals

3. Many food processing units in this cluster fall under the micro/ small category, hence they have lower confidence on high investment state-of-art technologies

Technology demonstrations with a focus on hands-on training to enhance confidence of MSMEs and provide touch-and-feel experience for state-of-art technologies is essential.

4. MSME units have low awareness regarding the various ongoing schemes for energy efficiency financing in the country by BEE and others. BEE's Facilitation Centre under the *ADEETIE – Assistance in Deploying Energy Efficient Technologies in Industries and Establishments* has extremely low awareness among the MSME units.

Awareness programmes need to be organised at state level in association with SDAs at regular intervals for disseminating the information on ongoing schemes for energy efficiency and financing in the country.

5. The implementation of any new technology has certain associated costs other than the initial cost of technology purchase like the operation and maintenance costs, energy costs, installation cost (if any), among others. The MSME unit owners need support in estimating the life cycle cost associated with a technology implementation so as to enable them to make informed decisions.

Reckoners for estimating the life cycle cost of a particular technology can be developed to assist the MSME unit owners with their technology purchase related decision.

7.1.1.1. Awareness Creations & B2B Interfacing Platform

We are proposing following interventions for creating awareness on techno-commercial feasibility of EE solutions:

Proposed Interventions:

- a. Increasing MSMEs' awareness through workshops on energy efficiency solutions, by including a generous dose of positive case studies from other successful implementations
- b. Providing the simplified case studies with calculations for the most relevant EE technologies based on typical estimation of energy cost savings, payback period & IRR
- c. Increasing MSME's awareness on the existing financing schemes by BEE, MoMSME, MNRE, MoFPI, SIDBI and others for boosting energy efficiency

- d. Match making between potential vendors and MSMEs from clusters will help in adoption of new and advanced EE technologies
- e. Providing handholding support to the MSME units in food processing for implementing the EETs and other decarbonization technologies
- f. Building the capacities of vendors and local service providers to strengthen the implementation of EE measures and post implementation services
- g. Development of reckoners for estimating life cycle cost of energy saving equipment

Implementation Roadmap:

- 1. B2B workshops and focused technical seminars with the State and Cluster level associations and technology providers shall be organised. Technical workshops are to be designed to meet the cluster process technology upgradation requirements.
 - a) Conducting workshop on state of art technologies
 - a. Rice mills - AI based paddy drying, New Age Rice Whiteners and Polishers, etc. in progressive MSME clusters of Vellore, Kaithal-Karnal, Ganjam-Nayagarh, among others.
 - b. RTE-RTC food processing – Turbo drop cookie depositors, Rotary rack baking oven, IQF freezer, etc. in MSME clusters like Ludhiana, Pune, Mumbai, Allahabad, Coimbatore, among others
 - c. Seafood processing – Brine freezers, among other new age freezing technologies
 - b) 1 workshop per energy intensive cluster shall be organized on decarbonization solutions in food processing sector with solutions such as Automation and Control in Food Processing, Energy Efficient Technologies and Measures, and New Age Technologies.
- 2. BEE shall also deploy consultant for these awareness and capacity building activities. The consultant will also assist in developing the case studies with support from the national and local industry associations for the new technology implementation.
- 3. BEE with the help of SDA should deploy a Project Management Unit (PMU) at the SDA office for providing handholding support on implementing EETs and other decarbonization technologies in key food processing clusters.
- 4. BEE with the help of a consultant should develop reckoners for estimating the life cycle costs for key energy consuming technologies for the food processing sector like boilers, ovens, chillers, compressor, among others. BEE in collaboration with regional associations should give a walk-through of the reckoners to the food processing unit owners, ESCOs, among others.
- 5. BEE shall designate a consultant with the responsibility to disseminate the information regarding any financing scheme by BEE, MNRE, MoMSME, MoFPI, SIDBI and others for encouraging energy efficiency in the MSME food processing units. The responsibility of this consultant will be to share such information with the key national, state and local associations so that it can be further communicated to the MSME unit owners in the food processing clusters. BEE can also appoint a nodal person at cluster level for key food processing clusters like Vellore, Kaithal-Karnal, Kochi, Bhubaneshwar, Ludhiana, Coimbatore, among others who can assist the MSME unit owners with the necessary information and support for availing the benefits under the schemes.

6. Technology workshops should be conducted on regular intervals (one annual workshop in each cluster and at National level) to address the changing needs of the cluster and development of new energy and resource efficient technologies.
7. These workshops shall include minimum 50% of the food processing MSMEs in the cluster and shall also invite local institutes/ MSME departments. These workshops shall also include the case studies presentations from technology vendors, with minimum 3-4 vendors for each workshop.
8. Consultant shall also provide support for the capacity development of ESCOs and LSPs in executing EE projects and implementing the ESCO/ RESCO based projects. Consultant shall assist in developing the capacities for minimum 2 vendors/ OEMs/ ESCOs in each food processing cluster.
9. Post workshop, Consultant shall also provide support for dissemination of case studies and these case studies shall be circulated to food processing clusters through national/ regional level associations.

References to similar activities

- BEE has set up an online Facilitation Centre for boosting energy efficiency financing in the country. To meet the overall goals and objectives of the Facilitation Centre, BEE organizes Investment Bazaar in association with SDAs at the state level events to showcase bankable energy efficiency projects in presence of stakeholders including industries, FIs, OEMs, ESCOs, and others. This creates awareness among the industries on EE technology and measures, financing schemes for EE, business models like ESCO for implementation, among others.⁹⁰
- ⁹¹Ministry of Micro, Small and Medium Enterprises for the implementation of scheme for *Technology and Quality Upgradation Support to MSMEs* under *National Manufacturing Competitiveness Program* has implemented activities like
 - Capacity Building of MSME Clusters for Energy Efficiency/Clean Development Mechanism (which included activities like **conducting awareness programmes in MSME clusters on EETs**, their availability, need and monetary benefits from them, extending **handholding support to the MSME clusters** in adopting energy efficient processes, among others)
 - Implementation of EETs and other technologies mandated as per the global standards in MSMEs
 - **Setting up of Carbon Credit Aggregation Centers (CCA)** for introducing and popularizing Clean Development Mechanism (CDM) and assisting MSMEs in registering GHG reduction projects for allocation of Certified Emission Reduction (CER) **in 16 MSME clusters**
 - Encouraging MSMEs to acquire Product Certification Licenses from National/International Bodies
 - Impact assessment of the scheme

7.1.1.2. *Developing EE Assessment Tool for Financial Institutes*

Energy efficiency financing is inherently risky because of the uncertainties associated with the technology risk, performance risk, and re-payment risk based on demonstrated savings. EE assessment tool along with capacity building of local financial institutions (FIs) can play a crucial role in building the confidence of both MSMEs and FIs in EE technologies.

⁹⁰ <https://www.adeetie.beenindia.gov.in/investment-bazaar>

⁹¹ https://www.dcmsme.gov.in/schemes/TEQUP_Guidelines_latest.pdf

The tool will provide reliable information about estimated potential energy savings compared to similar MSMEs, sector-wise Energy Efficiency measures implemented by similar MSMEs understand equipment's / utilities' performance, identify the potential energy savings measures, and associated Investment and payback period.

- a) Standard online tool which houses the technology compendium with typical use cases and payback, IRR, NPV analysis.
- b) Establishing standard contracts for Energy Efficiency project appraisal through sector specific EE assessment tool
- c) Developing the capacities of FIs (Banks and NBFCs) in evaluating EE proposals and sharing standard EE project appraisal documents for faster loan disbursement

Implementation Roadmap:

1. BEE may hire the consultant to develop this Energy Efficiency assessment tool for food processing sector.
2. This activity will start by carrying out an analysis of sector with respect to key sub-sectors, energy consuming processes. BEE will leverage the detailed analysis carried out during the mapping study.
3. It will also involve Integration of sector/ sub-sector SEC benchmarking data from this energy mapping study to this EE assessment tool.
4. It will also involve identification of unit level parameters affecting SEC as an input variable such as sub-sector, annual production, type of fuel and fuel consumption.
5. BEE will also leverage the list of EE technology solutions relevant to sector for suggesting EE measures through assessment tool. BEE jointly with prominent national level associations like AIREA, FSNM, FBMI, AIBMA, SEAI, etc. will shortlist the EE technologies based on their techno commercial feasibility and financial viability.
6. The tool will perform the cost payback analysis – NPV, IRR, payback period. Banks / FIs can know about potential EE Measures in MSMEs, attractiveness of the EE investments and the cost savings and payback period.
7. BEE can also leverage the existing tools / or improvise existing tool prepared by SIDBI-ISTCL and other tools prepared under SAMEEKSHA/ other ongoing IDA led interventions.
8. BEE shall develop the technical capacities of FIs (banks/ NBFCs) for using this interactive EE assessment tool which will help them in the cost benefit analysis of the EE and RE technologies.

⁹²An **Energy Savings Assessment Tool** has been developed using the database comprising of more than 2000 energy audit reports prepared under the World Bank – GEF Program 'Financing Energy Efficiency in selected MSME Sectors in India' and the 4E Scheme of ISTSL. This master database covers 30 MSME sectors, 800+ MSME units, 2000+ energy audit reports, and nearly 5000 EE measures. The **Unified Navigation Tool on Energy Efficiency for MSMEs** generates credible Energy Assessment reports and is available to MSME stakeholders, Financial Institutions and Energy Experts alike. For Banks, the Dashboard provide information on the investment and monetary savings due to implementation of the EE measures in a particular cluster. In addition,

⁹² <http://sidbieetool.in/>

there is a provision to estimate Energy Savings through basic and advanced analysis. The analysis results provide information on the gap in annual energy consumption in mtoe and kWh (mtoe converted into kWh, 1 mtoe = 107/860 kWh) and maximum monetary savings potential in Lakh INR per year. The “Estimate Energy Savings” feature is currently available for sectors like chemicals, die casting, engineering and machining, forging and heat treatment, foundry, plastic and rubber, sheet metal, and textile.

Role of Industry Associations and Local MSME DC/ DIC Centers:

Industry associations can be positioned as opinion influencers among the local industrial community, and ownership of association in all cluster events, workshops, B2B exhibitions etc. can be ensured and knowledge material like Case Studies can be shared.

National Institute of MSMEs: NIMSME, which works in the areas of capacity building, research, and job enrichment training, shall be leveraged for conducting workshops on creating awareness on energy efficient and state-of-art technologies.

Technology Suppliers: Support for B2B interactions and sharing of knowledge material like technology brochures, and Case Studies.

Project consultants and Financial Institutes: Developing the standard contracts for project appraisal of EE technologies, developing EE assessment tool with NPV, IRR calculations for faster loan appraisal process.

7.1.1.3. *Technology Demonstration Platform*

Need Assessment:

- One of the key findings of cluster level discussions was MSMEs were more likely to invest in EE Technologies specifically in state-of-art technologies on the basis of recommendations from peers. Also, the MSMEs lack confidence in few energy efficient technologies like the *Oil Free Refrigeration System* and *Screw Compressor* (*in case of units where the existing compressors are of Reciprocating type*).
- While interacting with the MSMEs and associations during the workshops and consultations as part of the BEE Energy and Resource Mapping Assignment, it was observed that sometimes the MSME units are not aware of the technology vendors providing an energy efficient technology at lower cost compared to the market players.

Proposed interventions:

Hence, it has been proposed that more demonstrations should be conducted in the MSME clusters to enhance confidence of MSMEs and provide touch-and-feel experience to them

- a. Technology demonstrations workshops for state-of-art and advanced energy efficient solutions shall be conducted. Also, the techno-economic feasibility of the new technologies in the food processing sector should be evaluated and the technologies for which the confidence lacks at MSME level must be considered for demonstration.
- b. Cross-cluster visit to near-by clusters for building confidence of MSMEs in advanced EETs shall be organized.
- c. We propose that as part of the “BEE Facilitation Centre” wherein the details with respect to energy and monetary savings, investment and payback are provided for the EETs, details on vendors providing the technology at a reasonable price should also be provided.

Implementation Roadmap:

1. BEE will carry out such pilot demonstrations in coordination with cluster stakeholders such as industry associations, technology suppliers
2. Industry associations to ensure participation from food processing MSMEs, this will help in addressing the perceived risks of investing in such EETs
3. BEE shall carry out 3-5 demonstrations in each of the 10 key MSME clusters identified and invite participants from near-by clusters for creating outreach and availing the benefits of cross learning.
For example- food processing participants from Red Hills can be invited to Vellore cluster; also, Khanna and Kaithal cluster units to Karnal food processing cluster, and Mumbai cluster units to Pune cluster, etc.
4. BEE will identify the demo projects based on cluster's needs and product mix, progressiveness of the cluster, available suppliers in the cluster etc. *The consultant should identify the new energy efficiency interventions like the Oil Free Refrigeration System, Thyristor based power quality filter (wherein depending on the percentage of harmonics the power quality filter is required), VFD based Screw Compressor (wherein the existing compressors used are of Reciprocating type and the feasibility of using a screw compressor with the existing reciprocating compressors need to be evaluated), among others. The identified new technologies should be evaluated to check their feasibility in the food processing MSME units.*

As part of the UNIDO-GEF-BEE project “Promoting Energy Efficiency and Renewable Energy in Selected MSME Clusters in India”, sector and cluster specific Technology Compendium for Energy Efficiency and Renewable Energy Technologies have been prepared. This technology compendium provided details like conventional practice followed, EET detail, benefits and limitation of EET, energy and GHG emission saving potential, investment required and cost benefit analysis, and more importantly success stories among other details for the EETs and RETs.

Below is the list of some state-of-art EE technologies relevant to respective MSME clusters. The consultant should conduct technology demonstration sessions for those technologies with low level of confidence at the MSME unit level in association with the industry association, MSME DI, DIC, among other stakeholders.

EE Technology / solutions for demonstration	Relevance to food processing clusters
Artificial Intelligence based processing	All clusters
IPM Compressor	All clusters
Compressed Biogas	All clusters
Biomass pellet-based burners	All clusters
Electric Thermic Fluid Heater / Electric Boiler	All clusters
Chillers	Seafood processing clusters
Oil free refrigeration system	Frozen food clusters
IQF Freezers	Frozen food clusters
Screw compressor in combination with reciprocating compressor system	Frozen food (RTC) clusters
Thyristor control-based power quality filter	All clusters

5. BEE shall identify the other industry decarbonization solutions such as rooftop Solar PV, biomass, hydrogen as a fuel and various possibilities of electrification in food processing sector for demo projects.
6. BEE should hire a consultant to map the vendors for the energy efficient technologies included in the Facilitation Centre. While identifying the vendors, efforts should be extended by the consultant to cover the vendors providing the technology at a reasonable price without compromising with the quality and expected results. These vendors list should be uploaded on the BEE Facilitation Centre website for wider dissemination among the MSME food processing units.
7. BEE shall invite local bankers for these technology demonstrations to apprise them about state-of-art technologies. These demonstrations will help reassure FIs of performance of EETs, which in turn lead to technical capacity building within FIs, enabling them to better appraise such interventions.

⁹³The BEE-SME programme aimed to enhance energy efficiency in India by accelerating adoption of EE measures and EETs in MSME sectors and extend handholding services to MSMEs through knowledge sharing, capacity building, demonstrations of efficient technologies and measures and, suitable financial mechanisms. As part of this programme, demonstration of EETs was done in 21 units of 4 selected clusters to further promote technology implementation across the sector.

Relevant Stakeholders:



Role of Various Actors/ Stakeholders

BEE to fund activities like vendor mapping study, techno-economic feasibility study for new technologies, technology demonstration, etc.

Industry Association to ensure active participation of the MSMEs in all the activities mentioned above

MSME DI and DIC to provide support for implementing the technology demonstration activities in their premises

Technology Suppliers: Support for B2B interactions, sharing of knowledge material like technology brochures and Case Studies (including investment related information), etc.

7.1.2. Creating Conducive Environment for Increasing the Adoption of EE

MSME food processing units need to become more energy efficient to increase their competitiveness and maintain profits, however due to lack of supporting infrastructure in MSME clusters, food processing owners face various challenges in adoption of EE technologies.

1. Poor practices on energy management, lack of consistent data on energy consumption limits the scope for realizing the benefits of energy efficiency

⁹³ <https://beeindia.gov.in/en/programmes/small-medium-enterprise>

This could be addressed by promoting ISO 50001 EnMS and IoT technologies which will help MSME units to adopt the energy monitoring practices.

2. Lack of supporting infrastructure such as limited access to energy auditors, non-availability of testing facilities, non-presence of active local association limits the uptake of EE technologies

A permanent Energy Management Centre at cluster level with energy auditing facilities, testing instruments and common utility solutions shall be established.

3. Non-existence of skilling infrastructure to meet the ever-changing technology needs and lack of standard curriculum on energy conservation

A range of skills including hands-on training are required to operate new technologies, to adopt best operating practices and comply with minimum energy efficiency standards.

4. Presence of non-energy efficient technologies in the market

As not all the energy consuming equipment are covered by the BEE Star Labelling Programme, many non-energy efficient models are available in the market. Hence unit owners tend to buy these non-energy efficient technologies due to their lower cost compared to the energy efficient alternatives.

5. Lack of awareness on technology vendors

It was observed during the workshops and stakeholder consultations that MSMEs are sometimes not aware of the technology vendors who are providing energy efficient technologies at a lower cost compared to the other vendors in market.

7.1.2.1. Developing the Ecosystem for the Energy Monitoring by Supporting ISO 50001 EnMS Implementations in MSMEs

Need Assessment:

Energy Efficiency efforts are often plagued by lack of consistent data on energy and operations, therefore, push is required to promote energy monitoring practices and technologies. Energy monitoring will also ease out the M&V process where EE implementations are taking place.

In typical food processing unit, it is very essential to operate the equipment scientifically with proper measurements by giving due focus to the energy monitoring and by conducting regular energy audits which can highlight the potential areas for energy conservation.

Proposed Interventions:

ISO 50001 EnMS will help the MSME units to develop the EE culture, adopt the energy monitoring practices and sustain the benefits of energy conservation measures. It will also ease out the Monitoring & Verification process where EE implementations are taking place.

- a) Technical consulting services for ISO-50001 certification in selected MSME clusters (10 MSME units in each food processing cluster)
- b) Workshops on creating awareness on ISO-50001 and training on ISO-50001 protocols – The frequency of workshops on energy management system must be increased, with a focus on including a generous dose of positive case studies from other successful implementations.

Implementation Roadmap:

- a) Market assessment: Identifying early adopters in each of the 10 key clusters for implementation of EnMS
- c) Launch Workshop - Cluster level launch workshop in association with AIREA, SEAI, and other National and local level associations for food processing in each of the 10 key identified clusters
- d) Technical consulting services in 5 MSMEs in each of 10 identified MSME clusters
 - a. Energy Review of Facilities, Equipment, Systems, Processes and Personnel
 - b. Energy Baseline Setting, Derivation of EnPIs and Energy Performance Improvement Measures
 - c. Development of energy policy, implementation roadmap, and building capacity of MSME personnel for conducting Internal Audits
- e) Support for EnMS certification through accredited bodies and organizations
- f) Building capacities of local service providers and local consultants for sustenance of EnMS culture at local level and building markets for ISO-50001
- g) Dissemination workshop at cluster and national level for sharing the learnings and felicitations of EnMS adopters

⁹⁴The BEE-GEF-WB's *Financing Energy Efficiency at MSMEs project (FEEMP)*, focused on supporting capacity building and awareness activities in MSMEs, activities promoting EE investment in MSMEs, and developing programme knowledge management. Some of the key achievements under this project are

- Design and implementation of EnMS (ISO 50001) in 50 MSME units
- Certified more than 40 units
- About 350 professionals were trained of which 100 were trained as ISO 50001 internal auditors

Major Stakeholders and their Responsibilities



- **Industry Associations:** Industry associations can be positioned as opinion influencers among the local industrial community and ownership of inviting member MSMEs to cluster events, workshops etc. can be ensured through them. IAs shall facilitate the sharing of knowledge material like Case Studies with the MSMEs.
- **Project consultants:**
 - Identification of interested MSME units for ISO 50001 certification
 - Providing consulting services for EnMS implementations and certifications
 - Carrying out awareness workshops on importance of ISO 50001- EnMS

⁹⁴ <https://beeindia.gov.in/en/programmes/demand-side-management/small-medium-enterprise/bee-gef-wb-project>

- **National Institute of MSMEs:** NIMSME, which works in the areas of capacity building, research, and job enrichment training, shall be leveraged for conducting workshops on creating awareness on ISO-50001 and training on ISO-50001 protocol
- **Bureau of Energy Efficiency:** BEE can provide services for technical consulting for ISO-50001 certification in selected MSME clusters. BEE can engage project consultants to provide these consulting services.

Benefits to Sector Stakeholders

- Energy management system will build a culture of sub-process level energy benchmarking
- Easing out of the M&V process where EE implementations are taking place
- Helping in strengthening the ESCO based projects, establishing the baselines and also helping in better evaluation of the savings

7.1.2.2. *Promoting Internet of thing (IoT) systems & Energy Monitoring Technologies*

These IoT systems provide access to real-time equipment performance, energy consumption, and building data to support a smarter, data-driven maintenance strategy. Hence, push is required to promote IoT systems and energy monitoring technologies.

- a) Linking IoT technologies with ISO-50001 for realizing the energy savings of installed EETs
- b) 2-3 demo projects in few progressive MSME clusters on IoT technologies and providing training for implementing the IoT based solutions in units
- c) Providing incentives and subsidies on IoT and energy monitoring solutions
- d) B2B matchmaking between MSMEs & vendors and building capacities of LSPs

Implementation Roadmap (2 Year timeline):

1. BEE should link this activity with ISO-50001 EnMS implementation and leverage the MSME premises where ISO-50001 is implemented for carrying out demo projects on IoT systems
2. BEE should make these IoT systems and energy monitoring equipment mandatory (as a pre-requisite) for ISO-50001 implementation, however, BEE should also provide upfront subsidies for installation of these energy monitoring technologies
3. BEE should carry out these demo projects in 5 units which are shortlisted for ISO 50001 implementation from each of the 10 prominent MSME clusters.
4. The timeline for this activity would be 2 years, where first 3 months would be installation and certification of EnMS. The next 9 months would be for monitoring and assessing the benefits of EnMS implementations and IoT installations. Second year onwards, MSME units will be invited for demonstrations. BEE in association with industry associations will invite MSME units for hands-on-training.
5. BEE will support in inviting technology vendors of energy monitoring solutions on common platform and creating awareness by sharing case studies on successful implementations
6. BEE will assist in building capacities of local service providers in food processing clusters to implement energy monitoring solutions in MSME food processing units

Relevant Stakeholders:



Role of Various Actors/ Stakeholders

Technology vendors: Supporting the B2B interactions and sharing the knowledge material like technology brochures, and Case Studies

Industry Associations: Ensuring ownership of food processing units in all cluster events, workshops, B2B exhibitions etc.

India Smart grid forum: It can help in creating awareness on state-of-art IoT systems and assist in organizing B2B vendor exhibitions for promoting these technologies. Smart grid forum can also help in identifying IoT technologies eligible for subsidies and incentives.

Benefits to Sector Stakeholders

- Increased awareness on energy monitoring solution including the direct and in-direct benefits of IoT system
- Assistance in strengthening the ESCO based projects and establishing the baselines faster
- Energy monitoring systems will also help in better evaluation of the savings

7.1.2.3. *Energy Management Centre (EMC) at Cluster Level*

Need Assessment:

During energy studies it was identified that limited access to energy auditors and lack of handholding support to MSMEs limits the EE implementations in MSME clusters. Many food processing units in the sector fall under micro category with limited financial capacities, hence they have limited funds to invest into energy auditing activities and high-cost investments solutions.

Proposed Interventions:

We propose to have permanent Energy Management Centre at each major food processing cluster. We propose to establish a common facility, may at Industry Association's premise, to provide services for energy auditing, testing facilities and common utility solutions. We are proposing following interventions for creating the ecosystem for EE interventions in MSME clusters through this EMC:

- Demonstrating the direct, in-direct benefits of EE technologies through energy auditing services
- Providing access to energy auditors and building the capacities of local consultants on carrying out energy auditing activities
- Providing common testing and utility solutions for food processing MSMEs in the cluster

Implementation Roadmap:

1. BEE will provide its support to local associations for developing Energy management Centre at cluster level.

2. Establishment of EMC will be done in 1 year and for the next year BEE will provide handholding support for the various activities of EMC
3. BEE will support in identifying local auditors, provide them with hands-on training followed by sample energy audits through experts with food processing specific energy audit experience
4. BEE will also support in encouraging plant heads and production managers of food processing units to enroll for energy auditor and energy manager examinations
5. BEE will support in reskilling of certified energy auditors for food processing focused audit in each food processing cluster
6. BEE will provide support for establishing standard energy audit template for Energy Efficiency project evaluation
7. BEE will also carry out awareness workshops through energy auditors to be led by EMC in cluster and invite testimonials from plant managers of food processing units

Functions of Energy Management Centre:

- Conducting energy audits at subsidized rates for food processing MSMEs. BEE may consider linking these energy auditing activities with PAE scheme for additional benefits.
- Providing end-to-end hand holding support to MSMEs for installation of the EE projects
- Developing capacity of local consultants in conducting energy audits, walk-through audits

⁹⁵The GEF-UNIDO-BEE's "Promoting Energy Efficiency and Renewable Energy in Selected MSME Clusters in India" programme aimed to develop and promote market environment for introducing EETs and enhancing the use of RETs in process applications. One of the key achievements under this programme during FY 2018-2019 was the establishment of Energy Management Centres in various MSME Clusters.

Relevant stakeholders:



Role of Industry Associations and Local MSME DC/ DIC centers:

Industry associations can be positioned as opinion influencers among the local industrial community, and ownership of association in all cluster events, workshops, B2B exhibitions etc. can be ensured. IAs can also host the energy management center at their premises.

DI-MSME/ MSME-DIC: Establishment of an energy management center at MSME DIC premises to carry out demonstration/ pilots in coordination with cluster level stakeholders.

Technology Suppliers: Supporting the B2B interactions and sharing the knowledge material like technology brochures, and Case Studies

⁹⁵ <https://beeindia.gov.in/en/programmes/demand-side-management/small-medium-enterprise/gef-unido-bee-project>

7.1.2.4. *Industry Association at Cluster Level*

Need Assessment:

During interaction with MSME units as part of the inception and post audit workshop and stakeholder consultation meetings, it was observed that there are clusters like Pune RTC-RTE cluster, among others which do not have a presence of active cluster level association. An active cluster level association

- acts like a voice of the MSME units while raising the issues faced by them with respect to policy matters, trade and others
- disseminates the best practices of the sector with respect to energy efficient technologies and measures, and state of the art technologies among the MSMEs
- supports in reaching out to the MSME units for awareness creation and other project activities to increase energy efficiency
- acts as an information source while cluster profiling for seeking information like number of MSMEs, size of the units, barriers faced while implementing the energy efficiency measures

Absence of a local level association results in slow dissemination of the industry best practices among MSMEs, acts like a barrier during consideration of the cluster for any energy efficiency related intervention, prevents MSMEs from raising their concerns in an effective manner, among others.

Proposed Interventions:

We propose to encourage the formation of a local level association in each of the energy intensive MSME clusters who are at present not having it. Formation of local level association will bring increased visibility to the MSMEs operating within the cluster and hence will result in increased consideration of the cluster for future energy efficiency related interventions. The association formed can focus on the following objectives

- acting like a link between the MSMEs and the central and state government for raising the MSME's concerns
- keeping the MSMEs well updated on the industry best practices with respect to energy conservation, decarbonisation, etc.
- establishing connections with stakeholders like the
 - IDAs – for consideration in programmatic interventions
 - ESCOs operating in the region, energy efficiency consultants, technology vendors, local service providers – for matchmaking among the MSMEs and technology and service providers, for regular knowledge dissemination activities to keep the MSMEs well aware of the best practices

Implementation Roadmap:

- BEE to appoint a consultant for mapping the energy intensive MSME clusters across the country without active local level association. The consultant will also map the activities undertaken by the existing associations to understand the aggressiveness and proactiveness level of the association for pursuing energy efficiency within the MSME cluster.

- The consultant to identify the best operating associations among the food processing sector to consider them as the role model to be implemented in other clusters.
- The existing associations with low level of efforts for energy efficiency measures will be trained by the consultant for enhancing their efforts.
- In case of clusters with no active local association, the consultant will engage with the unit owners of the top performing MSMEs within the cluster and encourage them to form a local level industry association. The consultant will share the benefits of having a local association with case studies from the most active associations with the MSME unit owners.
- The consultant will assist the unit owners with the activities for setting up an association and for drafting their strategy consisting of the vision and mission, objectives, detailed activities, among others.

Relevant Stakeholders:



Role of Industry Associations and Local MSME DC/ DIC Centers:

- **MSMEs** to come forward and establish a local level association which will act like a catalyst to their business and energy efficiency performance
- **Technology Vendors and Local Service Providers:** Supporting the B2B interactions and sharing of knowledge material like technology brochures, and Case Studies, and providing the services for energy efficiency measures implementation
- **DI-MSME/ MSME-DIC:** Assisting in establishing the local association and collaborating with the association for activities like demonstration/ pilots in coordination with cluster level stakeholders.

7.1.2.5. *Skill Development in Food Processing MSME Sector*

Need Assessment:

Non-existence of skilling infrastructure is the major hurdle in adopting the ever-changing technology & processes. A range of skills are required to operate new technologies, to adopt best operating practices and comply with minimum energy efficiency standards.

Proposed interventions:

We are proposing to leverage and expand existing center of excellence institutes such as Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, CSIR – Central Food Technological Research Institute (CFTRI), National Institute of Food Technology, Entrepreneurship and Management, Thanjavur (NIFTEM-T), Centre for Energy Studies (CES), Savitribai Phule Pune University and NSIC Technical Services Centre in New Delhi, Chennai, Rajpura, Faridabad etc.

- Leveraging Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, CSIR-CFTRI, NIFTEM-T and Savitribai Phule Pune University's Centre for Energy Studies department for conducting hands-on-training and holding diploma courses on food processing technologies

- Leveraging NSIC Technical Services Centre and National Skill Development Centre for developing curriculum on skill development on food processing specific technologies

Implementation roadmap:

A. Leveraging Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, CSIR - Central Food Technological Research Institute (CFTRI), National Institute of Food Technology, Entrepreneurship and Management, Thanjavur (NIFTEM-T) and Centre for Energy Studies (CES), Savitribai Phule Pune University

Odisha University of Agriculture and Technology (OUAT), Bhubaneswar is a agriculture engineering and technology institute in Bhubaneshwar, CSIR-CFTRI is a research and development and academic institute focusing in the areas of food science and technology, National Institute of Food Technology, Entrepreneurship and Management, Thanjavur (NIFTEM-T) is a Research and Educational Institution under the Ministry of Food Processing Industries, and Centre for Energy Studies (CES), Savitribai Phule Pune University is focused on energy technologies and undertakes teaching, research and development in the field of energy in close collaboration with industries. *During consultations, there was a need felt to prepare the work force in the food processing sector for new skill sets. These institutions can play the leading role in developing the new age of the skillset required by the industry to meet next generation of technological advancement.*

1. OUAT, CSIR-CFTRI, NIFTEM-T and CES – Pune University to set up a series of training and diploma courses for the operating level staff on best operating practices in food processing units. These courses can be developed jointly with industry stakeholders, NSDC and BEE which is the nodal agency for EE in India.
2. OUAT, CSIR-CFTRI, NIFTEM-T and CES – Pune University with support from BEE and/or MoMSME can support in conducting hand-on trainings for skill enhancement of shop-floor workforce around energy efficiency technologies.

Example for this include AI/ ML based enhancements for process technologies and IoT integration, best operating practices in Ovens, Thermic Fluid Heaters, Wood Fired Boilers, Refrigeration System, among others.

3. OUAT, CSIR-CFTRI, NIFTEM-T and CES – Pune University to consider developing various local chapters at key Food processing clusters across India in consultation / collaboration with prominent industry associations.

B. Leveraging NSIC Technical Services Centre and National Skill Development Centre

NSIC through 'NSIC Technical Services Centers' (NTSCs) provides technical support to MSMEs including skill development in Hi-Tech as well as conventional trades, product testing at testing laboratories accredited by NABL, energy audit, environment management etc.

We envisage that NSIC, through its extensive experience to perform the duties shall support BEE with the following activities:

1. NSIC in support with NSDC to develop professional training courses and curriculum for the operating level staff on EETs and best operating practices in MSME food processing units.

These courses can be developed jointly with BEE, being the nodal agency of the Govt. of India on energy efficiency matters in the country.

The National Skills Qualification Framework (NSQF) theoretically makes it possible to drive competency-based training for every job role in industry. Framework from

NSDC on National Occupational Standards (NOS) will be followed for creating course curriculum.

NOS specify the standard of performance an individual must achieve when carrying out a function in the workplace, together with the knowledge and understanding they need to meet a standard consistently.

- Each NOS defines one key function in a job role
- Each NOS must be a concise and readable document
- Each NOS usually consists of no more than five or six pages (some are only 1 or 2)
- NOS describe functions, standards of performance and knowledge / understanding

It is possible for all current vocational courses, like, ITI Courses, or similar vocational courses in polytechnics, to be aligned to job roles (including food processing sector) at specific NSQF Levels. For Example- An ITI Course in Plumbing would say they are training for plumbers at NSQF Level 3. Similarly, a polytechnic training in fashion design, may say it is training for NSQF Level 5 for Garment Cutters.

2. NSIC with support from BEE can support in creating the ecosystem for scaling up the implementation of some of the state-of-the-art technologies through live demonstrations
 - Some such technologies include AI based paddy drying, New Age Rice Whiteners and Polishers, Water Recycle System, Rotary rack baking oven, Turbo drop cookie depositors, Brine freezers, etc.

C. Leveraging local universities, ITIs and other institutes for developing EE curriculum

Leveraging local institutes, universities, and centres for developing courses on Energy management- Odisha University of Agriculture and Technology (OUAT) in Bhubaneshwar, CSIR - Central Food Technological Research Institute (CFTRI), National Institute of Food Technology, Entrepreneurship and Management, Thanjavur (NIFTEM-T), NSIC – NTSC in Rajpura, Chennai, Faridabad, Savitribai Phule Pune University, University of Mumbai, etc.

Collaboration with private institutes like Application and Training Center (ATC), Bühler Bengaluru which conducts training for Mill Proprietors, Managers and Operators can be sought for upskilling the rice mill owners and staff on the advanced technologies for energy efficient and cost-effective processing of rice.

1. Inclusion of the technical courses on energy management and conservation and inclusion of Advanced Diploma courses in local ITIs
2. Develop curriculum for professional courses in food processing processes and technologies through consultation with stakeholders

Benefits to sector stakeholders

- a. This will prepare the workforce for ready to implement best practices and energy efficient technologies in the sectors
- b. Different food processing clusters will have easier access to the Centres of Excellence
- c. Skilled labour will empower the units to adopt the new technologies.

Relevant stakeholders:

BEE	National Skill Development Corporation	National Institute of MSMEs
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Role of various actors/ stakeholders

BEE: Assist in providing finance for procuring state-of-art technologies for hands-on-training at NSIC center and local skill development institute

Industry associations shall ensure inviting member MSMEs to trainings and workshops for capacity development

National Institute of MSMEs: NIMSME, which works in the areas of capacity building, research, and job enrichment training, shall be leveraged for developing the technical courses on energy management and conservations

National Skill development Corporation: Assist in developing training courses and curriculum on in food processing processes and technologies and deploying local resource for continuous improvement at cluster level

7.1.3. Financial Incentives for Adoption of Low Carbon Technologies

Need Assessment:

Energy efficiency or decarbonization is perceived as a secondary aspect when compared to the core business activity or only considered when it directly links to increase in production/output. Higher cost of energy efficient or decarbonization technologies due to advanced features and lack of upfront capital in MSMEs remained one of the biggest hurdles in adoption of EE or decarbonization technologies.

Proposed interventions:

Capital Subsidy scheme is most popular and has seen significant uptake as it offers to reduce the burden of high upfront cost of EE projects along with simplified process of availing subsidies.

7.1.3.1. Capital Subsidies on EE Technological Solutions

We are proposing following interventions catering to the needs of MSMEs. CLCSS has seen significant uptake in MSMEs and has been operational for two decades

- a. Increasing the limit of capital incentives under CLCSS, both maximum subsidy amount (15 lakhs) and applicable loan amount (1 Cr.) and launching CLCSS again for the food processing sector
- b. Higher % of capital subsidies on EETs for differentiating from productivity improvement
- c. Increasing the purview of technologies and sectors under existing subsidy schemes
 - i. AI Paddy Dryer
 - ii. Optical Sorter
 - iii. New Age Rice Whitener and Polisher
 - iv. Online Moisture Meter – PLC controlled
 - v. Semi-Automation System for soaking tanks – PLC controlled

- vi. IQF Freezers
- vii. Turbo Drop Cookie Depositor
- viii. Rotary Rack Bakery Oven
- ix. IoT based EMS

Implementation Roadmap:

- a) Awareness and cluster level engagement is essential for capital subsidy scheme as well. Majority of the units in the different clusters still lack the knowledge of the different schemes.
 - Conducting the workshops for promoting the awareness of the financial schemes across clusters of Kaithal-Karnal, Ganjam-Nayagarh, Vellore, Ludhiana, Pune-Mumbai, Coimbatore, Allahabad, etc.
- b) Even though capital subsidy schemes are highly accepted in MSMEs it is vital that it incorporates important features like simple application process, quick approval and disbursement of subsidy, wide coverage of technologies & MSME clusters and awareness of the scheme.
- c) Regional level consultations should be conducted across all food processing clusters to draft the possible recommendations for the faster and wider adoption of these schemes.
- d) After consolidating the inputs received, AIREA, FSNM, FBMI, AIBMA, SEAI along with BEE can conduct the stakeholder consultation with MoMSME for further simplification of the processes.

7.1.3.2. *Lower Interest Rates on EE Loans and Faster Disbursement*

The prime objective of this mechanism is to promote ease of financing for the adoption and implementation of energy efficiency measures across all the selected sectors (mainly demand side).

1. Identifying list of key EE technologies applicable for interest subsidies based on minimum energy saving potential threshold
2. The minimum investment required for availing the benefits under interest subvention scheme of BEE should be brought down to INR 10-15 lakhs from the current INR 50 lakhs criteria.
3. Building the capacities of Financial Institutes in cost-benefit analysis of EETs
4. Quick and fast disbursement for adoption of EE technologies

7.1.3.3. *Differential Taxes on EE Technologies*

A tax exemption will allow the purchaser of an equipment, such as an energy-efficient technology, to be exempt from paying tax on that purchase. Tax credit can also be provided to allow MSMEs to deduct the tax credit amount from their annual taxes as a percentage of a purchase price.

1. Charging lower GST and differential tax breaks on purchase of EE technologies.
2. Different GST slabs based on EE potential of technologies for shortlisted equipment
3. Additional energy efficient and decarbonization equipment should be considered for tax benefits under Accelerated Depreciation, for example, electric oven, EE blast freezers,

screw chillers, IPM compressor, low pressure air piping, pellet-based EE burners, IoT, among others

Implementation Roadmap:

Regional level consultations should be conducted across all food processing clusters to draft the possible recommendations for list of technologies that should be included in this scheme.

- We propose one workshop in each Cluster for compiling the requirements of the different food processing units.
- After consolidating the inputs received, BEE together with associations like AIREA, FSNM, FBMI, AIBMA, SEAI, and others can propose a consultation with GST Council and other relevant stakeholders for addition of most relevant technologies in the list and revising the criteria under the schemes if necessary.

The government levies 5%⁹⁶ GST on Compressed Biogas (CBG) to promote the supply and use of CBG against 14%⁹⁷ custom duty and 14%⁹⁷ basic excise duty on compressed natural gas (CNG).

Benefits to Sector Stakeholders

- a. Increasing affordability of energy efficient technologies
- b. Faster adoption and replication of new & advanced technologies

Relevant Stakeholders:



Role of Various Actors/ Stakeholders

BEE: Providing list of Energy efficient technologies applicable for incentives and subsidies and preparing revised guidelines for schemes like interest subvention.

Commercial banks- Developing in-house capacities on evaluation on EE technologies and ready reckoner for quick sanction & faster loan disbursement

MoMSME: Revising guidelines for capital subsidies schemes and shortlisting EE technologies for GST breaks and differential taxes

SIDBI – Expanding the capacity building of industries and FIs, standardization of the project documents

7.1.3.4. *Incentives for Transitioning to Decarbonisation or Net-zero*

As India has pledged for 2070 Net Zero target, the role of MSMEs accounting for around 110⁹⁸ million tonnes of CO₂ emissions annually will be crucial in achieving the country's Net Zero goal. However, the financial and other incentives for the MSME sector till date focus on aspects like quality enhancement, productivity improvement, energy efficiency, among others. And there has been no push for promoting the decarbonisation technologies other than energy efficient ones. The MSMEs who already have limited financial capacities do not find concerns related to climate change and Net Zero on their top priorities. However, with awareness on the benefits of

⁹⁶ <https://satat.co.in/satat/assets/about.pdf>

⁹⁷ <https://ppac.gov.in/prices/central-excise-and-customs-rate-on-major-petroleum-products>

⁹⁸ Centre for Study of Science, Technology and Policy (CSTEP) 2018

decarbonisation and incentives to support the MSME's decarbonisation journey, the sector can also play its part in the country's Net Zero journey.

Some of the sub-sector specific barriers faced by MSMEs in the Net Zero journey are as below.

- Bakeries: Investment in technologies like Electric Oven needs capital and there is no support or incentive given to MSMEs at present for encouraging them to make this investment
- Seafood: This sector is mostly an export oriented sector and has lot of their emissions from the transportation of their products to the ports in the form of fuel usage and refrigeration requirement. Also due to low level of processing the mass of product transported is more thereby resulting in increased refrigeration requirement during transportation.

Implementation Roadmap:

- The coverage of the existing schemes should be expanded to include the decarbonisation technologies other than energy efficiency
- Focus should be expanded from energy efficiency to Net Zero and favourable policies and schemes supporting Net Zero must be launched. For example, incentives supporting electrification of technologies.
- Several indirect measures to reduce the sector's energy demand must be targeted. For example, optimisation of the distance between MSME unit and the port from where the products are exported by developing new ports in vicinity if feasible (like development of Paradeep port can eliminate the need for transportation of seafood products from Bhubaneshwar to Kolkata). MoMSME should incentivise the food processing sector to produce more value added products. In case of seafood processing the production of value added products can reduce the mass of the food products to be transported thereby reducing the requirement for refrigeration. The incentivisation for producing value added products can be in the form of any of the following:
 - Capital subsidies or interest subvention for investment in equipment for value addition during processing
 - Reduced GST on value added products

The value addition in food processing will also increase the food processing sector's revenue thereby increasing its economic contribution in the country. State and Centre can develop a holistic programme in association with SEAI to boost the production of the valued added products (in RTE/RTC category) in the Fish and other sea food processing segment.

Benefits to Sector Stakeholders:

- Complying with Net Zero standards makes the product more exportable as the export markets are demanding this, for example, the seafood importers are increasingly interested in buying products from units complying with the Net Zero standards.

7.1.3.5. *Financial Incentives for Carrying Out Energy Audit Studies*

For identifying the exact energy efficiency potential in a unit and the capital requirement for energy efficient technologies and measures and most importantly identification of the relevant energy efficiency measures for a unit requires conducting an energy audit study by a BEE empanelled Energy Auditor. However, the MSME unit owners do not find the cost of conducting an energy audit study pocket friendly. As a result, they remain unaware of the energy savings potential in their

processes and the energy conservation measures applicable to their unit. This lack of information prevents them from taking steps towards improving their energy performance.

- SDAs shall provide financial support to the MSMEs for carrying out energy audit studies in the form of subsidies.

Implementation Roadmap:

- BEE shall appoint a consultant to engage with the SDAs (MEDA, GEDA, HREDA, etc.) who have provided subsidies in energy audits in the past to understand the success and challenges associated with the scheme
- The consultant shall then engage with the key food processing related associations in the states wherein the key food processing clusters are located and which do not have energy audit subsidy scheme yet (like Madhya Pradesh, Uttar Pradesh, Odisha, etc.) to take their inputs in designing the subsidy scheme
- Based on the consultations with the SDAs and key associations, the consultant shall design the subsidy scheme for the SDAs of the states which are important for the food processing sector
- In addition to the subsidy scheme, the consultant should design a strategy to empanel the energy auditors and energy auditing firms. These empanelled firms or auditors should provide energy audit consultancy services to the MSMEs at subsidised rates.

7.1.3.6. Innovative Business Models

Most of the MSMEs in the food processing sector have a good potential for installing rooftop solar PV plant. However, the initial capital investment creates a barrier in transitioning to solar energy. The MSMEs lacks awareness on the innovative business models for availing solar energy service like the RESCO model. The high upfront costs also creates a hurdle in implementing the EETs in the units.

- Leveraging public-private partnerships for promoting EE
- Raising awareness on the RESCO model will promote solar energy use in the MSMEs
- Bundling of projects can help the ESCOs/RESCOs and unit owners to implement the EETs and RETs in a financially feasible manner

Implementation Roadmap:

ESCO/RESCO

- To increase private investment in energy efficiency and thereby promote energy efficient transition, the public sector in collaboration with private companies and Energy Saving Companies (ESCOs) implements the energy savings projects through Energy Performance Contracts (EPC) which defines the contracting parties' obligations and rights
- The SDAs in association with the entrepreneurs engaged in providing solar energy as a service shall conduct awareness campaigns in key food processing clusters like Vellore, Indore, Kaithal, Ganjam, Kanpur, Ludhiana, Pune, among others.
- The SDA shall act like a matchmaker if any MSME unit wishes to connect with a business engaged in providing solar energy as a service through the RESCO model.
- In Food Parks with tariff subsidies, the RESCO models can be implemented due to which the subsidy burden on the government can be reduced.

- The SDAs in association with the ESCOs and RESCOs shall bundle the demand for EETs and RETs for successful implementation of EETs and RETs in MSMEs in a financially feasible manner

⁹⁹EESL in past have conducted workshops in MSME clusters including Surat Textile Cluster, Jorhat Tea Cluster, among others wherein the information on business models and incentives for EETs and RETs was disseminated among the MSMEs, along with presentations by technology providers on EETs/RETs, among other activities. These activities were part of the UNIDO-GEF-EESL's Promoting Market Transformation on Energy Efficiency in MSMEs project.

7.1.4. Collaborative Efforts Among Institutional Stakeholders and IDAs

Need Assessment:

State specific departments and institutes participate minimally in implementing centrally funded support programmes. The wider reach to state specific institutes coupled with increased ownership can significantly improve the outcome of existing schemes. Support from DICs, State ministries and departments are needed to facilitate better implementation.

Proposed Interventions:

There is a need felt across clusters to leverage other institutes for promoting EE interventions in the MSME food processing clusters. We are proposing following interventions for institutional capacity building

7.1.4.1. Collaborative Efforts among Various Institutes:

- a. Building capacity of SDAs/MSME-DIs, to include a full time EE-MSME expert to facilitate MSMEs in availing benefits of existing cluster specific schemes
- b. Support from SDAs and DICs is needed to facilitate better implementation and collect timely feedback on the performance of energy efficiency programmes.
- c. The wider reach of State government agencies, coupled with increased participation can significantly improve the outcome of existing schemes
- d. BEE should share the outcomes of the Benchmarking Exercise conducted by them with the SDAs and State level associations or Regional chapters of the National associations. The associations can then disseminate these benchmarks among the units.
- e. BEE, MoFPI and MoEFCC should collaborate to find synergies with the India Cooling Action Plan for reducing the energy demand from the Food Processing sector as refrigeration is one of the major energy consuming processes in the food processing industry applicable to seafood, frozen food, among other food products.

7.1.4.2. Creating Synergies with IDAs Led Existing EE Interventions

- a. Identifying IDA led ongoing EE interventions in MSME clusters and exploring options for synergies for capacity building and technology demonstration activities
- b. Combining IDA led EE financing schemes and revolving funds (EESL UNIDO EMRF fund) with technical assistance activities of BEE in food processing MSME sector

⁹⁹ <https://msme.eeslindia.org/events.aspx>

- c. Leveraging the existing platforms by IDA for other MSME sectors to equip the MSMEs in food processing sector with the required technical and financial related information

Implementation Roadmap:

- a) Developing the common platform to map the different initiatives carried out for the food processing sector by the different stakeholders. This will result into propagating the benefits and learning captured in different program though web portal accessible to food processing units.
- b) Strengthening of SDAs, DICs and regional associations for wider dissemination of the learning to the food processing units in their respective regions.
- c) Creating the common platform for exchange of thoughts and ideas among the regional stakeholders to identify the key areas for development.
- d) Establishing the long-term programmatic interventions focused for specific cluster led by one IDA or collaborative efforts - including the capacity building programmes, technology demonstration, hand-holding support for implementations.
- e) Developing new focused programs for food processing clusters where limited or less program intervention has been carried out in the past.

GIZ is currently developing *SME Helpdesk*, a platform which is envisaged to support the MSMEs in secondary steel and paper subsectors with their customized queries related to energy efficient technology implementation through its Helpdesk feature which is backed by a pool of experts and secondly by creating a knowledge platform compiling the existing and additional information on energy efficiency in MSMEs in general. This SME Helpdesk platform can be leveraged to support the MSMEs in food processing sector as well with their customized queries on EE and RE technology implementation.

- f) Programmatic interventions should leverage cross-cluster learnings and interventions of different IDAs in other clusters through knowledge exchange programmes, industry tours and hand-on training in Centres of Excellence.

¹⁰⁰The World Bank – GEF project on Financing Energy Efficiency at MSMEs focused on five energy intensive clusters which were foundry cluster at Kolhapur, Forging at Pune, Limekilns at Tirunelveli, Chemical at Ankleshwar and mixed at Faridabad for activities like capacity building and awareness for EE in MSMEs, to increase investments in EE in MSMEs, among others.

¹⁰¹SAMEEKSHA and SIDHIEE¹⁰² are the online platforms which hosts knowledge resources and synergizes the efforts by various institutions and organizations working towards the goal of cleaner and energy efficient technology penetration in the MSMEs in India. It acts as a communication channel for the industry to interact with stakeholders including technology development specialists, R&D institutions, government bodies, training institutes, funding agencies and academia.

Benefits to Sector Stakeholders

- a. Development of the collaborative ecosystem for wider outreach of programmatic activities
- b. Different food processing stakeholders will have increased awareness and access to various cluster specific interventions
- c. Removal of the duplication of efforts by various stakeholders.

¹⁰⁰ [https://sidbi.in/files/posts/ProjectBrief-\(1\).pdf](https://sidbi.in/files/posts/ProjectBrief-(1).pdf)

¹⁰¹ <https://www.sameeksha.org/>

¹⁰² <http://sidhiee.beeindia.gov.in/>

Relevant Stakeholders:

BEE	International development agencies	DICs/ MSME DI	SDAs
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BEE: Engaging all stakeholders at the inception of the programme and ensuring ownership from them by highlighting mutual benefits and opportunities for synergy

MSME DI: Creating awareness on current initiatives among MSMEs at cluster level and providing support during awareness workshops by inviting MSMEs in the cluster

International development agencies (IDAs)- Supporting ongoing BEE interventions through bundling of ongoing EE financing schemes and revolving funds

7.1.4.3. *Creating Supporting Infrastructure for EE Technology Upgradation*

Lack of supporting infrastructure and regulatory support also limits the uptake of EE interventions in various MSME clusters in food processing sector.

1. Ease of Regulations from DISCOMs:

- a. Creating a bridge between MSME industries & DISCOMs
- b. Additional financial incentives for technology upgradation which will lower the overall projects costs related to infrastructure upgradation
- c. Developing ready reckoner and list of documents required for getting the clearances

BEE appointed project consultant will understand the regulations and perform need assessment at MSME level.

2. Extension of Natural Gas Pipelines:

- a. Strengthening & extension of the Natural Gas pipeline within clusters
- b. Prioritizing availability of Natural Gas pipelines across all energy intensive food processing MSME clusters

BEE appointed project consultant will do study to identify industrial areas where NG pipelines are not available

3. Easing the Net-metering Policies and wheeling charges support for solar roof-top installations in MSMEs

BEE appointed consultant with the help of MNRE will do gap assessment and propose interventions which are required.

4. Efforts to avoid emissions at first place should be made such as **developing ports nearby the clusters** engaged in processing export oriented products.

BEE appointed consultant with the help of prominent export focused associations will carry out a study to optimize the road transportation of food products. The outcomes of the study will help BEE in proposing an Infrastructure Development plan to the government to minimize the transportation related emissions including the refrigeration emissions.

5. Strengthening the Supply Chain for Biomass based Pellets in regions where there is monopoly or duopoly in the market

BEE shall incentivize entrepreneurs engaged in the business of supplying biomass-based pellets in the form of GST waiver or other incentive to bring competition in the market of supplying biomass based pellet.

Benefits to Sector Stakeholders

- a. Evaluation of technical viability of EE technologies, cost benefit assessment
- b. Access to cleaner fuel by switching to electricity and NG, hence reduction of emissions
- c. Easy access to energy auditors in the clusters and support required during implementations
- d. Food products will be of more export value if their value chain emissions are minimized

Relevant Stakeholders:



Role of various Actors/ Stakeholders

Industry Associations: Outreach to food processing MSME industries in the cluster

DISCOMs: Assisting MSMEs in providing required documents for clearance and approval

MSME DI in collaboration with Gas Companies can assist in getting the clearances for extending Gas pipelines in industrial MSME clusters

BEE- Supporting in carrying out regulatory interventions in the cluster for NG lines

7.1.5. *Regulatory Options to Promote Energy Efficiency*

7.1.5.1. *Perform Achieve and Earn (PAE) Scheme:*

Learnings from the Perform Achieve Trade (PAT) scheme should be extended to the MSME sector. These mandatory programmes should not be perceived by MSMEs as an administrative burden and therefore, the incentives should be provided based on EE potential achieved.

Because SMEs already face significant barriers to energy efficiency implementation, proposing a scheme which penalizes SMEs on non-compliance may widen the relationship gap between the government and enterprises and create extra burdens on these enterprises. Therefore, an incentive-oriented compliance mechanism (e.g., offering ESCerts based incentives) is proposed.

Proposed Interventions:

Programme coverage: In the pilot phase for Food processing across 10 clusters, over 200 units will be covered. Different clusters that can be considered under the programme include- Kaithal-Karnal, Ganjam-Nayagarh, Vellore, Warangal, Ludhiana, Coimbatore, Pune-Mumbai, Allahabad, Kochi, etc.

A mandatory audit programme will help policymakers and regulators identify major energy efficiency bottlenecks and opportunities to intervene at scale. However, enterprises may perceive mandatory energy audits as an added administrative burden, hence, they can be incentivized by providing free/ subsidised energy audit services.

Implementation Roadmap:

As a first step, energy audits must be made mandatory in the next 3-5 years for all energy intensive food processing units having an annual turnover of more than INR 50 crore (medium scale units), this can later be extended to enterprises having turnover of more than INR 25 crore.

- The pilot for this program will cover MSME food processing clusters across India in 3 subcategories i.e., Rice mills, RTE/RTC, processed seafood.
- BEE team in close consultation with national food processing association (AIREA, SEAI, AIBMA, among others) will navigate the execution of this programme.
- Interested SMEs can opt for the energy savings programme by reaching out to Industry Association. Industry associations will be given ownership to register the MSMEs for programme and to engage with them in a meaningful and sustainable way
- BEE will promote the voluntary uptake of energy conservation by carrying out the energy audits in MSMEs and assign targets for reduction of their specific energy consumption
- BEE appointed agency will carry out baseline energy audit as per prescribed format of BEE, recommend ECMs for energy saving after conducting techno-commercial feasibility for EE solutions
- BEE will also provide handholding support to MSMEs during implementation phase
- SMEs that achieve or exceed the reduction targets would be issued ESCerts based monetary incentives. MSMEs will be required to achieve a minimum of 30% of the agreed targets
- BEE will also assist in building confidence of MSMEs by technology demonstration and creating awareness on EE solutions and technologies.
- After two years, some of the forward-looking clusters can be given mandatory targets for reducing their specific energy consumption (SEC). Mandatory targets can also cover renewable energy integration targets, targets for use of energy from waste sources, among others in addition to the specific energy consumption reduction targets.
- Post completion of each SEC reduction cycle, BEE should undertake a monitoring and evaluation exercise to check the compliance of the units with the given targets. An estimation of the overall reduction in energy consumption at a cluster level as a result of this PAE programme should also be done.

Role of various stakeholders:

BEE: Rolling out of the pilot phase of PAE scheme, selecting and procuring services of EA agency for baseline energy audits, issuing ESCerts to MSMEs, target setting, monitoring and evaluation

Project consultants: Carry out baseline energy audit as per prescribed format of BEE, recommend ECMs for energy saving post conducting techno-commercial feasibility for EE solutions, target setting, monitoring compliance with the targets, evaluation of the programme

Industry association: Disseminate the programme objectives across different clusters through workshops and collate expression of interest from different food processing clusters

MSME: Support EA agency appointed by BEE, facilitate EA study, share the details and data required for baseline study

7.1.5.2. *Other Regulatory Measures*

Need Assessment:

Effective regulation helps the country in achieving its energy efficiency goals in a smooth, efficient and rapid manner. Regulation if mandated across the country rather than in a specific geography will boost the energy efficiency transition with increased competitiveness. Also, increased regulatory control over the technologies will help in bringing more energy efficient options to the market because of standardisation of technology.

Proposed interventions:

- Consistency in environmental regulations and increased control over technologies important for the food processing sector like furnaces, burners, among others can help in achieving the energy efficiency goals.
- There should be uniform environmental compliances for all states. This will help in reducing the carbon footprint of the sector in a more competitive manner through standardization of the technologies, sharing of learnings and best practices resulting in the competitive and sustainable growth of the sector.
- The BEE Star Labelling Programme should expand its coverage to include more technologies prominent for the food processing sector like blast freezer, IQF, furnaces, burners, among others.

Implementation Roadmap:

Expanding the coverage of BEE Star and Label Programme to cover GHG emissions and additional equipment

- BEE should appoint a consultant for conducting a study on energy and GHG intensive technologies for the food processing sector.
- The consultant should engage with key industry associations to understand the processes followed and technologies used for making the several food products.
- Based on the inputs received, share of the technology in the sector's energy consumption and GHG emissions, existing regulations for the technology, interaction with technology vendors, among other factors, the consultant should identify a list of technologies for inclusion in the BEE Star and Label programme. The technologies on the list should be categorized like Technologies for Immediate Inclusion, Inclusion in next 3 years, Inclusion in Next 6 years, and so on.
- The consultant should then further connect with the technology vendors for designing the energy efficiency and GHG emission standards for the relevant technologies for food processing.
- An Eco Label programme should be initiated wherein the existing technologies under BEE Star and Label and new identified technologies for food processing will be covered and the Eco Label will indicate information on the energy consumption and GHG emissions for the particular technology.
- Finally, the consultant should prepare a roadmap for including the food processing related equipment in the BEE Eco Label programme including the energy efficiency and GHG emission standards and year of inclusion for the technologies.

¹⁰³The Carbon Trust Footprint Label informs consumers about the emissions from the products they are about to purchase. These emissions cover GHG emissions from the extraction of raw materials, product's manufacturing, distribution, use and disposal. They have labelled over 27000 individual products and their label is displayed in more than 40 countries.

Uniform policies across states

- BEE should appoint a consultant to map the several policies pertaining to the food processing sector in each of the districts and states.
- The consultant should identify the list of regulations which are specific to a particular region.
- The consultant should then identify the reasons for the non-uniformity in regulations.
- Further, a feasibility study should be conducted to expand the coverage of the regulations, for example, from district to state level and from state to national level. The stakeholders at various levels should be consulted for understanding the challenges in complying with a particular regulation.
- The regulations which are important for reducing the food processing sector's energy demand and are feasible to apply over a larger geography should be considered for application in other regions where it is currently not applicable.
- The consultant should then devise a strategy for applying the key regulations over a larger geography.

¹⁰³ <https://www.carbontrust.com/what-we-do/assurance-and-labelling/product-carbon-footprint-label>

Figure 35 presents the role of various stakeholders in implementing the Policy Roadmap for EE and RE transition of the food processing MSME sector.

		Nodal Agency	Implementation Partner	Implementation Support
Technology Capacity Building	Awareness Creations & B2B Interfacing Platform	BEE	<ul style="list-style-type: none"> SDA Industry Association MSME-DI / DIC 	<ul style="list-style-type: none"> Project consultant Technology suppliers
	Developing EE Assessment Tool for Financial Institutes	BEE	<ul style="list-style-type: none"> Industry Association 	<ul style="list-style-type: none"> Ni-MSME Financial Institutions Project consultant Technology suppliers
	Technology Demonstration Platform	Industry Association	<ul style="list-style-type: none"> MSME BEE Fis/SIDBI 	<ul style="list-style-type: none"> Technology suppliers Project consultant

		Nodal Agency	Implementation Partner	Implementation Support
Creating Conducive Environment for Increasing the Adoption of EE	Supporting ISO 50001 EnMS Implementations in MSMEs	MSME DI	<ul style="list-style-type: none"> Industry Association SDA 	<ul style="list-style-type: none"> Ni-MSME Project consultant
	Promoting IoT systems & Energy Monitoring Technologies	BEE / MoMSME	<ul style="list-style-type: none"> Industry Association India Smart Grid Forum 	<ul style="list-style-type: none"> Technology suppliers Project consultant
	Energy Management Centre (EMC) at Cluster Level	Cluster Association	<ul style="list-style-type: none"> BEE SDA 	<ul style="list-style-type: none"> MSME – DI / DIC Technology suppliers Project consultant
	Industry Association at Cluster Level	MSME	<ul style="list-style-type: none"> MSME - DI / DIC 	<ul style="list-style-type: none"> MSMEs Project consultant
	Skill Development in Food Processing MSME Sector	BEE / MSME	<ul style="list-style-type: none"> MSME-DI / DIC Industry Association 	<ul style="list-style-type: none"> Ni-MSME / NSDC Local Universities and Institutes
	Feasibility Analysis and Awareness Creation on New Age Technologies	BEE	<ul style="list-style-type: none"> MSME-DI / DIC Industry Association 	<ul style="list-style-type: none"> Project consultant Technology suppliers

		Nodal Agency	Implementation Partner	Implementation Support
Financial Incentives for Adoption of Low Carbon Technologies	Capital Subsidies on EE Technological Solutions	DC-MSME	<ul style="list-style-type: none"> BEE FIs 	<ul style="list-style-type: none"> Commercial banks / SIDBI Project consultant
	Lower Interest Rates on EE Loans and Faster Disbursement	BEE / MSME	<ul style="list-style-type: none"> FIs National Banks 	<ul style="list-style-type: none"> Commercial banks / SIDBI Project consultant
	Differential Taxes on EE Technologies	Goods and Services Tax Council	<ul style="list-style-type: none"> BEE MoMSME 	<ul style="list-style-type: none"> Commercial banks / SIDBI Project consultant
	Incentives for Transitioning to Decarbonisation or Net-zero	BEE	<ul style="list-style-type: none"> MoMSME MoFPI 	<ul style="list-style-type: none"> Goods and Services Tax Council Commercial banks / SIDBI Project consultant
	Financial Incentives for Carrying Out Energy Audit Studies	SDA	<ul style="list-style-type: none"> Industry Association 	<ul style="list-style-type: none"> SDA Commercial banks / SIDBI Project consultant
	Innovative Business Models	BEE	<ul style="list-style-type: none"> SDA MoFPI Industry Association 	<ul style="list-style-type: none"> ESCOs / RESCOs Technology suppliers Project consultant

		Nodal Agency	Implementation Partner	Implementation Support
Collaborative Efforts Among Institutional Stakeholders and IDAs	Collaborative Efforts among Various Institutes	BEE	<ul style="list-style-type: none"> MoMSME MoFPI MoEFCC 	<ul style="list-style-type: none"> MSME-DI / DIC SDA Project consultant
	Creating Synergies with IDAs Led Existing EE Interventions	BEE	<ul style="list-style-type: none"> SDA MSME-DI / DIC Regional Association 	<ul style="list-style-type: none"> IDAs EESL Project consultant
	Creating Supporting Infrastructure for EE Technology Upgradation	DC-MSME	<ul style="list-style-type: none"> BEE SDA 	<ul style="list-style-type: none"> SERCs / DISCOMs Petroleum and Natural Gas Regulatory Board GST Council
Regulatory Options to Promote Energy Efficiency	Market based incentive programme	BEE	<ul style="list-style-type: none"> MoMSME Industry Association 	<ul style="list-style-type: none"> MSMEs Project consultant
	Other Regulatory Measures (BEE Star & Label, Uniform policies)	BEE	<ul style="list-style-type: none"> MoEFCC 	<ul style="list-style-type: none"> State Environment Departments Technology suppliers Project consultant

Figure 35: Role of various stakeholders in Roadmap Implementation

Annexure



Annexure

A. **Production process and technology adopted**

Food processing industry is energy intensive and energy cost accounts for about 15^{104} per cent of total production cost. The primary process steps in food processing varies with the type of product processed. In case of rice mills, the process steps are pre-cleaning and destoning, parboiling, drying, final cleaning, de-husking, husk separation, and whitening/polishing. Whereas in case of raw rice the process steps include cleaning, de-husking, un-husked paddy separation, polishing, and grading. In case of parboiled rice mills, parboiling and drying accounts for 90% of the total energy consumption, and the balance energy is used in utilities and auxiliary operations.

Type of production processes in food processing

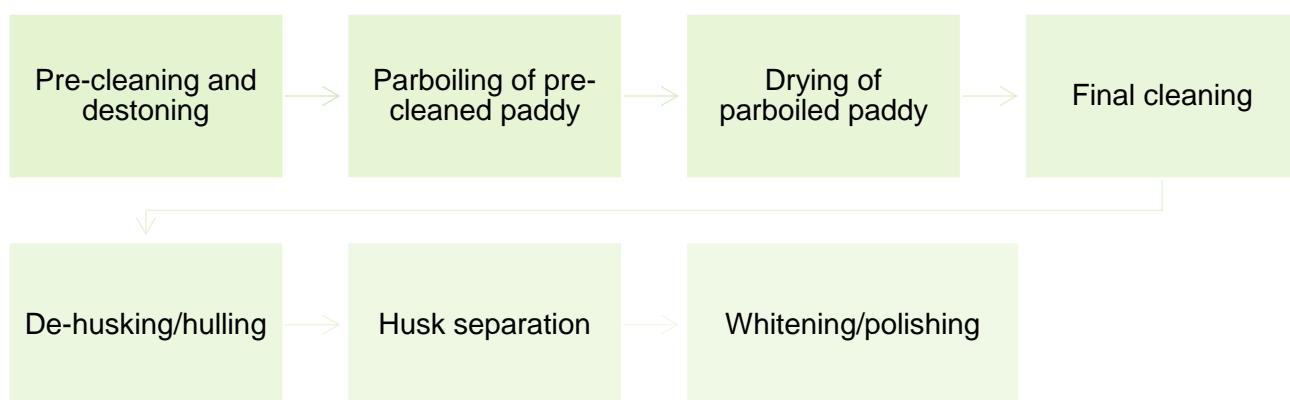
The production process flow in food processing certainly depends on the type of product processed. The sub-category wise production process flow is described below.

Rice mills

The major steps involved in typical rice mill unit in Kaithal cluster include cleaning, parboiling, dehusking, separation, polishing, grading, sorting and packaging, among other processes. Paddy processing is an energy intensive process, where significant amount of energy is consumed for parboiling and drying operations.

Different processes in the rice mill unit can be classified under the below mentioned heads:

Parboiled Rice



¹⁰⁴ <https://www.centricabusinesssolutions.com/blogpost/energy-accounts-15-food-and-drink-manufacturers-costs-scope-ease-pressure-margins-clear#:~:text=Blogs->
,Energy%20accounts%20for%2015%25%20of%20food%20and%20drink%20manufacturers'%20costs,pressure%20on%20margins%20is%20clear

White (Raw) Rice Mill



Detailed process flow diagram for a rice mill is presented in Figure 36.



Figure 36: Process flow diagram of typical rice mill unit

Cleaning: Raw paddy rice is received and stored in a clean, dry area. Prior to the milling process the paddy received from silos is cleaned to protect the processing equipment and improve the final product. Normally the impurities present in the paddy are found in three sizes i.e., large size (consisting of rice straw, panicles, bag strings, soil stones, and sometimes iron parts), small size

(consisting of dust, sand, soil, weed seeds, insects and small stones) and impurities of the same size as the paddy (empty grains, stones and iron particles). The paddy is cleaned to remove these impurities and is done using a series of machines that include aspirators, destoners, and sieves.

Parboiling: Parboiling is one of the pre-milling conditioning treatments given to paddy to improve its nutritional profile and cooking quality. In this process, the paddy is soaked in water and later steamed and dried. Parboiling helps to reduce rice breakage and nutrient loss during milling operation.

Drying of parboiled paddy: After parboiling, due to soaking and steaming the paddy contains moisture in the range of 35-40%. In case of pressure parboiling, it may contain moisture in the range of 20-30%. In both the cases the paddy needs to be quickly dried to 14% moisture for enabling safe storage or be suitable for milling operation. Drying is a crucial process and if not done properly, can lead to huge paddy breakage during milling.

Parboiling and drying of parboiled paddy are the major energy consumers in a rice mill. Both these processes use steam for energy requirement. Most of the rice mills use rice husk in boiler as a fuel for meeting their thermal needs. There are few units in the cluster which use other fuels such as cane straw.

Dehusking: The outer husk of the paddy rice is removed to reveal the inner grain. This is done using a machine called a huller, which uses mechanical or abrasive force to remove the husk. The objective of the dehusking process is to remove the husk from the grain with a minimum damage to the bran layer and if possible, without grain breakage. However, due to application of friction in the process, some of the grains break during dehusking.

Separation: The hulled rice is then separated from the chaff using a machine called a sheller. The chaff is then removed from the rice using a winnowing machine.

Polishing: The rice is polished to remove the bran layer and to give it a smooth, shiny appearance. This is done using a machine called a polisher, which uses friction to remove the bran layer.

Grading: The polished rice is then graded according to its size and shape. This is done using a series of sieves and screens that separate the rice into different grades.

Sorting: The graded rice is then sorted to remove any remaining impurities, broken grains, or discoloured grains. This is done using a machine called a sorter, which uses optical sensors to identify and remove any unwanted particles.

Packaging: The sorted rice is then packaged in bags or other containers for distribution and sale. The process flow diagram for Rice mill is depicted in Figure 36.

RTE-RTC Food Products

Bakery:

Biscuits/Cookies/Puff/Cake/Sonpapdi/Baklawa/Sweets

Raw materials such as sugar, maida, atta (wheat flour) and other ingredients are weighed as per the requirement. This step needs to be done carefully as the changes in proportion may affect the product quality. These different ingredients are then mixed in blending machine and then poured into moulds as per the required shapes. The moulds are kept for yeast action and the fermented products are baked in oven at temperature and for duration depending on the type of product baked. The baked products are then naturally cooled and sent for packaging. This process is used for production of biscuits, puff, etc.

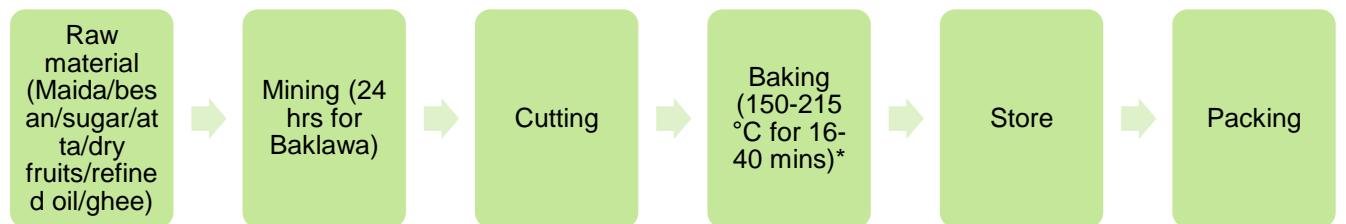


Figure 37: Process flow diagram of bakery unit

*Baking temperature and time depends on the product manufactured

Sauces

Batches of mixture of raw materials which are tomato, onion, garlic, sugar and salt are prepared. The mixture is cooked at 90 °C for 20-25 minutes. The mixture is then kept on hold for 5 minutes and sent to cooling tank where it is water cooled. The prepared sauce is then packed.

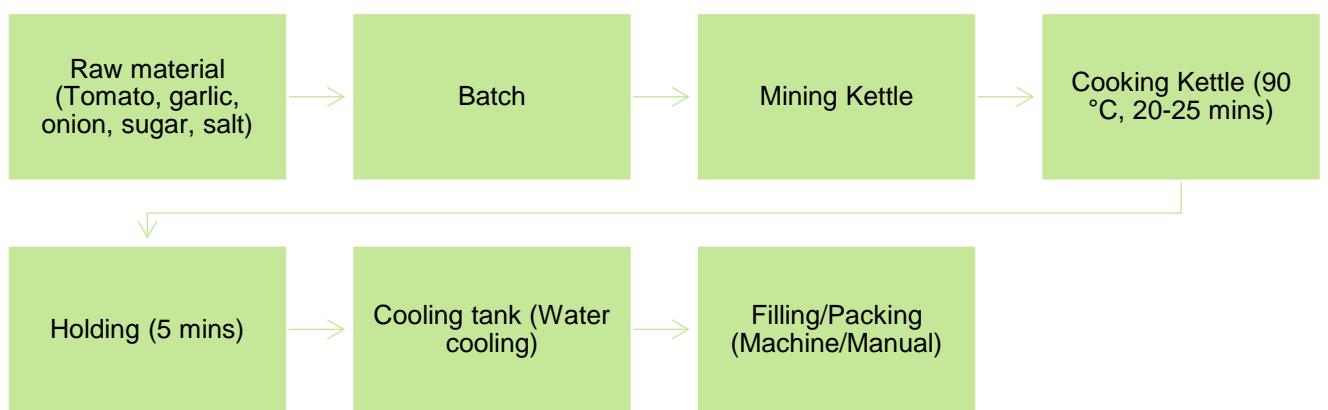


Figure 38: Process flow diagram of sauces

Sweet Corn

The process flow of sweet corn begins with the arrival of raw materials in the form of sweet corn kernels. These raw materials are then subjected to a thorough washing process to remove impurities and ensure food safety. Following the washing step, the corn undergoes blanching, a brief heat treatment that helps preserve its colour, flavor, and texture. After blanching, the corn is rapidly cooled to halt the cooking process. Next, a vibrating mechanism is used to remove any excess moisture from the corn, ensuring optimal freezing. The corn is then blast-frozen to lock in freshness and maintain its nutritional value. Once frozen, it is transferred to cold storage facilities, where it awaits dispatch to various distribution points and consumers.

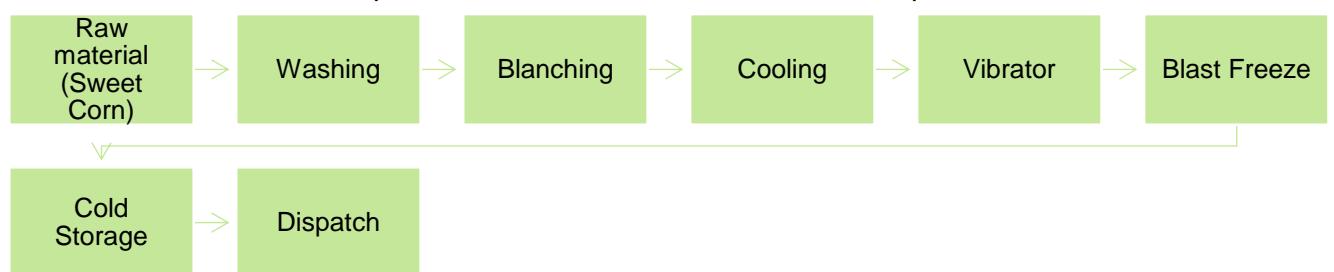


Figure 39: Process flow diagram of Sweet Corn

Frozen Fruits/Vegetables

The process flow for frozen fruits and vegetables commences with the arrival of raw materials, which can vary from an assortment of fruits and vegetables. These raw materials are then meticulously peeled to remove outer skins or rinds, enhancing both the appearance and taste of the final product. Subsequently, a thorough cleaning process ensues, effectively eliminating dirt, debris, and contaminants. The cleaned fruits and vegetables are then carefully drained to remove excess moisture, ensuring optimal freezing and preventing ice crystals from forming. Finally, the processed fruits and vegetables are promptly stored in a state-of-the-art cold storage facility, where they are maintained at sub-zero temperatures, preserving their freshness. The process of freezing fruits and vegetables starts with raw materials, which are then peeled, cleaned, and drained to eliminate impurities and excess moisture. Finally, the processed produce is stored in cold storage, preserving their freshness and nutritional value until they are ready for distribution and consumption.



Figure 40: Process flow diagram of Frozen Fruits and Vegetables

Other Products

In addition to the above mentioned products the other RTE products include murabba, sauces, pickles, rusk, shrimp samosa, chat, desi ghee, chikki, namkeen, candies/jellies, various types of frozen food products like frozen desserts and others. The production process of these products include processes like baking, cooking, drying, frying, thawing, flour making, mining, soaking, kneading, cooling, freezing, cold storage, grinding, cutting, among others.

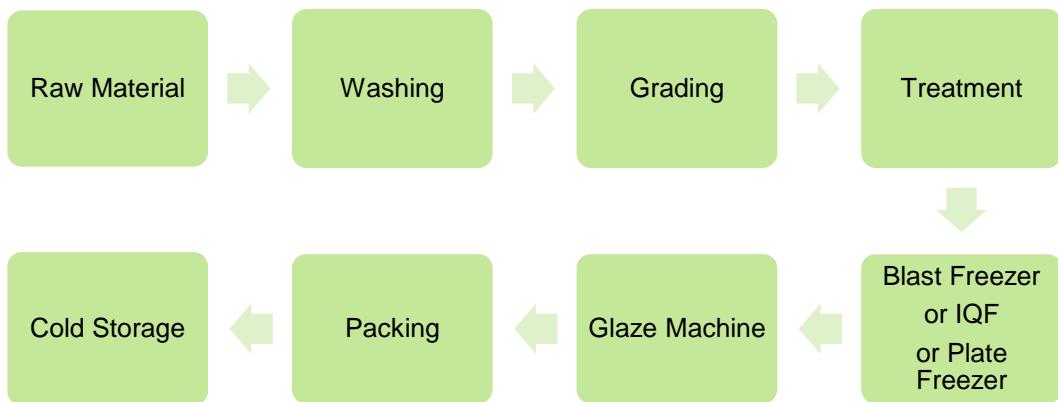
Processed seafood products

There are various production processes across the plants in Kochi which revolve around fish processing and cold storage. These plants are pivotal players in the market, dedicated to delivering top-quality marine products, encompassing a diverse range including octopus, cut squid, thondi squid, prawns, cutting fish, and other fish related items such as fish fillets or fish steaks. While the products might be the same, different plants may employ unique process flows tailored to their specific needs and objectives often maintaining a separate department for each item. The fish processing and cold storage of seafood items follows a comprehensive process flow to ensure the freshness and quality of the end products. We'll discuss the numerous distinct production processes below.

Octopus, Squid, Prawns, Cutting Fish, and Other Fish Items

The fish processing and cold storage of seafood items involves a meticulous process flow. The plants begin with the raw material, where the catch is received and inspected for quality and freshness. This is followed by a thorough washing to ensure cleanliness and hygiene. Grading follows, as the marine products are sorted and categorized based on size, weight, and quality. The treatment phase involves processes like cleaning, filleting, and other necessary preparations. Settings are crucial to maintain the right temperature and humidity conditions, ensuring the integrity of the products. To maintain the products' quality and freshness, they are rapidly frozen through a choice of methods: a blast freezer at -40°C for 5-7 hours, Individual Quick Freezing (IQF), or a plate freezer at -40°C for 2-2.5 hours. After freezing, a glaze machine adds a protective ice coating for preservation. The seafood products are then carefully packed to maintain their integrity and hygiene, and finally stored in a cold storage facility. This comprehensive process ensures that the

marine products maintain their high quality, flavor, and safety standards until they are ready for distribution and consumption.



Freeze drying process

This specific production sequence begins with a thorough washing of the raw material to ensure cleanliness and hygiene. The grading and sorting phases follow, where products are carefully categorized based on size and quality. To maintain freshness, the items are subjected to a plate freezer at -40°C, followed by storage in a cold environment at -22°C. In the subsequent steps, any unwanted ice is removed, and the products are then subjected to an extreme temperature range from -90 to 95°C, followed by a chilling process at 0 to -5°C. The journey continues with a blast freezer at -40°C. For certain products, raw materials may go through a pre-processing phase before freezing, which involves vacuum treatment for an hour and then freezing with a 14-hour tray hold. After this, there is a 16-hour heating phase, followed by further sorting and blending. The products are then sealed in a vacuum chamber, preserving their quality. Finally, the goods are ready for final packing, resulting in meticulously processed and preserved end products.

This method uses freeze drying (also known as lyophilization) which is a water removal process typically used to preserve perishable materials, with the goal of extending their shelf life and/or preparing them for transport. Freeze drying works by freezing the material, then reducing the pressure and adding heat to allow the frozen water in the material to change directly to a vapor (sublimate).

Freeze drying occurs in three phases:

1. Freezing
2. Primary Drying (Sublimation)
3. Secondary Drying (Adsorption)

Proper freeze drying can reduce drying times by 30%

Freezing is the most critical phase of freeze drying, and there are many methods for it. Freezing can be done in a freezer, a chilled bath (shell freezer) or on a shelf in the freeze dryer. Cooling the material below its triple point ensures that sublimation, rather than melting, will occur. This preserves its physical form.

Freezing Phase

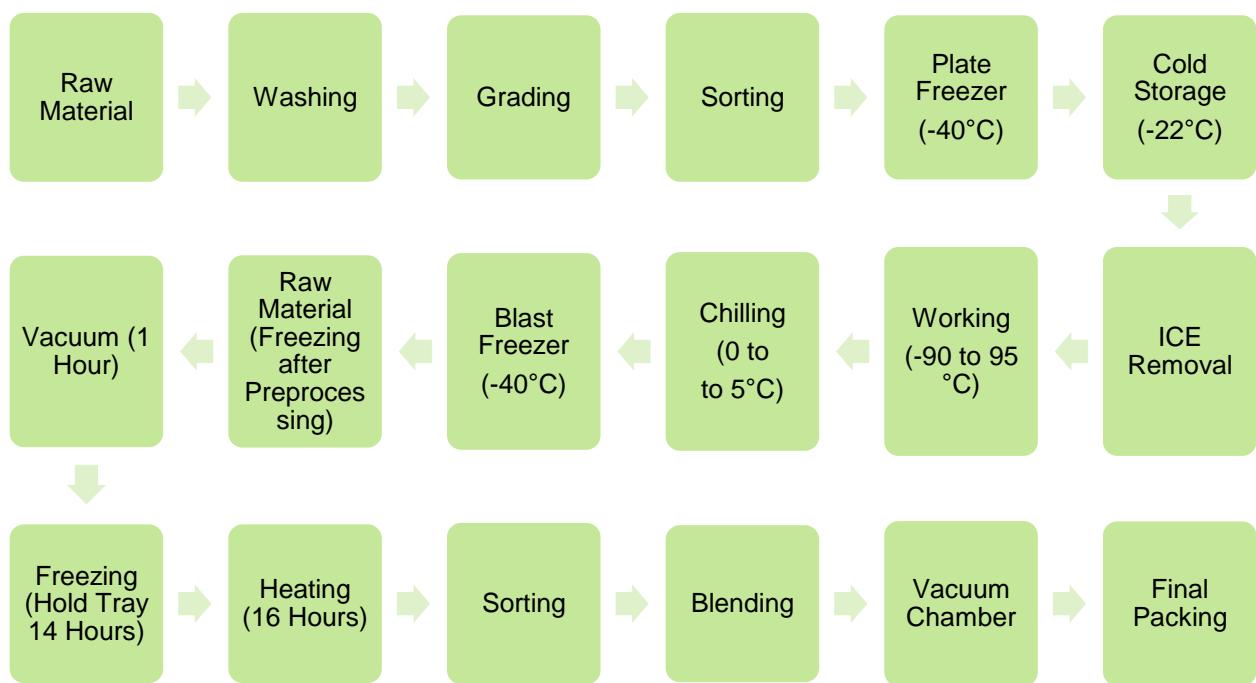
Freeze drying is easiest to accomplish using large ice crystals, which can be produced by slow freezing or annealing. However, with biological materials, when crystals are too large, they may break the cell walls, and that leads to less-than-ideal freeze-drying results. To prevent this, the freezing is done rapidly. For materials that tend to precipitate, annealing can be used. This process involves fast freezing, then raising the product temperature to allow the crystals to grow.

Primary Drying (Sublimation) Phase

Freeze drying's second phase is primary drying (sublimation), in which the pressure is lowered and heat is added to the material in order for the water to sublimate. The vacuum speeds sublimation. The cold condenser provides a surface for the water vapor to adhere and solidify. The condenser also protects the vacuum pump from the water vapor. About 95% of the water in the material is removed in this phase. Primary drying can be a slow process. Too much heat can alter the structure of the material.

Secondary Drying (Adsorption) Phase

Freeze drying's final phase is secondary drying (adsorption), during which the ionically-bound water molecules are removed. By raising the temperature higher than in the primary drying phase, the bonds are broken between the material and the water molecules. Freeze dried materials retain a porous structure. After the freeze-drying process is complete, the vacuum can be broken with an inert gas before the material is sealed. Most materials can be dried to 1-5% residual moisture.



B. EE Technology compendium

Energy efficient technologies are usually sector specific but also governed by the fuel availability, awareness levels, technology availability and level of sophistication in technology and operations etc.

Different clusters have different requirements depending upon the present level of technologies being used and progressiveness of the specific cluster. We have evaluated and subsequently prioritized EE technologies for the rice mill sector based on various parameters such as investment cost, energy savings potential, payback period, replication potential etc.



Project team has carried out the in-depth review of the EE technologies based on primary data collection, energy audits carried out in the cluster and in close consultation with industry associations and technology providers.

EE Technologies and Best Practices for Process Applications

Rice - Installation of Energy Efficient Paddy Cleaner

In about 50 % of the rice mills have installed old and local make equipment like paddy cleaners. The inferior design of old paddy cleaners leads to higher power consumption with respect to technologies available in the market.

It is recommended to install energy efficient Paddy cleaners replacing old and conventional paddy cleaners. The new modern Pre-Cleaning and Cleaning Sections with improved design paddy cleaner accurately separates Oversized and Undersized impurities and part of the Immature Grains from Paddy, the inbuilt Self-Clean system ensures optimum efficiency during the production cycle. Vibro-motors make the operation noiseless and trouble-free.



Figure 41: Paddy Cleaner

Electricity savings to the tune of 50% can be achieved with this measure. The expected annual monetary savings for a typical mill of 1.5 TPH capacity would be 0.26 INR lakhs per year. The associated monetary savings and payback are given below.

Table 55: Paddy cleaner for a 1.5 TPH mill

Particular	Unit	Values
Electricity savings	%	50%
Monetary saving	INR lakh/year	0.26
Investment cost	INR lakh	0.75
Simple payback period	years	2.9

Rice - Installation of Energy Efficient Separators

The separators are used for separating broken rice, unfinished rice and finished rice. Majority of the separators installed in the rice mills units are local make. The separators are of inferior design and consuming more power.

It is recommended to replace the present separators with new reputed company make separators such as suri engineering works, ricetec, milltech etc., The reputed make separator

consumes less power due to better design and productivity is also more for the same capacity. The following are the features of reputed make Separator:

- Precise construction assures stone less paddy
- Negligible loss of paddy
- Vibro motors assure noiseless trouble-free operations
- Self-cleaning system for maximum operating efficiency
- Removes immature grains along with other impurities

Electricity savings to the tune of 50% can be achieved with this measure. The associated monetary savings and payback are given below.

Table 56: Separator for a typical mill

Particular	Unit	Values
Electricity savings	%	50%
Monetary saving	INR lakh/year	0.14
Investment cost	INR lakh	0.40
Simple payback period	years	2.8

Rice - Installation of Plastic bucket for elevators

The elevators are the most common type of equipment found in rice mill industries. The elevators are used for transferring the paddy, semi finished and finished rice. The detailed studies undertaken in various rice mills, it is found that majority of the rice millers are using iron or MS material buckets for elevators. The iron or MS buckets consume more power due to heavy weight than the

plastic buckets. There are about 15 elevators in a typical unit of the cluster. All elevators are connected by a typical 1 HP motor each.

The replacement of iron and MS buckets with plastic buckets having lesser weight for elevators will reduce the power consumption by 10 %. The associated monetary savings and payback are given below.

Table 57: Plastic bucket for elevators for typical mill



Figure 42: Separator



Figure 43: Iron and Plastic bucket for elevators

Particular	Unit	Values
Electricity savings	%	10%

Particular	Unit	Values
Monetary saving	INR lakh/year	0.14
Investment cost	INR lakh	0.40
Simple payback period	years	2.8

Rice - Mechanized Soaking and Cooking unit

In majority of the rice mills, the paddy is handled manually during soaking and cooking of paddy. The paddy from the bags is unloaded to the soaking tanks. After soaking process is completed, the soaked paddy is removed from the soaking tanks manually and loaded for cooking. The process of handling paddy is labor intensive and handling cost is high.



Figure 44: Mechanized Soaking

It is recommended to install mechanized Soaking and cooking unit for reducing the labor charges. The system consists of elevators and SS tanks for soaking tanks and cooking of paddy at a height of 25 to 35 feet. The paddy is unloaded from the bags manually and loaded to the tanks through elevators and paddy is unloaded after completion of the process.

Table 58: Mechanized Soaking and Cooking unit

Particular	Unit	Values
Monetary saving	INR lakh/year	0.12
Investment cost	INR lakh	0.20
Simple payback period	years	1.8

Rice - Replacement of Cones Polishers with Whitener

White rice is produced from brown rice by removing the bran layer and the germ in the cone polishers. The bran layer is removed from the kernel by applying friction to the grain surface either by rubbing the grains against an abrasive surface or against each other. The amount of bran removed is normally between 8-10% of the total paddy weight but this will vary according to the variety and degree of whiteness required. The process used to whiten brown rice can be classified as either abrasive. Either one or two cone polishers are installed depending on the requirement of polishing and paddy processing capacity.

More than 60% of the rice mills are old more than 15 years and these industries has installed old cone polishers. The rice mills have either one or two cones and are driven by separate motors or common drive shaft system. The old cone polishers have disadvantages regarding low polishing quality due to abrasive polishing resulting in lower price in market and low yield of rice per ton of paddy processing.

It is recommended to install whiteners replacing cone polishers which whitens the unpolished rice with means of air blowing (the chaff will be blown off). The rice polisher features low mill pressure, low crushed rice rate, high rice output, small percentage of bran, the rice whiteness is improved, and quality is good. No fuel or electricity savings are envisaged by this measure, but better rice quality will offer higher market price with the same consumption profile.

RTE-RTC - Thyristor control for Electric Ovens

The Electric Ovens installed in the units are of resistance heating type. The heating cycle is usually controlled with the help of ON-OFF controls. This continuous switching subjects the heating coil to thermal shocks resulting in reduced life of heating coil and frequent failures. Thyristor based control enables smooth switching and precise temperature control. Replacing ON-OFF control with thyristor based control can result in 7-15%¹⁰⁵ savings in energy consumption.

Table 59: Cost benefit analysis of thyristor based control for electric ovens

Particular	Unit	Values
Energy saving	%	7-15
Investment cost	INR lakh	1
Simple payback period	years	~2

RTE-RTC - Recuperative Type Burner for Ovens

The burners of the diesel fired ovens in the units are of Monoblock type and are equipped with attached blower. The temperature of these burners drop when the diesel supply is cut off as the blower continues to supply air. As a result, the inside temperature of the oven is reduced which leads to increased operating time for burner. Hence the specific energy consumption of the burner is increased, and these burners also need to be finely tuned. These Monoblock burners can be replaced with recuperative type burners which are energy efficient. Recuperative burners use waste heat from furnace exhaust gases to preheat the combustion air. It is estimated that the energy savings as a result of using recuperative burners replacing the Monoblock type are around 30%.¹⁰⁶

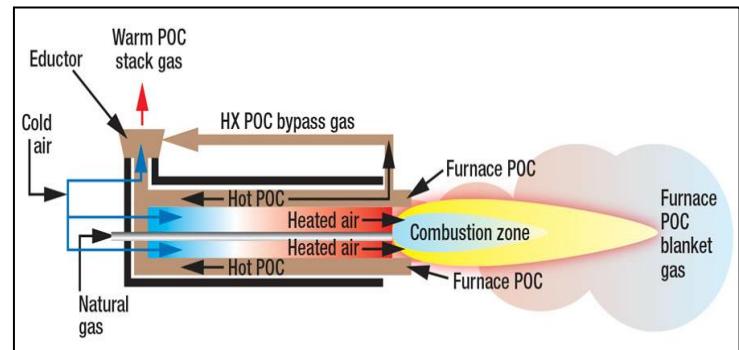


Figure 45: Recuperative burner (Source: Industrial Heating)

Particular	Unit	Values
Energy saving	%	30
Investment cost	INR lakh	10
Simple payback period	years	2

RTE-RTC - Reducing heat losses from oven by providing proper insulation

In most of the units it was observed that the wall surface temperature of oven was between 45 to 70 °C. This increases the heat loss from the surface of the oven. It is recommended to minimize the temperature of the oven surface up to 40°C to reduce the fuel consumption of the oven.

¹⁰⁵ <http://www.sameeksha.org/pdf/clusterprofile/ludhiana-bakeries-Punjab.pdf>

¹⁰⁶ <https://www.ee-metal.com/techniques/recuperative-and-regenerative-burners/>



Figure 46: Thermal images of surface of oven

The baking chamber must be properly insulated for minimising the heat losses from the oven. It is recommended to do relining of combustion zone and surface walls to reduce the heat loss. Reducing surface heat loss will result in significant fuel savings. Relining of combustion zone and surface walls of oven can result in heat loss reduction in the range of 33 – 74%. The associated energy savings and investment details for the cluster are mentioned in the table below.

Table 60: Savings by relining of combustion zone and surface walls of baking oven

Particular	Unit	Values
Reduction in heat losses	%	53
Monetary saving	INR lakh/year	6
Investment cost	INR lakh	1.75
Simple payback period	years	0.3

RTE-RTC – Maintaining air to fuel ratio in oven

During audit it was observed that the oxygen percentage in flue gas from oven was slightly higher and in the range of 7.3 – 8%. For LPG combustion the optimal oxygen level in flue gas is 4 – 5%. The excess air supplied during combustion results in dry flue gas losses.

It is advised to maintain air to fuel ratio for better combustion of fuel. The associated energy savings and investment details are mentioned in the table below.

Table 61: Savings by maintaining air to fuel ratio in oven

Particular	Unit	Values
Reduction in losses	%	1.2%
Monetary saving	INR lakh/year	0.4
Investment cost	INR lakh	0.75
Simple payback period	years	1.7

RTE-RTC - Removal of LPG vaporizer by recovering waste heat from Ovens

The units in the cluster have installed Ovens for meeting the process heat demand. The flue gas exhausted from these Ovens had temperature of around 145 degree Celsius. The flue gas exiting at such high temperature is resulting in heat loss and on the other hand the unit has installed LPG gas Vaporizer to vaporise the LPG which uses electricity.

It is advised to recover waste heat from flue gas of Ovens to Vaporize the LPG so that there will be savings in the electricity used for LPG gas Vaporizer. The associated energy savings and investment details are mentioned in the table below.

Table 62: Savings by recovering waste heat from flue gas of Ovens

Particular	Unit	Values
Energy savings	toe/year	0.9
Monetary saving	INR lakh/year	0.95
Investment cost	INR lakh	1.0
Simple payback period	years	1.1

RTE-RTC - Replacing diesel based ovens by LPG based ovens

The drawbacks with diesel based ovens are that they are inefficient and polluting. Diesel ovens have low productivity which makes it difficult to produce premium products for meeting the demand of niche market. Hence it is recommended to replace the existing diesel fired ovens with energy efficient LPG based rotary ovens. This transition can result in multiple benefits like increased production, production of premium products, improved product quality, reduced energy cost and emissions, improved factory environment, among others. At a cluster level there is a potential of energy savings equivalent to 645 toe and emission reduction of 95 tonne of CO₂.⁶⁵

RTE-RTC – Reduction of the weight of baking fixtures

The products while baking are kept on fixtures with multiple shelves for support. These baking fixtures or racks are manufactured usually using mild steel (MS) angles and plates. These supporting MS racks accounts for around 90% of the total weight of the baking trolley structure. Both the product and trolley structure are heated inside the oven up to a set temperature of 80-250 °C. As it is a batch operation the MS trolley structure which only provides support to the product to be baked also gets heated and cooled alternatively. The weight of the trolley can be reduced by using stainless steel mesh trays in place of supporting plates placed in the middle. There is a potential to reduce the weight up to 20% without the performance of the baking process being affected. Due to reduction in the mass to be heated, this measure can help in saving energy used for baking. There is a potential to reduce energy consumption by 5-10%.¹⁰⁵

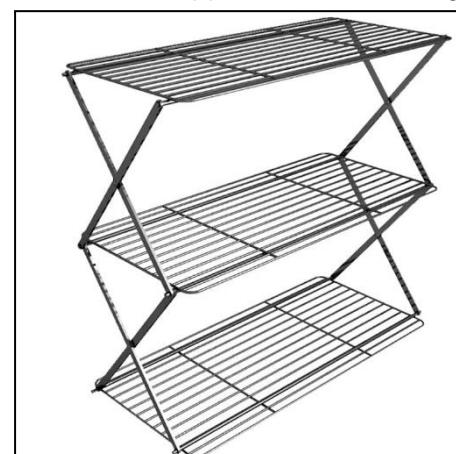


Figure 47: Wire mesh baking fixture

RTE-RTC: Reduce the radiation losses from accumulator pipe



Figure 48: Accumulator pipe

Plant has installed refrigeration system for storing the frozen sweet corn, this system includes arrangement of compressors, condensers, accumulators, evaporators and cooling towers. The temperature measurement of accumulator was done in order to calculate the radiation losses. The surface temperature was observed to be -3 °C on surface which could be minimized to 15 °C.

It is recommended to insulate accumulator piping to reduce the radiation loss. Reducing surface radiation loss results in significant energy savings. The estimated annual energy savings by

recommended measure are given in Table 63. The annual reduction in GHG emission is estimated to be 0.36 tCO₂.

Table 63: Savings from radiation loss from accumulator pipe

Particular	Unit	Values
Reduction in losses	%	82.6
Energy saving	toe/year	0.04
Monetary saving	INR lakh/year	0.04
Investment cost	INR lakh	0.1
Simple payback period	years	2.7

Seafood - Replacement of Ammonia Reciprocating Compressors with VFD based Screw Compressors



The screw compressors with VFD have low specific energy consumption compared to reciprocating compressors resulting in low energy consumption for refrigeration purposes. Reciprocating compressors often face load cut-off issues when the demand fluctuates, whereas screw compressors adapt smoothly to varying loads. They offer the advantage of facilitating gentle startup and shutdown procedures, even when operating at maximum load capacity.

Consequently, it is advisable to consider replacing reciprocating compressors with screw compressors equipped with VFD for enhanced efficiency and load management.

The estimated annual energy savings by recommended measure are given in Table 64. The annual reduction in GHG emission is estimated to be ~300 tCO₂.

Table 64: Replacement of Ammonia Reciprocating Compressors with VFD based Screw Compressors

Particular	Unit	Values
Energy saving	toe/year	34
Monetary saving	INR lakh/year	29
Investment cost	INR lakh	63
Simple payback period	years	2.2

Seafood - Defrosting with the help of hot gas instead of electric heating system in cold storage

In cold storage facilities, the issue of ice formation on the evaporator coil hampers heat transfer and the refrigeration process. Typically, electric heaters rated between 7.5 - 15 kW are used for defrosting, but this method can be time-consuming. An efficient alternative is the hot gas defrosting approach, where hot gas is diverted from the compressor to defrost the coil before it reaches the condenser. This significantly reduces defrosting time, leading to a notable increase in production rates within the cold storage facility.

It is recommended to defrost with the help of hot gas instead of an electric heating system in cold storages. The estimated annual energy savings by recommended measure are given in Table 65. The annual reduction in GHG emission is estimated to be ~2.7 tCO₂.

Table 65: Defrosting with the help of hot gas in cold storages

Particular	Unit	Values
Energy savings	toe/year	0.3
Monetary saving	INR lakh/year	0.35
Investment cost	INR lakh	0.5
Simple payback period	years	1.4

Seafood - Installation of FRP blades at evaporative side FCUs in cold storage and blast storage

The plants have installed a refrigeration system for processing and supplying marine products. The present specific power consumption per tonne of refrigeration is 1.8 – 3.0 kW/TR in air cooled refrigeration, 1.4 – 2.7 kW/TR in water-cooled chiller, and 2.7 – 3.7 in the evaporative condenser which is slightly above than the standard value for the refrigeration systems.

It is recommended to install FRP blades at the evaporative side of FCUs in cold storages and blast storages for improving the performance of the refrigeration system. The technological advantages for adoption of FRP blades fans are

- Maximum fan performance with maximum air flow with minimum power consumption.
- Light-weighted components including fan blades and impeller leading to less torque requirement on the drive.
- Improved fan efficiency by incorporating aero foil design to maximize airflow and lesser number of blades. Higher service life, lower noise, non-corrosive and less maintenance.



The estimated annual energy savings by recommended measure are given in Table 66. The annual reduction in GHG emission is estimated to be 37 tCO₂.

Table 66: Installing FRP blades fans at evaporator side FCU

Particular	Unit	Values
Energy savings	toe/year	4
Monetary saving	INR lakh/year	3.5

Particular	Unit	Values
Investment cost @5000 Rs/Fan	INR lakh	2.1
Simple payback period	years	0.6

RTE-RTC and Seafood: Installation of air curtains to reduce the heat loss during air infiltration

The plants have installed a refrigeration system for making ice and freeze fruits, sweet corn and seafood products. This system includes an arrangement of compressors, condensers, evaporators, evaporative condensers, and cooling towers. The plants have installed chilling units, cold storages, and blast storages, IQF, tunnel freezer, flake ice machine, tube ice machine, chill rooms, plate freezer, and a spiral freezer which uses reciprocating compressors for water cooled system and air cooled outdoor unit. Infiltration needs to be taken into consideration as it adds 1-10% to the cooling load. This occurs when the door opens resulting in a transfer of heat into the space through the air. The other consideration is ventilation. The products stored give off carbon dioxide so some stores will require a ventilation fan. This air needs to be cooled down, so it is required to account for this if it's used.

It is recommended to install air curtains to reduce the heat loss. Reducing heat loss results in significant energy savings. The estimated annual energy savings by this recommended measure are given Table 67. The annual reduction in GHG emission is estimated to be ~34 tCO₂.

Table 67: Installation of air curtains to cease heat loss by infiltration of air

Particular	Unit	Values
Energy savings	toe/year	3.5
Monetary saving	INR lakh/year	3.25
Investment cost	INR lakh	0.65
Simple payback period	years	0.2

RTE-RTC and Seafood: Installation of automatic ON-OFF controls for evaporator FCU temperature

Various plants have installed a refrigeration system for making ice and freeze fruits, vegetables and seafood. This system includes an arrangement of compressors, condensers, evaporators, evaporative condensers, and cooling towers. The plants have installed cold rooms, blast rooms, IQF, tunnel freezer, flake ice machine, tube ice machine, chill rooms, plate freezer, and a spiral freezer which uses reciprocating compressors for water cooled system and air cooled outdoor unit. In each cold room, two fans (FCUs) are installed for cooling purposes. Even after temperature is attained, the fans continue to run. It has a share of nearly 10% of the total cooling load. The duration that these fans operate need to be taken into consideration. For that purpose, the automatic ON-OFF control is required to shut down the fans based on the temperature achieved with respect to time.

This results in reasonable energy savings with minimal investment and good payback. The estimated annual energy savings by this recommended measure are given in Table 68. The annual reduction in GHG emission is estimated to be ~46 tCO₂.

Table 68 Installation of ON-OFF control for evaporator FCUs

Particular	Unit	Values
Energy savings	toe/year	4.8

Particular	Unit	Values
Monetary saving	INR lakh/year	4.4
Investment cost	INR lakh	3.5
Simple payback period	years	0.8

RTE-RTC and Seafood: Improve performance of refrigeration system by cleaning condenser tubes

The plants have installed a refrigeration system for processing and supplying marine and RTC products. This system includes an arrangement of condensers, compressors, and cold storage. The present power consumption per tonne of refrigeration is 1.4 – 3.7 kW/TR for water cooled refrigeration system and 2.2 - 3.2 kW/TR for air cooled refrigeration system which is a bit more than the standard values.

It is recommended to clean the condenser tube. Cleaning the condenser tube results in improving the performance of the refrigeration system. The estimated annual energy savings by recommended measure are Table 69. The annual reduction in GHG emission is estimated to be 4.8 – 202 tCO₂.

Table 69 Cleaning condenser tubes

Particular	Unit	Values
Energy savings	toe/year	11.0
Monetary saving	INR lakh/year	9.3
Investment cost	INR lakh	8.0
Simple payback period	years	0.9

Rice / RTE-RTC / Seafood: Installation of IoT based energy monitoring system

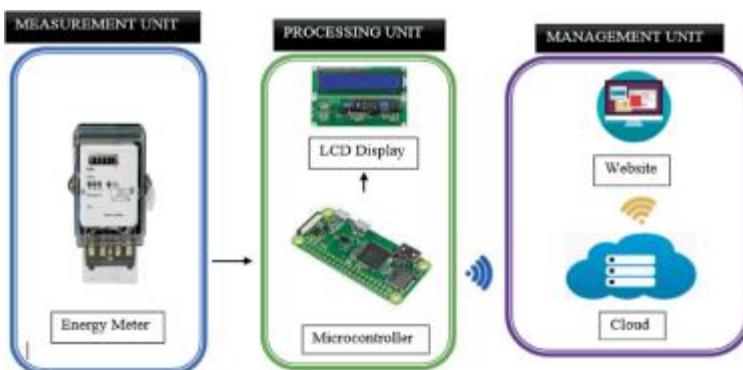


Figure 49: Illustrative schematics of IoT based EMS system

Presently plants have multiple energy meters installed in the different areas for the major loads. Manual energy monitoring and then analyzing the monitored data is a difficult task due to errors involved and monitoring of limited parameters. It is advised to implement internet of things (IoT) based i.e., cloud-based energy monitoring system which

will enable to record the energy consumption of different areas. The energy parameters like active power

(kW), voltage, current (Amps), demand (kVA) and energy (kWh) will be measured and recorded directly on the internet database from where it will be accessible through internet connection anytime and anywhere. These parameters can provide the clarity on the specific actions to be taken for energy efficiency.

Advanced EMS can provide losses calculation as well as alerts and notifications if losses starts occurring which can save significant energy and costs and plant can stay on top its consumption. IoT based EMS system can provide savings of 1 – 1.5% on total electricity consumption. The associated energy savings are given below.

Advanced EMS can provide losses calculation as well as alerts and notifications if losses start occurring. This can save significant energy and costs enabling the plant to stay on top of its consumption. The estimated energy savings by recommended measure are given in Table 70.

Table 70: Advanced Energy Management system

Particular	Unit	Values
Proposed reduction in electricity consumption of unit	%	1%
Energy savings	toe/year	3.2
Monetary saving	INR lakh/year	2.7
Investment cost	INR lakh	2.7
Simple payback period	years	1.0

Rice / RTE-RTC / Seafood: Boiler - Reduce the heat losses from the Boiler and Daeerator by relining of surface wall and doors of combustion zone and deaerator

Steam is required in dryers for removing the rice hull or chilka in rice mills, heating applications in RTE/RTC and seafood processing units. The steam is produced by burning fuel (e.g., rice husk, wood, LDO, etc.) in boiler. However, thermal imaging of the boiler combustion zone and deaerator were done in the cluster, and it was found that the surface temperature was high in the range of 60 – 180 °C on the doors while it was in the range of 50 - 100 °C on the surface walls in some units.

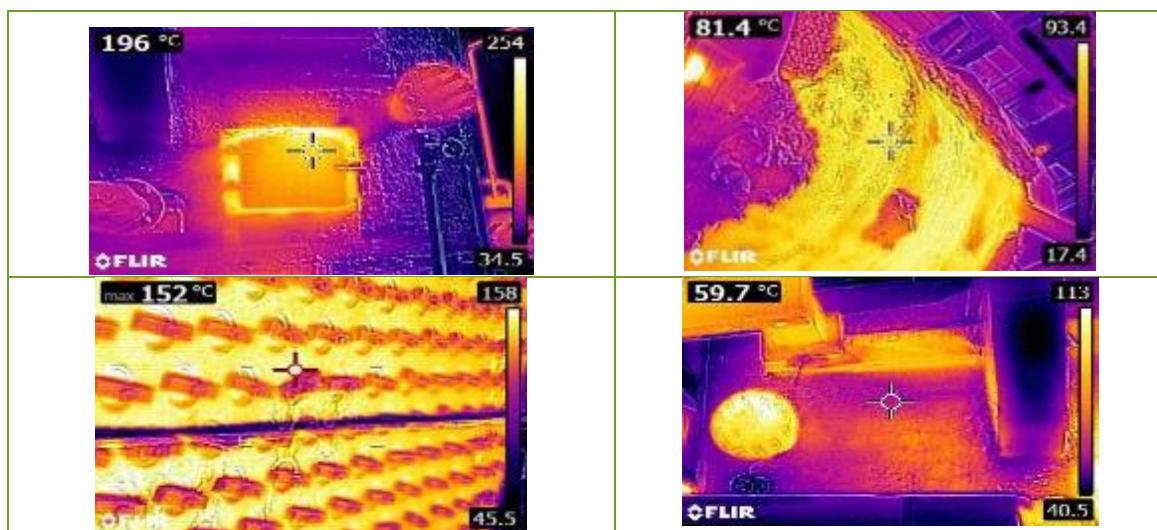
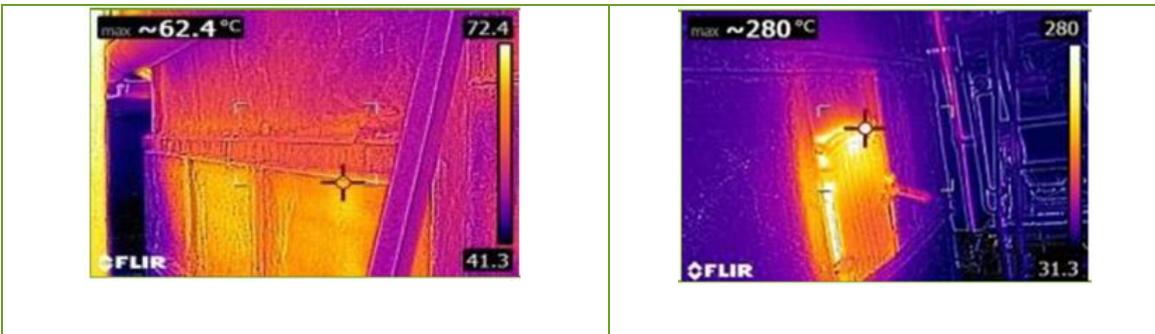


Figure 50: Illustrative hot zones where relining is required



It is recommended to do relining of combustion zone and deaerator surface walls to reduce the heat loss. It was observed that relining can lead to reduction in heat losses by ~55%. The associated energy and monetary savings for the cluster are given below.

Table 71: Savings by reducing heat loss by relining doors and surface walls

Parameters	Unit (-)	Values
Estimated heat losses reduced	%	55%
Annual Energy Savings	TOE/annum	8.5
Annual monetary savings	(Lakh Rs. /year)	1.9
Total investment cost	(Lakh Rs.)	1.8
Payback period	(Year)	0.9

Rice / RTE-RTC / Seafood: Boiler - Reduce the heat loss from condensate return line by providing insulation to line

The units in food processing clusters have steam lines running from boiler outlet to process and condensate recovery line running from a small collector to boiler feed pump. It was observed that the condensate recovery pipeline in most mills was observed to be without insulation. The boiler feed water temperature was measured below 80 °C which is extremely low indicating that high heat losses are continuously taking place on the condensate line.



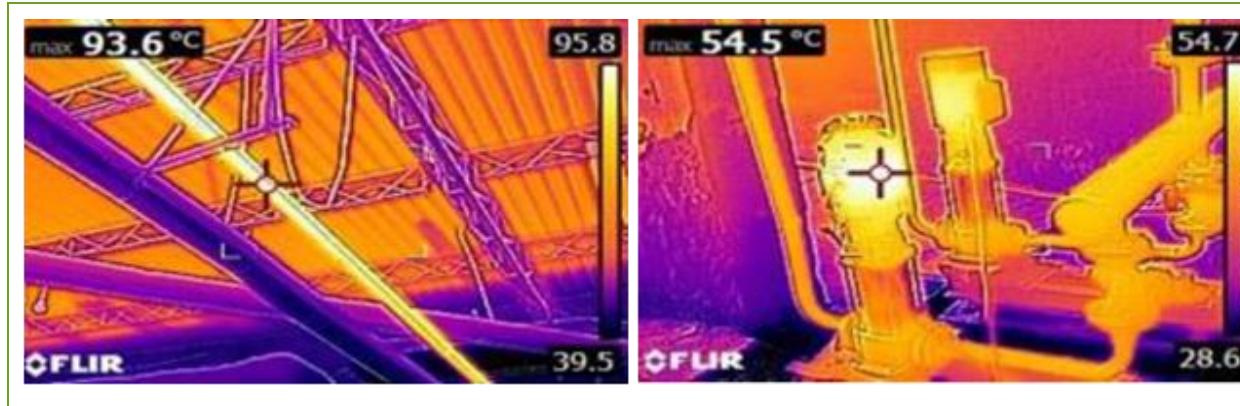


Figure 51: Illustrative hot zones where insulation is required

It is advised to apply insulation on the condensate line to avoid the heat loss so that the high temperature of condensate will be maintained till the feed water to boiler. It was observed that relining of combustion zone and deaerator surface walls in the mills can lead to reduction in heat losses of about 63%. The associated energy and monetary savings for the cluster are given below.

Table 72: Savings by reducing heat loss from condensate pipeline

Parameters	Unit (-)	Values
Estimated heat losses reduced	%	50%
Annual Energy Savings	TOE/annum	6.3
Annual monetary savings	(Lakh Rs. /year)	1.3
Total investment cost	(Lakh Rs.)	1.2
Payback period	(Year)	0.9

Rice: Boiler – Economizer for boiler

Most rice mills uses three-pass rice husk fired boilers generally without any waste heat recovery system. The flue gas exiting the boilers have high temperatures to the tune of 150°C or more, which carries heat out to the atmosphere.

It is recommended to install an economizer in the boiler which will utilize the waste heat flue gases and use it in preheating of feed water. The feed water can be preheated from normal 40°C to nearly 60°C or above temperature, depending on waste heat content available.

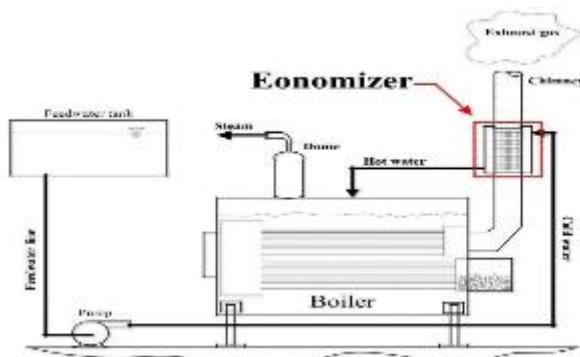


Figure 52: Schematic of boiler Economizer

This would result in fuel savings of around 7%. The associated monetary savings and payback are given below.

Table 73: Economizer for a 3 TPH boiler

Particular	Unit	Values
Fuel savings	%	7%
Monetary saving	INR lakh/year	1.4
Investment cost	INR lakh	3
Simple payback period	years	2.1

Rice: Boiler – Optimization of air supply and reduction of unburnts

A majority of boilers in rice mills are not equipped with control system to regulate combustion air supply with respect to husk feed rates. It is normal that the level of unburns in bottom ash are quite high in rice mills. It is common in rice mill units that black smoke is observed in flue gases. These indicate that optimum level of excess air is not maintained or/and proper mixing of combustion air with husk is not taking place.

It is suggested that rice mills in the cluster install auto/semi-auto control systems for optimizing air supply with respect to husk feed in boiler. By optimization and ensuring complete combustion, formation of unburns can be reduced to a large extent. Further, the units must also undertake periodical monitoring/testing of flue gases to check the level of excess air supplied to boiler. Fuel savings of 5% are expected from this measure.

Table 74: Optimization of air supply and reduction of unburns

Particular	Unit	Values
Fuel savings	%	5%
Monetary saving	INR lakh/year	2.2
Investment cost	INR lakh	0.7
Simple payback period	years	0.3

Rice: Boiler – Replacement of old boilers with energy efficient boilers

Most boilers in rice mills are old and inefficient. The typical efficiencies of old boilers in rice mills ranges from 40-65%. The low efficiency is due to low loading, inferior design, old boilers, structural and scale losses etc.

All inefficient existing boilers having 65% of boiler efficiency in parboiled rice mills are suggested to implement the energy efficient boilers to attain the maximum energy savings. By replacing the energy efficient boiler typical parboiled rice mill with capacity of 4TPH will save conservation potential 215 kg/hr fuel i.e., rice husk.

Table 75: Replacement of old boiler with EE boiler (4 TPH)

Particular	Unit	Values
Existing efficiency	%	65%
Proposed efficiency	%	80%
Fuel savings	Kg/hr	215
Monetary saving	INR lakh/year	1.2
Investment cost	INR lakh	5.0
Simple payback period	years	4.1

RTE-RTC: Thermopac - Optimization of Excess air in Thermopac

Some units in the cluster use Thermic Fluid Heater wherein the oil is heated and is further supplied to the processes where heat is required. During the flue gas analysis, the oxygen was measured to be 11.6% against the recommended level of 4.5%. This excess air which was supplied during combustion was resulting in dry flue gas losses in the boiler.

Hence it is recommended to fine tune the burner of Thermic Fluid Heater to minimise these dry flue gas losses. The dry flue gas losses can be reduced by 3 – 4%. The associated energy savings and investment details are mentioned in the table below.

Table 76: Savings by optimization of excess air in Thermopac

Particular	Unit	Values
Energy savings (LPG)	kg/year	~6000
Monetary saving	INR lakh/year	6.5
Investment cost	INR lakh	2.5
Simple payback period	years	0.4

RTE-RTC: Thermopac - Waste heat recovery from Thermopac to replace LPG vaporizer

Some units in the cluster have installed Thermopac for meeting the process heat demand. The flue gas exhausted from thermopac had temperature of around 239 degree Celsius. The flue gas exiting at such high temperature is resulting in heat loss and on the other hand the unit has installed LPG gas Vaporizer to vaporise the LPG which uses electricity.

It is advised to recover heat from flue gas of Thermopac to Vaporize the LPG so that there will be savings in the electricity used for LPG gas Vaporizer. The associated energy savings and investment details are mentioned in the table below.

Table 77: Savings by recovering waste heat from Thermopac

Particular	Unit	Values
Electricity savings	kWh/year	39,060
Monetary saving	INR lakh/year	3.06
Investment cost	INR lakh	2.0
Simple payback period	years	0.7

RTE-RTC: Thermopac - Reduce the heat loss from the Thermopac surface by relining of surface walls and doors of combustion zone

Some units in the cluster have installed Thermopac for meeting the process heat demand. During audit, the thermal imaging was done for the surface walls and door of the combustion zone of the Thermopac. The surface temperature of the walls and door of the Thermopac was measured to be high resulting in huge heat losses.

It is recommended to do relining of the Thermopac surfaces for reducing the heat losses. The associated energy savings and investment details are mentioned below.

Table 78: Savings by reducing heat losses from Thermopac surfaces

Particular	Unit	Values
Reduction in heat losses	%	69%
Energy savings	toe/year	10.72
Monetary saving	INR lakh/year	2.1
Investment cost	INR lakh	1.0
Simple payback period	years	0.5

RTE-RTC: Thermopac - Reduce the heat losses from the reserve oil tanks by providing insulation

The units in food processing clusters use Thermopac for heating purpose. These Thermopacs were associated with Reserve Oil Tanks from which the hot return oil was circulated. But these oil tanks are uninsulated causing the heat losses from the oil tank's surface.

It is recommended to install ceramic insulation on these tanks to minimize the heat losses from the surface of these tanks. The surface temperature of the oil tanks was measured to be more than 110 degree Celsius and average temperature value was more than 110 degree Celsius.

Table 79: Savings by reducing heat losses from Reserve Oil Tanks

Particular	Unit	Values
Reduction in heat losses	%	87%
Energy savings	toe/year	1.15
Monetary saving	INR lakh/year	0.2
Investment cost	INR lakh	0.3
Simple payback period	years	1.1

RTE-RTC: Electric heater - Reducing heat losses from electric heater by providing proper insulation

Few units in food processing clusters have installed electric heater for meeting the process heat demand. During audit it was observed that the wall surface temperature of these heaters was in the

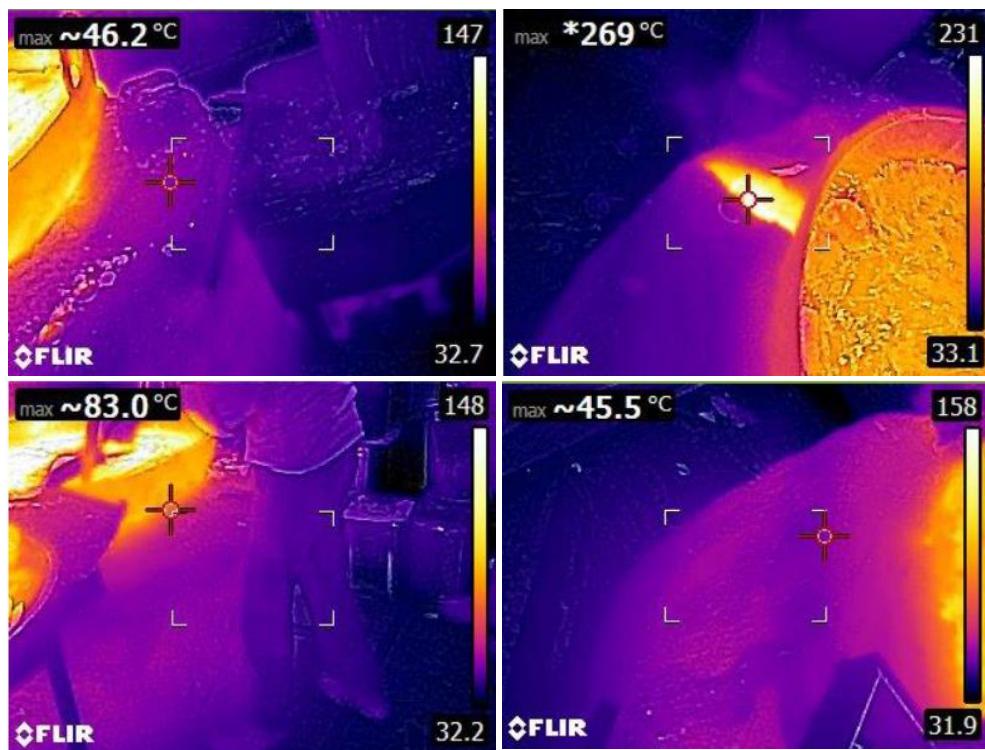


Figure 53: Thermal images of surface of Electric Heater

range of 45 – 60 °C. which is extremely high.

It is recommended to reduce heat losses from wall of the heater by properly insulating the heater surfaces. This will reduce the fuel consumption of the heater.

Table 80: Savings by reducing heat losses from electric heater

Particular	Unit	Values
Reduction in heat losses	%	66%
Energy savings	toe/year	0.21
Monetary saving	INR lakh/year	0.18
Investment cost	INR lakh	0.4
Simple payback period	years	2.3

RTE-RTC: Diesel heater - Reducing heat losses from diesel heater by providing proper insulation

Few units in food processing clusters have installed diesel fired heater for meeting process heat demand. During audit it was observed that the wall surface temperature of these heaters was in the range of 45 – 55 °C which is extremely high.

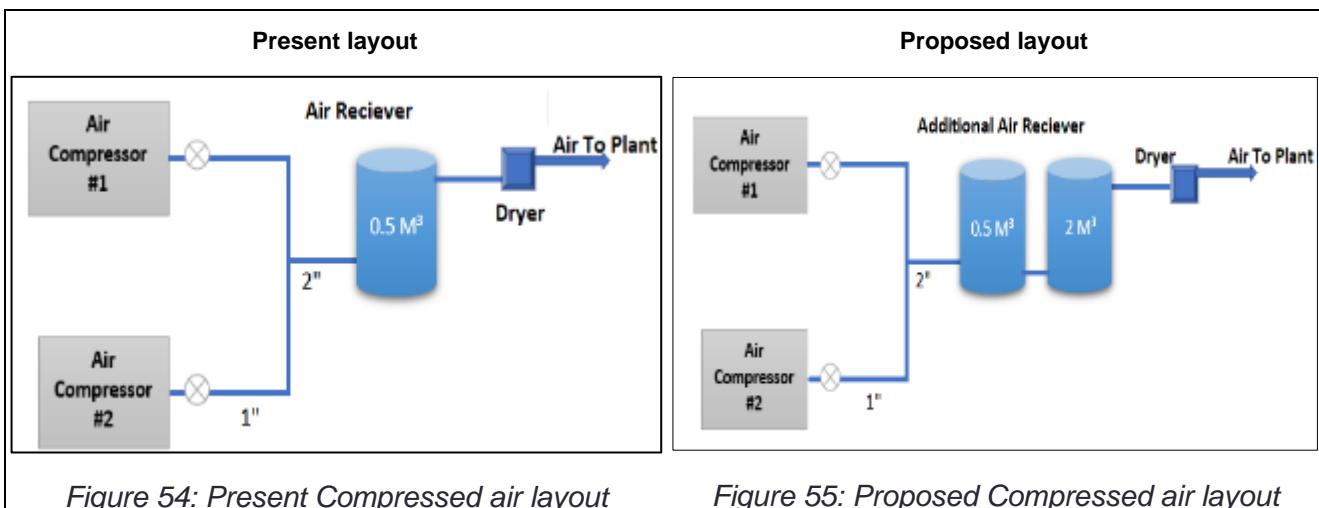
It is advised to apply insulation to surface of heater to avoid heat loss so that it will run at optimized efficiency.

Table 81: Savings by reducing heat losses from diesel heater

Particular	Unit	Values
Reduction in heat losses	%	64%
Energy savings	toe/year	0.19
Monetary saving	INR lakh/year	0.16
Investment cost	INR lakh	0.4
Simple payback period	years	2.5

Rice: Compressed air system - Installation of additional receiver as a buffer for compressed air system

It was observed that in majority of the units, the receiver installed for compressed air was not sufficient. This increased the loading of the compressors causing higher power consumption. It is recommended to install the extra receiver (2 m³ or 3 m³, depending on unit) on the shop floor to minimize the loadings of the compressors. The additional buffer receiver will decrease the power consumption.



This measure will result in energy savings of 5% with reduction in electricity consumption for the air compressors. The associated energy savings for this measure are given below.

Table 82: Installation of additional receiver for machine shop

Particular	Unit	Values
Proposed reduction in electricity consumption	%	5%
Energy savings	TOE/year	0.9
Monetary saving	INR lakh/year	0.8
Investment cost	INR lakh	0.8
Simple payback period	years	1.0

Rice / Seafood: Compressed air system - Installation of VFD for existing air compressor to reduce unload power consumption

Presently plants have installed air compressors to meet plant compressed air requirement. The loading of compressors in the plants varies greatly within a range of 40-85%, which increases the power consumption of the air compressors. It is recommended to install VFD to minimize unload power consumption of air compressor.

This measure will result in energy savings of ~35% with reduction in electricity consumption for the air compressors. The associated energy savings for this measure are given below.



Figure 56: VFD for compressors

Table 83: Installation of VFD for existing air compressor

Particular	Unit	Values
Proposed reduction in electricity consumption	%	35%
Energy savings	toe/year	3.9
Monetary saving	INR lakh/year	3.8
Investment cost	INR lakh	6.1
Simple payback period	years	1.6

RTE-RTC: Compressed air system - Decrease compressor pressure as per requirement

During the field study, it was observed that plant has installed air compressors for the compressed air requirement of the unit and has its self-mounted receiver. Compressed air from these air compressors is used for pneumatic utilities and as service air to whole shop. However, in few units it was observed that the supply pressure was more than the pressure actually required. It was observed that the load and unload pressure settings of the compressors were extremely high. Also, in few units zigzag piping was used after compressor for compressed air supply to the whole plant. This was leading to extra loading of the compressors.

It is recommended to optimise the compressor pressure as per the unit's requirement. This will result in reduced energy consumption by the compressor. The associated energy savings and investment details are mentioned below.

Table 84: Savings by reducing the compressor pressure

Particular	Unit	Values
Electricity savings	kWh/year	1900

Particular	Unit	Values
Monetary saving	INR lakh/year	0.2
Investment cost	INR lakh	Nil
Simple payback period	years	-

RTE-RTC: Compressed air system - Replacement of old reciprocating air compressor with new VSD based screw air compressor with proper piping

During the study it was observed that presently few units are using reciprocating air compressor for operations. Also, few of the units are using zigzag piping after compressor for compressed air supply to the whole plant. This leads to extra loading of the compressors.



Figure 57: Piping after compressor

The associated energy savings and investment details are mentioned in the table below.

Table 85: Savings by replacement of old inefficient compressor with new EE VSD compressor

Particular	Unit	Values
Electricity savings	kWh/year	11,115
Monetary saving	INR lakh/year	0.94
Investment cost	INR lakh	5.0
Simple payback period	years	5.3

Rice: Blower and Fan - Conversion of existing flat V belt to direct driven for ID fan and dryer blowers

Presently units in rice mill clusters have installed ID fans for boilers and dryers. It was observed during audits that, ID fan and dryer blower motors are belt pulley and driven using flat v belt with pulleys. Generally, both these applications runs continuously. It presents a disadvantage with belt drives with high slippage, high maintenance and increased consumption due to losses in transmission.

It is recommended to replace belt drives with direct driven system which will increase the efficiency and will reduce the energy consumption along with auxiliary benefit of high maintenance cost. This measure will result in energy savings of 8% with reduction in electricity consumption for the ID fans of dryers and blowers. The associated energy savings for this measure are given below.

Table 86: Direct drives for fans and dryer blowers

Particular	Unit	Values
Proposed reduction in electricity consumption	%	8%
Energy savings	toe/year	2.0
Monetary saving	INR lakh/year	1.9
Investment cost	INR lakh	3.1
Simple payback period	years	1.6

Rice / RTE-RTC / Seafood: Motors - Replacement of existing old inefficient motors with energy efficient IE4 motors

During the audit study it has been observed that the food processing units have some IE1 or IE2 standard motors in operation for applications like destoner, separators, pumps, ID fan, FD fan, chiller, blower, mixing motor etc. in the plant etc. IE1 standard motors are now being phased out slowly due to its lesser efficiency operation. IE4 standard motors are more efficient with better copper used and better insulation material used in its manufacturing increasing the overall efficiency. This also gives longer life and durability to motors.

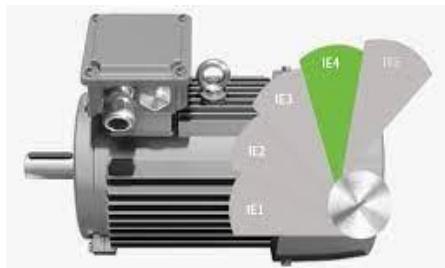


Figure 58: IE4 motor

It is recommended to replace existing old motors with new EE motors of IE4 standards. There is potential for the significant energy savings by using new EE motors, to the tune of 5-8% reduction in power consumption. The associated energy savings from this measure are given below.

Table 87: Adoption of IE4 motors

Particular	Unit	Values
Proposed reduction in electricity consumption	%	5 – 8 %
Energy savings	toe/year	0.1 – 15.0
Monetary saving	INR lakh/year	0.1 – 12.5
Investment cost	INR lakh	0.4 – 27.2
Simple payback period	years	0.9 – 5.3

RTE-RTC: Motors - Conversion of existing flat V belt to direct drive for motors

Presently units in food processing clusters have installed motor for applications like ID fan, FD fan, feed water pump, ETP blower, mixer, ball cutter, among others. It was observed during audit that all the motor and fan motors are of belt pulley type and driven using flat V belt with pulleys. Both these applications are running continuously. The disadvantage with belt drives are the high slippage, high maintenance and increased consumption due to losses in transmission.

It is recommended to replace belt drives with direct driven system which will increase the efficiency and will reduce the energy consumption along with auxiliary benefit of high maintenance cost. The associated energy savings for this measure are given below.

Table 88: Direct drives for fan and pump motors

Particular	Unit	Values
Proposed reduction in electricity consumption	%	8%
Energy savings	toe/year	0.9

Particular	Unit	Values
Monetary saving	INR lakh/year	0.3
Investment cost	INR lakh	0.9
Simple payback period	years	3.0

Seafood: Motors - Conversion of existing flat V belt to cogged v-belt driven motor

Presently, the plants have installed reciprocating compressors and are driven using flat v belt with pulleys. It was observed during the audit that, motors are belt pulley driven. Both these applications are running continuously. The disadvantage with belt drives are the high slippage, high maintenance and increased consumption due to losses in transmission. It is recommended to replace belt drives with cogged v belt system which will increase the efficiency and will reduce the energy consumption along with auxiliary benefit of low maintenance cost.

The estimated annual energy savings for motor is 2.0 – 23.2 toe/year equivalent to a monetary saving of Rs. 1.8 – 19.4 lakh per year. The investment requirement is Rupees 4.0 – 48.0 lakh with a simple payback period of 0.6 – 2.5 years. The corresponding reductions of GHG emissions are estimated to be 18.4 – 218.3 tCO₂ per year.

Table 89: Conversion of existing flat V belt to cogged V-belt system

Particular	Unit	Values
Energy savings	toe/year	12.6
Monetary saving	INR lakh/year	10.6
Investment cost	INR lakh	26
Simple payback period	years	2.5

Rice: Hot air generator for paddy drying

Rice mills use steam-based dryer system for drying of steamed paddy before milling process. Dryers are generally operated continuously, and estimates have shown that about 80% of steam is used in dryers. Use of steam for generation of hot air in heat exchangers is an inefficient process.

Hot air can be directly generated in husk fired hot air generators (HAG) with heat exchangers that would help in improving overall efficiency of dryer system. It is envisaged that 28–30% of husk can be saved with HAG system. By eliminating use of steam for paddy drying, steam load of the plant will come down substantially. The plant would require boiler size of up to 1 tph to meet steam demands for parboiling purpose only. The associated monetary savings and payback are given below.



Figure 59: Hot air generator

Table 90: Hot air generator for paddy drying

Particular	Unit	Values
Fuel savings	%	28%
Monetary saving	INR lakh/year	5.0
Investment cost	INR lakh	5.5
Simple payback period	years	1.1

Rice: Solar Water Heater

Both small and medium rice mills in the cluster provide significant scope for adoption of solar water heaters that can be used for generation of hot water at about 60–70°C. Hot water is required in soaking of paddy in steam bowls. Apart from soaking process, the hot water can also be used as boiler feedwater that would help in fuel saving.

Table 91: Solar water heater energy savings for a typical mill

Particular	Unit	Values
Monetary saving	INR lakh/year	0.15
Investment cost	INR lakh	0.35
Simple payback period	years	2.3

Rice: Biomass gasifiers for power generation

The excess rice husk after steam generation in boilers can further be used in biomass gasifiers for power generation. By improving the efficiency of steam generation and distribution system, the availability of rice husk in the mill can be optimized. This rice husk is used to generate producer gas, which is rich in carbon monoxide (CO) and hydrogen (H₂). This gas can be effectively utilized in internal combustion (IC) engines to replace completely/ partially diesel used for power generation. Thus, the high-pressure steam circuit along with steam turbine can be avoided in this mode.

The option of power generation would help in utilizing husk effectively instead of selling the same at lower costs. In a medium size rice mill, close to 330 tonne per year of husk may be available that includes savings with adoption of energy efficiency measures. The estimated capacity of biomass gasifier for such a mill is 30 kW. This measure would generate electricity and reduce costs by ~60% in comparison to diesel generators.

Table 92: Biomass gasifiers for power generation in a medium mill

Particular	Unit	Values
Husk available for power generation	tonnes per year	330
Proposed capacity of gasifier	kW	30
Estimated power generation	kWh/day	500
Monetary saving	INR lakh/year	~5
Investment cost	INR lakh	3.9
Simple payback period	years	0.8

RTE-RTC: Biogas Generation

During audit it was observed that few units generate food waste on a daily basis from their canteen. Considering 11 Kg (subject to vary depending on the unit) of daily food waste generation, the



Figure 60: Biogas generation plant

annual food wastage would be 56.21 tonne. If the unit utilises that food waste for biogas generation, it will replace huge quantity of LPG used for cooking the food. The household biogas plant is shown in Figure 60.

Table 93: Savings by biogas generation

Particular	Unit	Values
Energy savings	toe/year	0.2
Monetary saving	INR lakh/year	10.8
Investment cost	INR lakh	1.19
Simple payback period	years	0.11

RTE-RTC: Replacement of ETP pumps with new EE pumps

During audit, the performance evaluation of the pumps was carried out and it was observed that the efficiency of the pump was in the range of 27.8 - 34.5% which is on the lower side than the design value.

It is hence recommended to replace the inefficient ETP pumps in the units with EE pumps. The associated energy savings and investment details are mentioned in the table below.

Table 94: Savings by replacing inefficient ETP pumps with EE pumps

Particular	Unit	Values
Electricity savings	kWh/year	1,796 - 2,759
Monetary saving	INR lakh/year	0.10 – 0.16
Investment cost	INR lakh	0.3
Simple payback period	years	1.6 – 2.4

Appliances - Replacement of fluorescent Tubes with LED tubes

During the field study, it was observed that the units have installed fluorescent tubes of 60 watt power. It is suggested to use LED tubes of 25 watts instead. LED tube lighting is the better choice because it lasts about 40,000 hours longer in testing, is more energy efficient, will save the unit more money, and will leave less impact on the environment.

The associated energy savings and investment details are mentioned in the table below.

Table 95: Savings by replacing fluorescent tubes with LED tubes

Particular	Unit	Values
Energy savings	%	58%
Monetary savings per tube	INR/year	650
Investment required per tube	INR	300
Simple payback period	Years	0.5

Appliances - Replacement of traditional fans with BLDC fans

During the field study, it was observed that the units have installed traditional fans of rating 60 watts. It is suggested to use BLDC fans of 30 watts instead. BLDC motor comprises of permanent magnet for steering the motor which uses significantly less power with no loss of heat. BLDC motor fans do not use commutators and brushes and hence there is no mechanical wear and tear. The winding failure is also minimised due to thick copper wiring. Hence the maintenance charges for the fans are also less. The associated energy savings and investment details are mentioned in the table below.

Table 96: Savings by using BLDC fans

Particular	Unit	Values
Energy savings	%	50%
Monetary savings per fan	INR/year	550
Investment required per fan	INR	3000
Simple payback period	Years	4.5

Appliances - Use high efficiency air conditioner

During the field study, it was observed that the units have installed air conditioners of capacity around 6600 watt and ISEER rating of around 3.7. High-efficiency systems with higher SEER ratings use less energy, which translates to less money spent on energy bills. In fact, switching from an old 3.7 SEER unit to a 4.5 SEER unit can help units in achieving savings on their energy bills. The associated energy savings and investment details are mentioned below.

Table 97: Savings by using energy efficient air conditioner

Particular	Unit	Values
Energy savings	%	17%
Monetary savings per AC	INR/year	3541
Investment required per AC	INR	45,000
Simple payback period	Years	12.7

Rice / RTE-RTC / Seafood: Rooftop Solar

Installation of solar PV on the rooftops is being taken up by industrial and commercial consumers in the past few years due to reducing cost of solar panels. The rooftop solar PV can reduce the electricity cost of the consumer and help them in decarbonizing their energy demand. Rooftop solar also offers flexibility to sell the excess power to the grid for additional revenue for the units. However, there are several challenges associated with installation of rooftop solar:

- Space availability: For installation of solar panels, the MSME should have sufficient rooftop space available. Furthermore, the installation should be on a strong and stable structure which requires roof to have sufficient load bearing capacity. The efficiency of solar PV ranges between 15-22% depending upon the type of PV module. A list of average solar irradiance along with estimated annual power generation is provided in the table below.
- Regular Cleaning: Due to various processes in the rice and dust in the cluster, the solar panels are susceptible to acquiring dust which can reduce their performance significantly. The degradation of output with dust is shown in the adjacent figure.
- Higher level of vibration in the certain processing areas can failure of the solar modules, thus hampering the long-term energy generation, hence panel should be installed with dampers or away from the vibrating trusses.
- Hence, regular cleaning and maintenance of solar panels is required which may lead to additional cost.

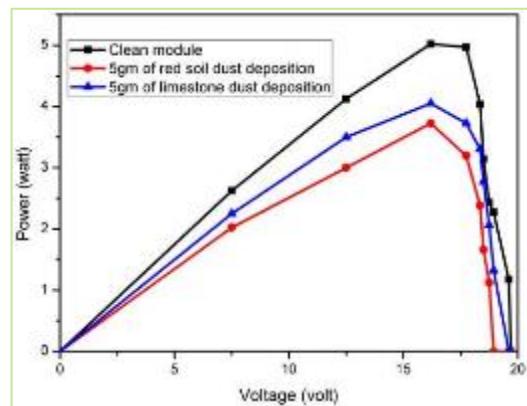


Figure 61: PV diagram of Solar PV system

- Policy challenges: The net metering policies are not favorable in many states and the sale of power to distribution company may not lead to significant revenue for the unit.

State of the Art Technologies in Food Processing

Rice: AI Paddy Dryer¹⁰⁷

The rice mill industry faces challenges with respect to the paddy drying such as unevenness of moisture content, unchangeable hot air temperature, and loss of quality and yield. The Artificial Intelligence based dryers automatically controls the hot air, circulation speed and air volume. Due to this the internal cracking of kernel is eliminated. The Grain Temperature Sensor measures the grain temperature all the time and adjusts the temperature of hot air for quality control of rice. Additionally, the Inverter controls the blower automatically based on the input capacity and moisture level for optimizing the air volume for drying the grain. The Humidity sensor measures the external humidity continuously and automatically controls the heat output from the burner such as the heat output is increased in high humidity conditions and decreased in low humidity conditions. The Moisture sensor measures the moisture level in the grain. The Multiple sensors and the Inverter in AI based dryers result in quality control of the rice grains and reduced energy consumption.

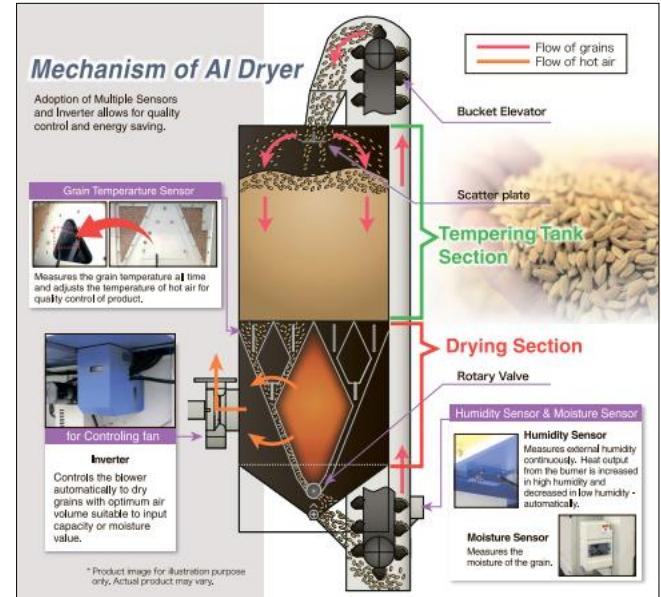


Figure 62: Operating mechanism of AI based paddy dryers

Features

- Reduced cracks and uniform quality resulting in higher yield
- Quick and effective drying
- Energy and heat source saving

Case Study¹⁰⁸

In Malaysia companies including Kilang Beras Mihoda Sdn. Bhd., Kilang Beras Rakyat Sekinchan Sdn. Bhd, Kilang Padi Berkat Jaya Sdn Bhd, Konsortium Kilang Padi PP Terengganu Sdn. Bhd., Mutiara Timur Rice Mill Sdn. Bhd. have installed Advanced Paddy Drying Automation System with features like optimized AI drying, PID based remote temperature control, grain moisture content prediction, powerful cloud system, and big data analysis.

Table 98: Cost benefit analysis of AI paddy dryer

Particular	Unit	Values
Energy savings	%	8%
Simple payback period	years	4

¹⁰⁷ <https://satake-group.com/products/uploads/79301-NSDR30C.pdf>

¹⁰⁸ <https://www.tanand.com.my/service/advanced-paddy-drying-apd-automation-system/>

Rice: Water Recycle System¹⁰⁹

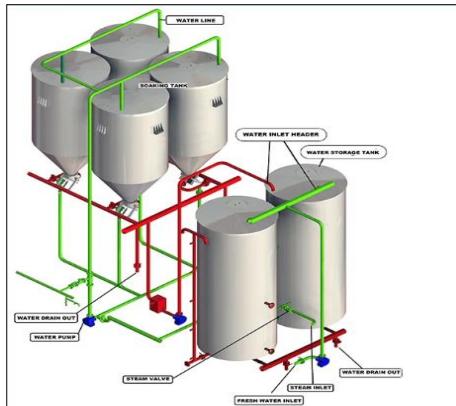


Figure 63: Water recycling system

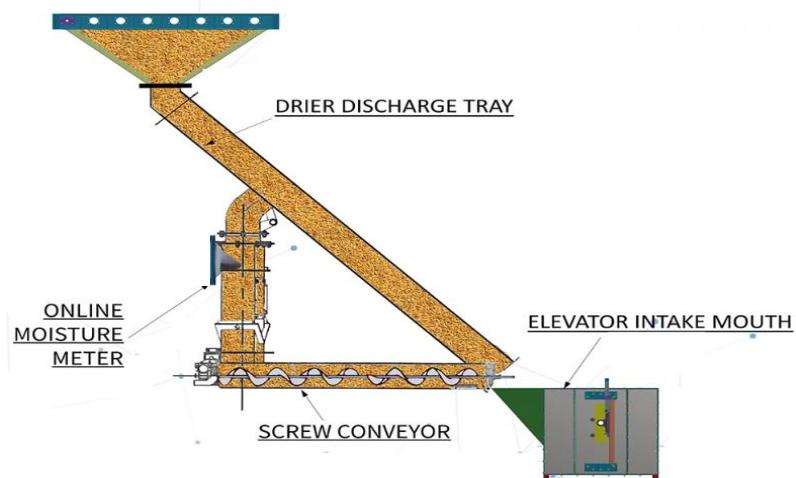
In this system, the water which is discharged from the parboiled tanks is recycled at least 30 times. This helps in reducing freshwater consumption by 70% which is in millions of litres for a rice mill. The colour, smell, brokenness and food safety in this system remains unchanged. As the hot water is being reused this results in reduced steam requirement which ultimately results in husk savings. This system eliminates the need for the expensive wastewater treatment plant. The 5% water discharge which is there from bottom of the tank can be used for road cleaning, plants, etc.

Features

- Reduced water requirement
- Low steam requirement and husk savings
- No effect on quality of rice (colour, flavor, safety, brokenness)
- Eliminates need for wastewater treatment plant, water pollution

Rice: Online Moisture Meter - PLC controlled¹¹⁰

During paddy drying the moisture in the paddy is continuously recorded and the steam flow cuts off automatically at a pre-set moisture value. As a result, there is no variation in moisture level of paddy across the different batches. As the steam flow is optimised based on the moisture level in paddy, it gets automatically reduced. This meter comes with cloud technology to enable data access from anywhere on Mobiles.



¹⁰⁹ <https://www.indusgroup.net/indus-products/>

¹¹⁰ <https://www.indusgroup.net/indus-products/>

Figure 64: Online Moisture Meter

Features

- Reduced steam consumption
- Uniform moisture level across batches

Table 99: Cost benefit analysis of installing an online moisture meter

Particular	Unit	Values
Energy savings	%	0.5
Investment cost	INR lakh	0.35
Simple payback period	years	Immediate

Rice: Semi-Automation System for soaking tanks - PLC controlled¹¹¹

The continuous circulation of water reduces the soaking time by 40% and also ensures uniform temperature during soaking. This results in faster drying, uniform colour, and reduces husk and electricity consumption. Due to reduced soaking time, this system enables processing of 3 batches per day against 2 batches processed by standard parboiling system.

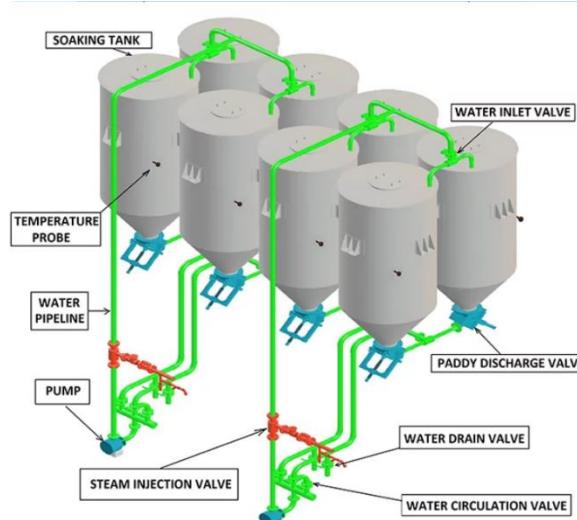


Figure 65: Semi-automatic parboiling system

Features

- Reduced soaking time by 3-4 hours
- Reduced drying time
- 3-4 batches per day against traditional 2 batches
- Uniform temperature and colour
- Less broken

Table 100: Cost benefit analysis of semi-automatic parboiling system

Particular	Unit	Values
Energy savings	%	5%
Investment cost	INR lakh	25
Simple payback period	years	6

¹¹¹ <https://www.indussgroup.net/induss-products/>

Rice: Optical Sorter¹¹²

The optical sorting technology is a revolution in rice sorting which helps the rice mills in delivering

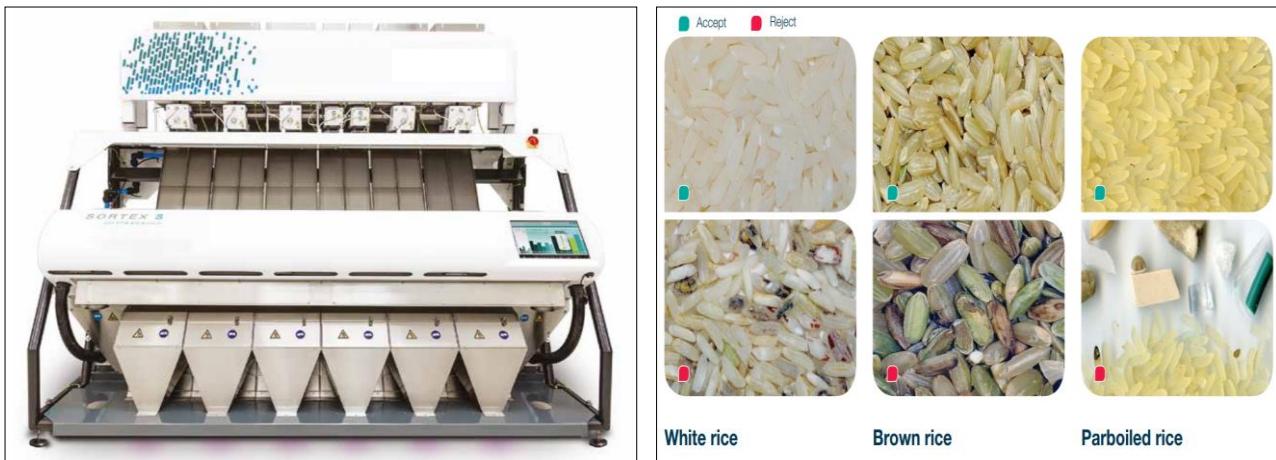


Figure 67: Optical Sorter Machine

Figure 66: Sorting in various types of rice

the highest capacity and export level quality standards easily and accurately. The main features of the Optical Sorter is its high precision in sorting, ability to sort colour defects, foreign materials and others, simplicity to use, great control over each individual effect, among others. This technology needs minimal operator intervention and monitoring as it automatically adjusts its sorting mechanism depending on the colour variations and foreign material presence in the incoming rice grains. This maximises the yield and minimises the waste thereby ensuring optimal sorting performance throughout the day. This level of accuracy in grain sorting results in energy savings in addition to reduction in wear on ejectors and downtime in clearing the grain build-up. Its easy to change the sorter settings without the need for complex programming. We just need to select the defect and use the slider to adjust the quantity to remove.

Features

- Improved sorting accuracy even during high capacity processing
- Pinpoint accuracy, enhanced defect detection, eliminates product breakages
- Reduced energy consumption
- Automation: Continuously scans and automatically adjusts depending on the incoming product
- Easily controlled and remotely accessible

Case Study¹¹³

Phung Hoang Rice, Vietnam uses SORTEX S UltraVision™ from Bühler and turns 400 tonnes per day of wet paddy into high value rice for export. The optical assessment of rice kernel for discolouration or damage is done at a rate of 20 million kernels per minute. This intervention has increased the total daily production for Phung Hoang Rice. The increased rice quality has also enabled them to export their rice to customers in Europe and the Middle East.

¹¹² https://www.buhlergroup.com/global/en/products/sortex_s_ultravisionopticalsorter.html

¹¹³ <https://www.buhlergroup.com/global/en/stories/phung-hoang-rice.html>

Rice: New Age Rice Whitener¹¹⁴

Modern rice whiteners have higher processing capacities and low energy consumption as a result of compact milling chamber. The milling chamber is shaftless and is designed for unrestricted air movement wherein the air freely moves around each rice kernel. As a result the bran gets removed efficiently which results in cleaner output. The free air movement also cools the rice kernels which helps in reducing the breakages. This process helps in achieving a better polished rice surface after the polishing stage thereby delivering a premium export quality rice which is smooth and silky. These whiteners have low processing cost per tonne of rice. It has a double aspiration system to carry away bran with high efficiency thereby giving a cleaner output.



Figure 68: New age rice whitener

Features

- High capacity processing
- Low energy consumption
- Double aspiration system
- Flexibility in application with respect to rice varieties and capacities
- Hygienic operation

Table 101: Cost benefit analysis for shaftless rice whitener

Particular	Unit	Values
Energy savings	%	10 ¹⁵
Investment cost	INR lakh	15
Simple payback period	years	5

¹¹⁴ https://www.buhlergroup.com/global/en/products/ultrawhite_verticalwhitener.html

¹¹⁵ <https://millingandgrain.com/the-future-of-rice-processing-23010/>

Rice: New Age Rice Polisher¹¹⁶



Figure 69: New age rice polishers

The new age polishers include innovative designs for the sieve, cam and teeth and deliver a high level of polishing even at high throughputs of up to 16 tons of rice per hour. The unique sieve design with reverse bends helps in enhancing the polishing performance as well as reduce the energy consumption. They are designed for easy cleaning as bran can get accumulated in the shaft during polishing operation. The cam teeth in these can be adjusted for the required polish. These polishers come with a feature due to which the unit owner can replace only the worn parts and not the whole cam, also the individual teeth can be replaced thereby reducing the maintenance costs.

Features

- High capacity
- Energy efficient operation
- Custom adjustment based on polishing needs
- Enhanced polishing – silky, smooth, uniform
- Reduced maintenance costs

Table 102: Cost benefit analysis of new age rice polisher

Particular	Unit	Values
Energy savings	%	3%
Investment cost	INR lakh	15
Simple payback period	years	5

Rice: Solar paddy dryer¹¹⁷

This is a tunnel type dryer which is designed to dry the paddy as well as protect it from the rains. The heated air vaporises the moisture content in paddy which is then exhausted through the exhaust ports. The rate of drying depends on the paddy but on an average, it is 0.5% moisture content per hour. When the outside conditions are optimal i.e., in case of high atmospheric temperatures, the paddy with moisture content between 14 – 22% is dried in about 6 to 8 hours. This type of dryer is provided with rake and tube mixers for optimal mixing.

¹¹⁶ https://www.buhlergroup.com/global/en/products/ultrapoly_polisher.html

¹¹⁷ <https://www.grainpro.com/grainpro-bubble-dryer>



Figure 70: Tunnel based solar paddy dryer

RTE-RTC – Individual Quick Freezing¹¹⁸

Individual Quick Freezing (IQF) is a freezing method used for freezing foods like berries, fruits, vegetables in whole, diced or sliced form, baked food, etc. There are two types of IQF treatment, mechanical IQF and cryogenic IQF. In mechanical IQF freezing system, recirculating refrigerant with an air cooler that exchanges heat from the circulating within the freezer to reduce temperature of the food is used. In cryofreezing, the items are sprayed immersed directly in liquid nitrogen or carbon dioxide and frozen almost instantly. This type of freezing prevents the formation of large ice crystal which ruptures the food's cell membrane and causes fluid loss. As a result, enhanced quality food product sustaining natural nutritional value, taste and shape is produced.



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Figure 71: IQF Freezing System

a

The mechanical IQF system is recommended for large scale and high-volume production of raw and finished food products. The initial cost of a mechanical IQF freezing system is higher compared to cryogenic IQF system but for large scale production with high volume food product the payback will be less than cryogenic one as a result of extremely large freezing capacity and efficient, cost-effective, and energy saving mechanical IQF technology. The mechanical IQF freezing system produces better quality and safe food and the many days of defrosting less operation leads to reduced water consumption, wastewater, and chemical usage. This system has operational savings and reduces environmental footprint compared to conventional technologies as this system is energy efficient.

The cryogenic type of IQF freezing system is recommended for those industries where food safety and quality is particularly important, for example, baked goods, seafood, meat, poultry, and dairy products. This system is recommended for new production lines, seasonal production, or small and medium productions of high-quality food. The operating costs are lower compared to mechanical IQF. The equipment size is also smaller, is ready to use and easy to clean compared to mechanical IQF. This type is also a flexible solution as it allows to change product, vary batch volume, and

¹¹⁸ <https://dsidantech.com/solutions/iqf-mechanical>

change temperature from -180°C to $+600^{\circ}\text{C}$ in the same machine. The cryogenic type of IQF freezing system is also energy efficient and uses energy to produce nitrogen whereas CO_2 is a waste product from ammonia plants and is reused. As this system is small and easy to clean, it uses less water for cleaning purpose.

Table 103: Cost benefit analysis of Individual Quick Freezer

Particular	Unit	Values
Energy savings	%	30 ¹¹⁹
Investment cost	INR lakh	55
Simple payback period	years	2-4 ¹²⁰

RTE-RTC - Rotary Rack Baking Oven¹²¹

Rotary rack ovens are designed to obtain uniform baking as the hot air reaches equally to all the surfaces regardless of up or down floor and right or left side of the tray. This results in homogenous baking thereby resulting in enhanced product quality, improved productivity and reduced energy consumption. The additional features of this oven include fast heat-up and recovery for continuous production, unique precision steam generators, large baking capacity, among others.



Figure 72: Rotary Rack Baking Oven

Table 104: Cost benefit analysis of Rotary Rack Baking Oven

Particular	Unit	Values
Energy savings	%	5%
Investment cost	INR lakh	10
Simple payback period	years	2.5

RTE-RTC - Turbo Drop Cookie Depositors¹²²

This cookie production machine ensures control of the parameters such as number of rows in a tray, gap between rows, weight of cookies, rotation of the nozzles with the help of a touch screen interface. The function and logic of the machine are PLC controlled. The tray movement is powered by a Servo Motor, which result in adequate positioning control. This machine operates on independent motors for all the functions, which give you the flexibility to make different kinds of products. The additional features of this machine includes Servo drive controls for high speed and accuracy, up and down movement of the table powered by a Servo Geared



Figure 73: Turbo drop cookie depositor

¹¹⁹ <https://octofrost.com/individual-quick-freezing>

¹²⁰ The average payback period for mechanical freezing is around three to four years, with some product applications achieving payback in less than two years.

<https://octofrost.com/news-room/cryogenic-freezing-vs-iqf-freezing>

¹²¹ <https://www.empirebakers.org/rotary-rack-ovens.html>

¹²² <https://www.empirebakers.org/turbo-drop-cookie-depositors.html>

Motor, nozzle rotation powered by a multi speed geared motor, wire cut frame powered by a geared motor, fully automatic table height adjustment, tip control mechanism, among others. There is a potential to save energy consumption by using these turbo drop cookie depositor machine.

Table 105: Cost benefit analysis of Turbo Drop Cookie Depositor

Particular	Unit	Values
Energy savings	%	3%
Investment cost	INR lakh	10
Simple payback period	years	3

Seafood processing – Brine Freezers¹²³

Brine freezing is a type of freezing technology wherein rapid freezing can be obtained by losing minimum weight of the processed product. Brine freezing can be done through three techniques: Immersion Batch Immersion Freezing, Continuous Immersion System Immersion Freezing, and Continuous Shower System.

- Immersion Batch Immersion Freezing: In this process type, the products packed in a plastic or stainless steel basket and placed in racks with several trays are immersed into the brine. The products are lowered into the agitated brine tank with the help of forklift or fixed monorail crane system for the freezing process.
- Continuous Immersion System Immersion Freezing: By using a conveyor system the product is immersed into the agitated brine and further is drained before it passes through the Hardening tunnel for deep freezing operation.
- Continuous Shower System: In this process type, several spray nozzles are used for spraying cold brine on the products placed on a conveyor belt. The spraying of cold brine brings down the temperature of the product rapidly further to which the products are drained before they are moved to the Hardening tunnel for deep freezing operation. This process is applicable to tray as well as IQF products.

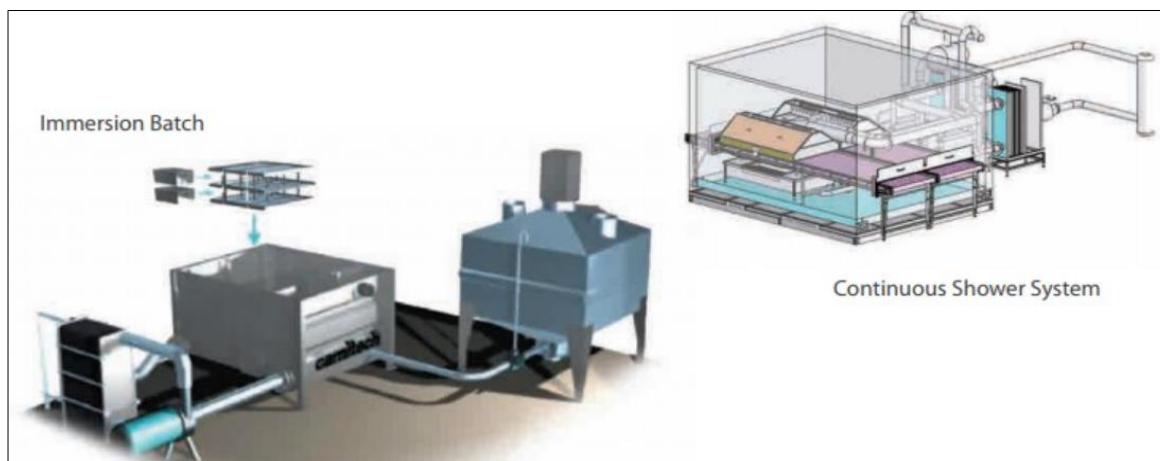


Figure 74: Immersion batch and continuous shower type brine freezing

¹²³ <https://www.indusref.com/freezer/brine-freezer/>

Table 106: Cost benefit analysis of brine freezers

Particular	Unit	Values
Energy savings	%	5%
Investment cost	INR lakh	10^{124}
Simple payback period	years	6^{125}

Best Operating Practices¹²⁶

Best operating practices (BOP) with regular monitoring helps in maintaining the best operational efficiencies. Regular monitoring of equipment also helps in reduction or elimination of system failures. To support the MSMEs with quick guidelines to monitor their process equipment and utilities, BEE had launched the energy conservation guidelines for MSME sectors in 2019. This section covers the BOP, monitoring parameters and SEC/Efficiencies defined for various MSME sectors as per energy conservation guidelines by BEE (Table 107, Table 108). Additionally, MSMEs should also carry out regular maintenance of the equipment as specified by the OEMs.

¹²⁴ <https://moontec.en.made-in-china.com/product/uwBfVHRyHnhE/China-Brine-Shrimp-Fluidized-Freezing-Machine-with-Competitive-Price.html>

¹²⁵ https://www.flanagan.ca/userContent/documents/Press%20Releases/Flanagan_Canadian_Pioneers.pdf

¹²⁶ <https://beeindia.gov.in/sites/default/files/Annexure%202.pdf>- Accessed during May 2023

Table 107: Best Operating practices for process equipment and auxiliaries

Equipment	Best Operating Practices	Parameters to be monitored	SEC/Efficiency range ¹²⁷	Adoption rate in MSME units ¹²⁸
Ovens	<ul style="list-style-type: none"> Provide adequate insulation to ovens. Ensure optimum loading of ovens. For LPG combustion maintain the oxygen level in flue gas between 4 – 5%. Maintain stack temperature between 120 – 130 °C by recovering heat to vaporise LPG 	<ul style="list-style-type: none"> Energy consumption and quantity of materials processed in ovens. Fuel consumption, residual oxygen (O₂) and carbon monoxide (CO) in flue gases, exhaust gas temperature, etc. 	• -	<ul style="list-style-type: none"> Low to medium
Thermic Fluid Heater	<ul style="list-style-type: none"> Maintain air ratio for LPG between 1.12-1.15 and for wood between 1.32-1.39 Maintain average external skin temperatures up to Ambient temperature + 20 °C. Undertake thermal insulation work according to the industrial standard practices for thermal insulation works and equivalent standards 	<ul style="list-style-type: none"> Fuel consumption, residual oxygen (O₂) and carbon monoxide (CO) in flue gases, and unburnt carbon in bottom ash and fly ash for solid fuels, preheat air temperature, exhaust gas temperature, etc. Thermic fluid circulation rate, pressure, supply and return temperature of fluid Temperatures of different surfaces on monthly basis. 	• 77 – 81%	<ul style="list-style-type: none"> Low to medium
Refrigeration system	<ul style="list-style-type: none"> Avoiding the entry of warm air from outside into the cold room area by properly sealing the cold room chamber Providing insulation of appropriate type, size and thickness to reduce the energy losses from uninsulated or 	<ul style="list-style-type: none"> Electricity consumption, supply voltage, current, power factor on daily basis. Temperatures of chilled water to process, return water, water inlet and outlet from cooling tower on 	• COP: 1.344 – 2.042	<ul style="list-style-type: none"> Low to medium

¹²⁷ Based on the multiple studies carried out in the Chennai cluster (range is best – median) for the cluster

¹²⁸ Based on our observations during the energy audits and discussions with MSMEs and industry associations in the cluster

Equipment	Best Operating Practices	Parameters to be monitored	SEC/Efficiency range ¹²⁷	Adoption rate in MSME units ¹²⁸
	<p>defective insulation portions of the refrigeration system. Providing thickness for insulation so as to maintain the surface temperature above the dew point temperature of ambient air</p> <ul style="list-style-type: none"> Minimising the corrosion on cold piping, ducts, chillers, etc. Cleaning the condenser coils on monthly basis. Using regular watch glass to inspect, observe and maintain refrigerant and recharge up to the essential level Minimising refrigeration loads with energy efficient measures like window shades, low thermal mass wall, etc. Seasonal variations shall be considered while choosing the operational parameters like temperatures of cooling water, chilled water and return water without affecting system performance. 	<p>daily basis.</p> <ul style="list-style-type: none"> Flow rate of coolant on a daily basis Motor body temperature, vibration and lubrication level on quarterly basis. 		

Table 108: Best Operating practices for Utilities in food processing industry

Equipment	Best Operating Practices	Parameters to be monitored	SEC/Efficiency range	Adoption rate in MSME units ¹²⁹
Rice husk / Cane straw fired boiler	<ul style="list-style-type: none"> Maintain stack temperature between 120 – 130 °C by recovering heat to preheat combustion air or boiler feedwater Maintain excess air between 30 – 40% Automatic blowdown control based on boiler water conductivity and pH. Regular removal of soot build up on tubes and scaling on water side. Optimising steam pressure based on process demand. Variable speed control for ID and FD fans if the boiler load characteristics are variable. Maintaining boiler loading at two-thirds of full load. 	<ul style="list-style-type: none"> O₂ and CO % in flue gas Stack temperature Insulation for walls and door of combustion chamber and aerator Boiler water conductivity and pH Scaling and soot build up Boiler loading 	<ul style="list-style-type: none"> 60 – 71% 	<ul style="list-style-type: none"> Low to medium
Wood fired boiler	<ul style="list-style-type: none"> Maintain stack temperature between 120 – 130 °C by recovering heat to preheat combustion air or boiler feedwater Maintain air 	<ul style="list-style-type: none"> O₂ and CO % in flue gas Stack temperature Insulation for walls and door of combustion chamber and aerator 	<ul style="list-style-type: none"> 73-74% 	<ul style="list-style-type: none"> Low to medium

¹²⁹ Based on our observations during the energy audits and discussions with MSMEs and industry associations in the cluster

Equipment	Best Operating Practices	Parameters to be monitored	SEC/Efficiency range	Adoption rate in MSME units ¹²⁹
	<ul style="list-style-type: none"> ratio between 1.32-1.39 Automatic blowdown control based on boiler water conductivity and pH. Regular removal of soot build up on tubes and scaling on water side. Optimising steam pressure based on process demand. Variable speed control for ID and FD fans if the boiler load characteristics are variable. Maintaining boiler loading at two-thirds of full load. 	<ul style="list-style-type: none"> Boiler water conductivity and pH Scaling and soot build up Boiler loading 		
Compressed Air system	<ul style="list-style-type: none"> Operate the compressor at the optimal pressure requirement Limit the compressed air leakage within 3% to 10%. Maintain operating SPC within the design range as provided by the OEMs. Periodic cleaning of the suction filters Ensure the optimal dryer operation Maintain specified air temperature after intercooler 	<ul style="list-style-type: none"> Power consumption Air flow Pressure of compressed Air Loading and Unloading time Pressure drop in piping system Pressure drop across the filters 	<ul style="list-style-type: none"> Reciprocating – 0.20 to 0.22 kWh/cfm Screw single stage – 0.14 to 0.19 kWh/cfm Screw multistage – 0.18 to 0.25 kWh/cfm 	<ul style="list-style-type: none"> Low to Medium – based on specific practices
Electric	<ul style="list-style-type: none"> Use IE3 or 	<ul style="list-style-type: none"> Voltage 	<ul style="list-style-type: none"> Refer Efficiency 	<ul style="list-style-type: none"> Low

Equipment	Best Operating Practices	Parameters to be monitored	SEC/Efficiency range	Adoption rate in MSME units ¹²⁹
Motors	<ul style="list-style-type: none"> higher rating motors • Use BLDC motors for fans, blowers etc. • Maintain voltage and current imbalance as low as possible as prescribed by IEEE • Replace the motor after rewinding once 	<ul style="list-style-type: none"> • Current • Power factor • Harmonics • Electricity energy consumption 	<ul style="list-style-type: none"> of Motor as per catalogue of motor manufacturer • Efficiency varies in range of 75%-95% for different rating of the motors from 0.3 kW-500 kW 	
Pump and pumping system	<ul style="list-style-type: none"> • Operate pump close to BOP as specified by the OEMs • Install VFD in case of variable loads • Use on-line monitoring for centralized large system and periodical measurement for decentralized smaller pumps • Replace worn out pumps with EE pumps • Maintain a minimum Net Positive Suction Head (NPSH) of pumps as prescribed by the manufacturer 	<ul style="list-style-type: none"> • Total differential head • Flow rate • Electricity consumption to evaluate efficiency of pumps on monthly basis 	<ul style="list-style-type: none"> • 35 – 38% 	<ul style="list-style-type: none"> • Low
Transformer	<ul style="list-style-type: none"> • Maintain winding temperature within 100 °C – 120 °C. • Maintain oil temperature within 90 °C. • Maintain unity power factor at the 	<ul style="list-style-type: none"> • Voltage, Current, Power factor • Oil temperature • Winding temperature • Harmonics (Voltage and Current) 	<ul style="list-style-type: none"> • Refer Efficiency as per catalogue of manufacturer or refer star label¹³⁰, generally efficiency are in range of 97-99% 	<ul style="list-style-type: none"> • Low

¹³⁰ <https://www.beestarlabel.com/Content/Files/DTnoti.pdf> Accessed during Jan - May 2023

Equipment	Best Operating Practices	Parameters to be monitored	SEC/Efficiency range	Adoption rate in MSME units ¹²⁹
	transformer.	<ul style="list-style-type: none"> Tap position if available 		
Lighting System	<p>Maintain the appropriate lux levels</p> <ul style="list-style-type: none"> Administrative building 50–400 Administrative corridor 100 Shop floor lighting (process) 150–300 Workshop 150–300 Warehouse storage area 100–150 Use 3-5 star rated LED lights 	<ul style="list-style-type: none"> Monitor the lux level Monitor the power consumption CRI to be monitored where required 	<ul style="list-style-type: none"> 90-120 watt/lumen¹³¹ 	<ul style="list-style-type: none"> Medium

List of Vendors / Suppliers of Energy Efficient Technology Solutions

Table 109: List of prominent technology vendors

Technologies	Vendors / Suppliers	Contact Details
Optical Sorter, New Age Rice Whitener, New Age Rice Polisher	Bühler Group	buhler.bangalore@buhlergroup.com +918067770000
Husk-Fired Furnace with Multiple Dryers, Water Recycle System, Semi-Automation System for soaking tanks - PLC controlled, Online Moisture Meter - PLC controlled	INDUSS – The Rice Engineers	info@indussgroup.com +913322878503
New age Paddy Drying with AI	Satake India Engineering	sales@satakeindia.com +918800605494
Cold Rooms, Refrigeration Unit	Blue Star	(+91) (22) 6654 4000
Compressors for Refrigeration, compressor and condenser controllers, electronic temperature control, evaporator and room control, and other cold room solutions	Danfoss	+91 22 22042187
IQF Freezer	DSI Dantech	info@dsidantech.com
IQF Freezer	GEA	+91 (0) 265 6141 700
Brine Freezer	Indus	+91-8333048451

¹³¹ BEE Star rated appliances - https://www.beestarlabel.com/Content/Files/LED_schedule.pdf Accessed during April 2023

Technologies	Vendors / Suppliers	Contact Details
	Refrigeration	md@indusref.com
Baking Oven	Zahabi Industries	sales@zahabiindustries.com +919823682152
Turbo Drop Cookie Depositor, Rotary Rack Baking Oven	Empire Bakery Machines Pvt. Ltd.	sales@empirebakers.com 9872490466
Screw Air compressor with VFD and WHR	Atlas Copco	Divya.Purohit@in.atlascopco.com
Screw Air compressor with VFD and WHR	Elgi	gopikrishna@elgi.com
Energy Efficient Blowers	Locally fabricated	
Energy Efficient Blowers	Alfa blowers	sales@alphablowers.com
Energy Efficient Blowers	Srilaxmi Air control	raju@srilaxmiair.com
IE3 / IE4 motors	Siemens	anshul.luthra@siemens.com
IE3 / IE4 motors	Crompton Greaves	sukhraj.singh@cgglobal.com
Aluminum compressed air piping	Parker Legris	joy.dewan@parker.com
Aluminum compressed air piping	Samarthair Pneumatics Pvt. Ltd	sales@samarthair.in
Aluminum compressed air piping	Luthra PNEUMSYS	r1@pneumsysenergy.com
EE pump sets	Grundfos	laxesh@grundfos.com
EE pump sets	Shakti pumps	Laxmikant.Joshi@kirloskar.com
IoT based EnMS	Schneider Electric	Rohit.Chashta@schneider-electric.com
IoT based EnMS	Enerlly	nil.shedje@gmail.com
IoT based EnMS	Sensegrow	krishanu.sudi@sensegrow.com
BLDC fans	Sinox	sinoxpower@gmail.com
BLDC fans	Atomberg	rohitvohra@atomberg.com
VFD drives	Schneider Electric	Rohit.Chashta@schneider-electric.com
VFD drives	Siemens	anshul.luthra@siemens.com
VFD drives	ABB	vinay.tiwari@in.abb.com

C. Existing EE Policy initiatives and programs for the sector

Realizing the importance of creating enabling environment for MSMEs- BEE, MoMSME and various international development agencies have been devising key programmatic interventions and policies for the MSME sector.

MoMSME has developed special subsidies schemes and funds to support Energy efficiency in MSME sectors. BEE had initiated an SME program during the year 2009 with an objective to improve the energy performance of MSME sector. EE in the MSME sector has also remained on the programme agenda of several institutes and development agencies, including GIZ, World Bank, UNIDO, UNDP, IFC and JICA for a significant time now.

The activities undertaken under these interventions include ranging from direct financial and technical support to capacity building and knowledge dissemination activities

- **Financial support**- Capital subsidies, soft loans, interest subventions, risk guarantee mechanism
- **Technical support**- Energy audits, preparing IGDPRs and hand-holding support for EE implementations
- **Knowledge and capacity building**- Preparation of cluster manuals, technology compendium, energy benchmarks and awareness creation through workshops, exhibitions, and technology demonstration

MSME specific EE policies, schemes, and programmatic interventions are categorized into following:

Govt. (MoMSME) supported subsidies scheme

- Financial Support to MSMEs in ZED Certification Scheme
- Lean Manufacturing Competitiveness Scheme (LMCS)
- Interest Subvention Scheme for MSMEs-2018
- Credit Guarantee Scheme for Micro & Small Enterprises (CGTMSE)

IDA led programmatic interventions

- GEF UNIDO BEE Program- Promoting EE and RE in Selected MSME Clusters
- GEF-World Bank BEE SIDBI Project- Financing Energy Efficiency at MSMEs

BEE Supported schemes

- Assistance in Deploying Energy Efficient Technologies in Industries and Establishments (ADEETIE)
- BEE SME Programme- including Energy mapping study for MSME clusters
- Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE)
- GEF Supported Programmes

Although these interventions have demonstrated the effectiveness of the energy efficient technologies however, the need of enabling eco-system for large-scale deployment of EE technologies in MSMEs has been extremely limited.

Schemes implemented by Ministry of Food Processing Industries (MoFPI)

Production Linked Incentive Scheme for Food Processing Industry (PLISFPI)¹³²

The objective of the Production Linked Incentive Scheme for Food Processing Industries (PLIFPI) is

- Supporting creation of global food manufacturing champions
- Promoting Indian food product brands
- Ensuring higher income to farmers and increasing availability of off-farm jobs
- Ensuring lucrative prices for farm produce

The scheme has three components -

1. **First component:** Incentivising manufacturing of four major food product segments i.e. Ready to Cook/ Ready to Eat (RTC/ RTE) including millet-based foods, Processed Fruits & Vegetables, Marine Products & Mozzarella Cheese.
2. **Second component:** Incentivising Innovative/ Organic products of SMEs across all the above four food product segments including Free Range - Eggs, Poultry Meat & Egg Products.
3. **Third component:** Supporting branding and marketing abroad to incentivise the emergence of strong Indian brands.

For the first component, some of the medium enterprises engaged in the processing of fruits and vegetables and mozzarella cheese manufacturing are eligible. For the second component, the MSMEs engaged in the manufacturing of innovative or organic products across the four segments mentioned above will be eligible. For the third component, the Indian brands completely manufacturing in India are eligible for receiving support.

MoMSME supported schemes

The Government launched National Competitiveness Programme in 2005 with an objective to support the Small and Medium Enterprises (SMEs) to become competitive and adjust the competitive pressure caused by liberalization and moderation. MSME Ministry employs the programme under the guidance of the National Manufacturing Competitiveness Council. Main components of the programme were aimed to address MSME competitiveness issues. 10 components of the programme are illustrated below-

- Support related to entrepreneurial and managerial development of SMEs by means of incubation
- Improving quality through Quality Management Standards in addition to technology Tools
- Technology up-gradation and quality certification assistance to SMEs
- Marketing assistance to MSMEs
- Marketing assistance for SMEs and technology up-gradation activities
- Design clinic scheme to convey design or innovation expertise

¹³² https://mofpi.gov.in/sites/default/files/guidelines_plisfpiwithcoveringltr_0.pdf (Accessed on October 26, 2023)

- Promotion of ICT
- Setting up the Mini Tool Room in addition to Training Centers
- Building awareness on Intellectual Property Rights
- National Programme related to the function of Lean Manufacturing

Few of these initiatives help in improvement in the efficiency of the MSMEs, adoption of the new energy efficient technologies and developing the ecosystem for energy efficiency, lean manufacturing, ZED leading to lowering the emission.

Financial Support to MSMEs in ZED Certification Scheme¹³³

Main objectives of the scheme include inculcating Zero Defect & Zero Effect practices in manufacturing processes, ensure continuous improvement and supporting the Make in India initiative. This scheme was launched to provide support the MSMEs for:

- Development of an ecosystem for Zero Defect Manufacturing in MSMEs
- Promote adaptation of Quality tools/systems and Energy Efficient manufacturing.
- Enable MSMEs for manufacturing of quality products.
- Encourage MSMEs to constantly upgrade their quality standards in products and processes.
- Drive manufacturing with adoption of Zero Defect production processes and without impacting the environment.

Financial outlay of 100 Crores was contributed by Government of India¹³⁴ during 2019-20 under the ZED programme for MSME sector.

Lean Manufacturing Competitiveness Scheme (LMCS)¹³⁵

The Pilot Phase of Lean Manufacturing Competitiveness Scheme was approved for 100 MSME Clusters. Main objective of the Scheme was to enhance the manufacturing competitiveness of MSMEs through the application of various Lean Manufacturing (LM) techniques by:

- Reducing waste
- Increasing productivity
- Introducing innovative practices for improving overall competitiveness
- Inculcating good management systems
- Imbibing a culture of continuous improvement

This scheme has supported over 3732 MSEs since the inception of the programme in 2007, financial support of over INR 48.46 crore has been provided by the government for this program since inception till 2016-17.

¹³³ <https://msme.gov.in/technology-and-quality-upgradation> Accessed on 19 August 2020

¹³⁴ http://www.dcmsme.gov.in/schemes/FAQ_ZED_11619.pdf - Accessed on 29 August 2020

¹³⁵ <https://msme.gov.in/lean-manufacturing> Accessed on 24 September 2023

Credit Guarantee Scheme for Micro & Small Enterprises (CGTMSE)¹³⁶

The objective of this scheme is to provide credit support to micro and small enterprises. The scheme is applicable to existing and aspiring entrepreneurs. The eligible credit facilities include any collateral or third party guarantee free credit facility by eligible institutions to new as well as existing micro and small enterprises with a maximum credit cap of INR 500 lakh.

The guarantee cover available under the scheme is to the extent of

- 85% for micro enterprises upto INR 5 lakh and 75% for micro enterprises for credit value more than INR 5 lakh
- 80% for MSEs located in North East Region (incl. Sikkim, UT of Jammu & Kashmir and UT of Ladakh) upto INR 50 lakh
- 85% for Women entrepreneurs / SC/ST entrepreneurs / MSEs situated in Aspirational District / ZED certified MSEs / Person with Disability (PwD) / MSE promoted by Agniveers upto INR 500 lakh
- 75% for All other category of borrowers upto INR 500 lakh

Micro & Small Enterprises - Cluster Development Programme (MSE-CDP)¹³⁷

For boosting the productivity and competitiveness and capacity building of micro and small enterprises (MSEs), the Ministry of Micro, Small and Medium Enterprises (MoMSME) has adopted a cluster development approach wherein the development of the MSEs and their collectives is envisaged. As the units in a cluster are in close proximity to each other and produce similar kind of products, they can be linked with a common infrastructural facility to address the common challenges with respect to productivity, electricity, water, testing, pollution control, green and sustainable manufacturing transition, marketing, among others faced by them.

The scheme will be implemented through following components:

1. **Common Facility Centers (CFCs):** The GOI grant will be 70% of the project cost subject to a cap of INR 20 crore and 90% of the project cost for CFCs in clusters falling under special category. The project cost covers expenses towards Land, building, pre-operative expenses, preliminary expenses, machinery & equipment, miscellaneous fixed assets, support infrastructure (water, electricity) and margin money for working capital.
2. **Infrastructure Development:** The GOI grant will be 60% of the project cost subject to a cap of INR 10 crore for Industrial Estate & Rs.15 crore for Flatted Factory Complex. The GOI grant will be 80% of the project cost for the clusters falling under special category.
3. **Marketing Hubs / Exhibition Centres by Associations:** The GOI grant (towards construction of building, furnishings, furniture, fittings, items of permanent display, miscellaneous assets like generators, etc.) will be 60% of the project cost subject to a cap of INR 10 crore for Product Specific Associations with SMO rating of Gold Category and above from NABET (QCI) and 80% for Associations of Women Entrepreneurs. The remaining project cost is to be borne by SPV or State government.

¹³⁶ <https://www.cgtmse.in/Home/VS/3> Accessed on 24 September 2023

¹³⁷ <https://www.dcmsme.gov.in/mse-cdprog.htm>

4. **Thematic Interventions:** The GOI grant will be 50% of the total cost for a maximum 5 thematic interventions subject to a cap of INR 2 lakhs for each of the thematic intervention in approved or completed CFC. The activities covered under this grant are Training programmes, Exposure visits, Strengthening the Business Development Service (BDS) provision through a panel of service providers, Any other activity related to creating business eco-system in cluster mode. The remaining cost is to be borne by SPV or State government.
5. **Support to State Innovative Cluster Development Programme:** This component will provide funding support to strengthen the State Cluster Development Programmes. The GOI fund will be equal to the State's share or INR 5 crore, whichever is lower. The GOI fund will be 90% of the project cost subject to a cap of INR 5 crore for CFC projects in clusters falling under special category.

BEE – Facilitation Centre ¹³⁸

BEE has set up a Facilitation Centre with an aim to upscale Energy Efficiency financing in the country. The Facilitation Centre spreads awareness of BEE's financing schemes and collects the willingness forms from the beneficiary group, prepare the list of EETs, and develop an online platform to mobilise energy efficiency financing in the country. The beneficiary group covers the large industries/ DCs under the PAT Scheme of BEE, MSMEs, Commercial and Institutional buildings, Municipalities, Corporations, and Commercial establishments. The following process is followed for financing loan for an energy efficiency project.

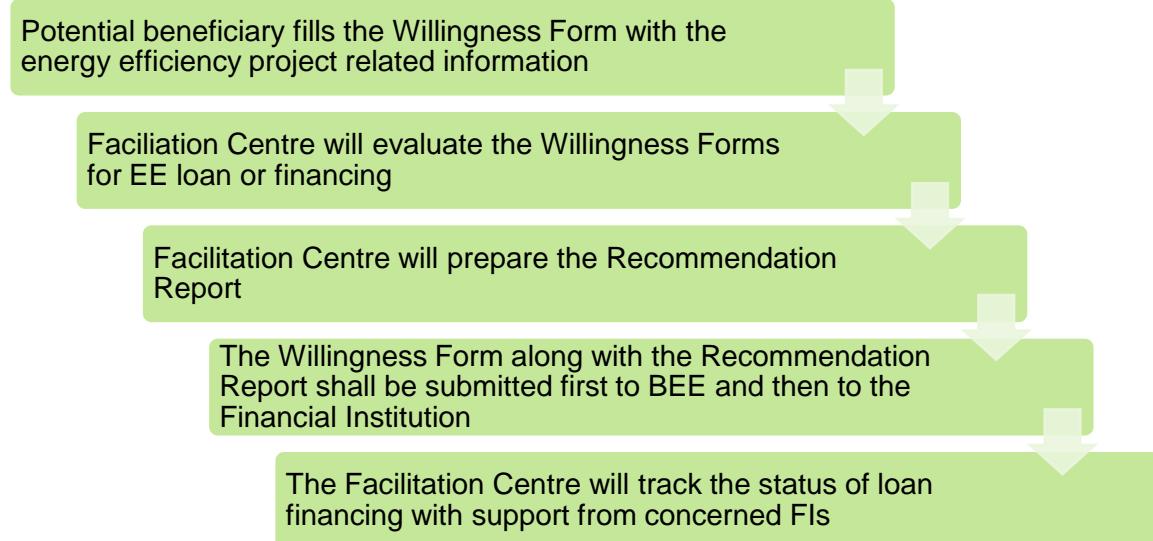


Figure 75: EE loan financing process through Facilitation Centre

The facilitation centre has already received over 250 willingness forms for implementation, conducted over 150 technical evaluations and facilitated loans for over 680 crores.

BEE -SME programme ¹³⁹

Considering the urgent need to develop, demonstrate and disseminate energy efficient technologies at the cluster level, "National Programme on Energy Efficiency and Technology Upgradation in SMEs" was evolved by BEE to address the various challenges faced by SMEs in India, subsequently BEE initiated the BEE-SME programme in 2009.

¹³⁸ <https://www.adeetie.beeindia.gov.in/bee-facilitation-centre>

¹³⁹ <https://beeindia.gov.in/sites/default/files/Situation%20analysis.pdf> Accessed on 20 September 2020

Over 375 Bankable DPR's for energy efficiency projects were prepared in 35 clusters across India. Under the programme several initiatives were taken for capacity building of Local Service Providers/Technology Providers. BEE facilitated implementation of Energy Efficiency Measures through development of DPRs in 29 out of the 35 clusters for which baseline studies were undertaken.

In recent years, under BEE SME programme various initiatives are being carried out as described below, to boost energy conservation in the SME clusters.

Energy and Resource mapping of SME sector

BEE is presently conducting an energy and resource mapping study in the most energy intensive MSME sectors in the country. Study is presently being carried out in twelve energy intensive sectors (Forging, Foundry, Bricks, Chemicals, Dairy, Glass and refractory, Pharma, Steel, Textile, Leather, Food Processing) in 60 MSME clusters across the country. Main objectives of the study are

- Evaluate the present specific energy consumption of the different MSME clusters for nine sectors
- Evaluate the extent of EE improvement potential across these sectors
- Estimation of energy efficiency improvement, energy saving potential for each sector.

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

Development and Launch of knowledge portal for SMEs

A knowledge management portal - *Simplified Digital Hands-on Information on Energy Efficiency in MSMEs (SIDHIEE)* has been developed by Bureau of Energy Efficiency which hosts variety of knowledge resources like case studies, best operating practices, details of latest energy efficient technologies etc. Dissemination of Recognizing the importance and effectiveness of well-presented success stories to ensure widespread replication of efficient technologies and practices, BEE has developed around 50 multimedia presentations showcasing successful case studies of implemented EE interventions for different MSME sectors. These are now being widely disseminated and are hosted in the Knowledge Management Portal "SIDHIEE" created under the BEE-SME Programme.

With an aim to pool the knowledge resources and synergise the efforts by several players involved in fostering energy efficiency in MSMEs like the BEE, MoMSME, EESL, among others, a collaborative knowledge platform called "SAMEEEKSHA - Small and Medium Enterprises Energy Efficiency Knowledge Sharing" was launched by BEE and MoMSME. The SAMEEEKSHA platform hosts the knowledge resource prepared under several past BEE programmes like BEE-SME programme, Energy and Resource Mapping in MSME clusters, and studies conducted by organisations like Shakti Foundation, TERI, CEEW, etc., information on major activities conducted in the MSME sector, among others. SAMEEEKSHA platform enables the industry players to interface with the R&D institutes, technology suppliers, government organisations, funding agencies, training institutes and academia with an aim to uptake energy efficiency in MSMEs.¹⁴⁰

¹⁴⁰ https://www.sameeksha.org/index.php?option=com_content&view=article&id=291&Itemid=508
<https://pib.gov.in/PressReleasePage.aspx?PRID=1780903>

Promoting Energy Efficiency and Technology Upgradation in SMEs through ESCO

BEE has institutionalized Partial Risk Guarantee Fund for Energy Efficiency (PRGFEE), which provides a partial coverage of risk involved in extending loans for Energy Efficiency projects. PRGFEE guarantees up to 50% of loan amount or Rs. 10 crore per project, whichever is less. PRGFEE support has been provided to government buildings, private buildings, municipalities, SMEs, and industries. This guarantee is extended to participating financial institutions which will extend loans to ESCOs for implementing EE projects.

Under the IFC Eco-cities programme supported by BEE, investment grade DPRs are presently being prepared for energy efficiency investments at MSMEs in 4 ECO-Cities across India, wherein a pipeline for loans benefitting from PRGFEE is expected to be created.

Dissemination of EE technologies and Awareness:

- a. More than 60 Capacity building cum Knowledge dissemination programme were organised in SME clusters for dissemination of available energy efficient technologies in SME sectors. National Summit on Energy Efficiency in SMEs was also organized in consultation with leading stakeholders for further scaling up the project for transformational results.
- b. Identification of Local Service Providers and Suppliers: About 70 local service providers were identified for offering services and supplies of various technologies in 5 clusters for ensuring the replication of the identified technologies in the clusters.

Uptake of existing and past EE interventions and schemes

Indian govt. has undertaken several policies, schemes and programs targeted at promoting energy efficiency in the MSME sector. Energy Efficiency in the MSME sector has also remained on the programme agenda of development agencies such as WB, JICA, IFC, GIZ, UNIDO, UNDP etc.

As single scheme/ interventions cannot eliminate all technical, financial and capacity building barriers faced by MSMEs while adopting energy efficiency enhancing projects. Accordingly, various schemes/ interventions have been introduced to promote MSMEs and energy efficiency or with a focus of promoting energy efficiency centric activities in MSMEs.

While these programmatic interventions have made an impact, there is a long way to go before majority of MSMEs voluntarily increase their uptake of energy efficiency interventions. The observations on the current and past EE schemes & interventions are presented below

Table 110: Major features and key takeaways from different schemes

Major Feature	Key Schemes	Observations/Takeaway
Capital Subsidy schemes	Credit Linked Capital Subsidy Scheme (CLCSS) High uptake	<ul style="list-style-type: none">• High uptake of the scheme due to direct financial benefits such as capital subsidies• Widely disseminated through comprehensive list of lending institutes• List-based approach simplifies the process
Subsidy linked to Energy audits	Technology Up-gradation Scheme for MSMEs (TEQUP) Low uptake	<ul style="list-style-type: none">• Scheme requirements such as Energy DPR increases the transaction cost and lead time• Lack of promotion and awareness of the scheme among MSMEs
Risk guarantee mechanism	PRSF, PRGFEE- Low uptake	<ul style="list-style-type: none">• ESCO eco-system, required for scalability, is not yet developed,• Need of energy study & M&V process

Major Feature	Key Schemes	Observations/Takeaway
		increases the project cost at MSME level
	CGTSME- High uptake	<ul style="list-style-type: none"> Simple procedural norms, less documents No need of project report for availing guarantee under the scheme
Long term Technical Assistance	WB-GEF FEEEMP High Uptake BEE SME Programme High Uptake UNIDO-GEF EE & RE Adoption- High Uptake	<ul style="list-style-type: none"> TA programs create awareness on EE amongst different MSME stakeholders Create culture for EE in clusters due to long term support, but not market driven Able to cater to part of the MSME sector, as outreach to limited number of clusters
List based scheme	JICA SIDBI – High uptake	<ul style="list-style-type: none"> Extensive list of EETs helped in faster loan appraisal, hence higher uptake SPEED Plus scheme promotes collaboration with OEMs/ vendors
Revolving funds for EE	SIDBI 4E Scheme- Medium uptake	<ul style="list-style-type: none"> Requires pipeline generation at cluster/ sector level for faster up-taking

Past initiatives supporting energy transition in MSMEs

BEE-GEF-WB Project - Financing Energy Efficiency at MSMEs (FEEEMP)¹⁴¹

The Financing Energy Efficiency at MSMEs" project (FEEEMP) aimed to support demand aggregation for EE investment in MSME industrial clusters and creating a sustainable mechanism for identifying and financing proposals at the local level in future. The World Bank was the implementing agency for GEF for this programme and this project was executed jointly by BEE and SIDBI. The project components were conducting capacity building and awareness creation activities and activities to promote investment for EE in MSMEs, and developing programme knowledge management. This project was implemented in various clusters across India from MSME sectors like Forging, Chemical, Limekiln, Foundry and Mixed Clusters.

The key achievements under this programme were

- KPIs and benchmarks development for forging and ceramics sectors
- 50 MSME units implemented and 40 units certified for EnMS (ISO 50001)
- 350 professionals trained for ISO 50001 of which 100 were trained as ISO 50001 internal auditors
- 133 shop floor employees were trained for BOPs and ECMs
- 2500 professionals participated in workshops
- 600 participants benefited from the certification programmes

¹⁴¹ <https://beeindia.gov.in/en/programmes/demand-side-management/small-medium-enterprise/bee-gef-wb-project>
(Accessed on 26 October 2023)

- 5 B2B forums organized with 150 stalls by EE technology and service providers and participation from more than 700 MSME representatives
- Knowledge Management portal development covering success stories, KPIs, BOPs, EE case studies and Technology videos, News letters, posters, etc.
- More than 530 Felicitation and certification programmes organized
- 12 documentaries prepared on cluster level success stories

State level initiatives

Goa Industrial Growth and Investment Promotion Policy 2022¹⁴²

The Goa Industrial Growth and Investment Promotion Policy 2022 was announced with an objective to provide specific incentives and enabling infrastructure to support local and existing business and attract new investment, promote local employment and skill development, among other goals.

- Reimbursement of 25% of the cost for conducting water and energy audit by a recognized institution/consultant.
- Reimbursement of 25% of the cost for installation of water and energy conservation equipment with a maximum cap of INR 1,00,000 per unit.
- Reduction of 100% in electricity duty for units installing renewable power generation equipment provided the units utilises a fixed percentage of open rooftop space for solar power generation.

Energy Audit and its Implementation Scheme by Haryana Renewable Energy Development Agency¹⁴³

Financial assistance of 50% of cost for conducting energy audit with a maximum cap of Rs 50,000 is being provided by the Haryana Renewable Energy Development Agency as part of the Energy Audit and Its Implementation Scheme.

Jharkhand Industrial and Investment Promotion Policy 2021¹⁴⁴

The Jharkhand Industrial and Investment Promotion Policy 2021 was launched with an objective to attract investment, generate employment, strengthen infrastructure including cold storage and others, encourage export oriented industries for increasing volume of exports, provide supportive institutional mechanism, promoting technology and skill upgradation in Agriculture and Processed Food products, among other industry subsectors, increase level of processing and value addition for overall development of food processing sector, promote technology transfer, among other goals.

- MSMEs will be entitled to get a Comprehensive Project Investment Subsidy of 25% of investments made in fixed capital investment.

¹⁴² <https://tribalwelfare.goa.gov.in/images/Aadhar-notification-13-10-2022.pdf>

¹⁴³ <https://hareda.gov.in/about-department/energy-audit-and-its-implementation-scheme/#:~:text=Buildings%20%2F%20Industries%20%2C%20financial%20assistance%20of,Rs%2050%2C000%20is%20being%20provided>

¹⁴⁴ <https://www.nswo.gov.in/s3fs/2022-10/Jharkhand%20Industrial%20and%20Investment%20Policy%202021.pdf>

- Assistance @ 100% of the expenditure incurred up to maximum of Rs. 10.00 lakh for obtaining quality certifications like ISO-14000, BIS certification, Green Energy Certificate, Bureau of Energy Efficiency (BEE) Certificate, LEED Certification in New and renewable Energy, Internationally accredited eco-labels OKE-TEX 100 etc., among other nationally/internationally accredited certifications that will enable better market positioning will be provided.
- Financial support will be extended for conducting Energy/Water audit in an enterprise by a recognised institution/consultant. For export oriented units, reimbursement up to 75% of the cost with a maximum cap of Rs. 3 lakhs will be entitled to the eligible units for conducting Energy and Water Audit.
- Financial assistance will be extended towards installation of machinery/ equipment aiming energy or water conservation.
- Financial support will be provided to each cluster for every innovative technology they adopt and introduce in the manufacturing process

Karnataka Industrial Policy 2020-2025¹⁴⁵

The objective of the Karnataka Industrial Policy 2020-2025 is to attract investment, create employment opportunities, increase merchandise exports, maintain 10% annual industrial growth rate, and provide an enabling ecosystem for technology adoption and innovation. The state plans to achieve these objectives through sustainable, balanced and inclusive industrial growth, development and promotion of the MSME Sector, support technology upgradation, boost international trade, promote Industry 4.0 concept, sector specific skill development, attract private investment in industrial parks, enhancing ease of doing business, among other strategies.

- To promote Sustainability and Responsible Industrialization by MSMEs following set of support is extended
 - Rain Water Harvesting: 50% of cost of equipment (max. INR 2.00 lakh)
 - Waste Water Recycling: 50% of cost of equipment (max. INR 7.50 Lakh)
 - Reimbursement of expenses incurred for Water Audit: 75% subject to max. of INR 1.00 Lakh each for water audit (one time)
 - Zero Discharge: 50% of cost of equipment (max. INR 7.50 Lakh)
 - Subsidy for setting up ETP: 50% of cost of ETP (max. INR 50.00 Lakh)

There are some additional incentives provided to MSMEs falling under special category.

- To promote technology upgradation, there is an interest subsidy offered on technology upgradation loan. A 5% interest subsidy is offered on loans availed from KSFC & Scheduled Commercial Banks which are not covered under CLCSS of Government of India for a period of 5-6 years.

¹⁴⁵ <https://industries.karnataka.gov.in/storage/pdf-files/Industry%20Policy%202020-25%20English.pdf>

- In addition, incentives for Quality Certification like ISO Series Certification and BIS Certification are provided. For ISO series certification, incentives amounting to 75% of the cost with a maximum cap of INR 75,000 are provided. Whereas in case of BIS certification, incentives covering 50% of the fees with a maximum cap of INR 20,000 are payable to BIS for certification.

M.P. MSME Development Policy, 2021¹⁴⁶

The M.P. MSME Development Policy 2021 was brought with an aim to achieve objectives like industrial development and boosting MSME competitiveness, creating enabling infrastructure, promoting inclusive growth, creating employment opportunities, among others.

- Reimbursement amounting to 50% of the cost of conducting energy audit with maximum limit of Rs. 50,000 and 25% of the cost for adoption of equipment and machinery with a maximum limit of Rs. 5 Lakhs is provided to promote energy efficiencies in MSME units investing up to a maximum of Rs. 10 crores in plant and machinery.

Promotion of Energy Audit and Conservation of Energy (PEACE)¹⁴⁷

Government of Tamil Nadu has launched the PEACE scheme with broader objective to foster the EE culture across the MSME sector. Main objectives of the scheme are –

- a. Creating awareness and promoting the advantages of new EE technologies.
- b. Identification of the gaps and barriers hindering the uptake of the for-energy conservation and promoting adoption of suitable techniques for energy efficiency and energy conservation.
- c. Promoting the culture for conducting the energy audits to improve energy efficiency and implementing the fuel substitution and monitoring the implementation of recommendations suggested by energy auditors.
- d. Subsidy offered to MSMEs - 50% of the Energy Audit cost subject to a maximum of 75,000 Rupees per energy audit per unit.

Tamil Nadu Industrial Policy 2021¹⁴⁸

The Tamil Nadu Industrial Policy 2021 was announced with an aim to achieve 15% annual growth rate in the manufacturing sector during policy term, attract investments, create employment opportunities, and increase manufacturing sector contribution in the state revenue. These goals are planned to be achieved through incentives and facilitation measures, promoting environmental sustainability and investment in technology adoption, encourage FDI and exports, among other strategies.

- The cost of obtaining certifications like ISO, BIS, BEE, ECOMARK, or any other national or international certification will be subsidised by 50% of the total cost incurred for obtaining the certification, as certified by the Chartered Accountant, limited to Rs. 25 lakh for the period of investment.

¹⁴⁶

<https://mpmsme.gov.in:8080/mpmsmecms/Uploaded%20Document/Documents/MP%20MSMED%20Policy%202021%20Booklet%20English%20-%20Copy%202.pdf>

¹⁴⁷ https://www.msmeonline.tn.gov.in/incentives/html_cye_peace1.php

¹⁴⁸ https://www.indembassybern.gov.in/docs/1617966871Tamil_Nadu_Industrial_Policy_2021.pdf

- Industrial projects undertaking green initiatives under solution areas like use of electric vehicles for transport of goods and people, water conservation, green building certification, pollution control devices, among others are eligible for a 25% subsidy on the cost of setting up such environmental protection infrastructure with a maximum cap of Rs. 1 cr.

Incentive Scheme for Micro, Small and Medium Enterprises in West Bengal¹⁴⁹

This scheme was sanctioned with an objective to extend fiscal incentives to encourage entrepreneurs for setting up MSMEs, creating a sustainable ecosystem which can maximise resource utilisation, create new employment opportunities, among other activities resulting in the accelerated growth of MSME sector in the State.

- Reimbursement of 50% of the cost of energy audit undertaken by a certified agency post implementation of the recommendations will be provided to eligible micro or small enterprise for its approved project.
- Reimbursement of 25% of the cost of installations for energy conservation as per energy audit with a maximum limit of Rs. 2 Lakh will be entitled to eligible micro or small enterprise for its approved project.
- Reimbursement of 50% of the expenditure incurred towards installation of captive Effluent Water Treatment Plant for wastewater recycling and/ or other pollution control devices with a maximum limit of Rs. 2 lakh will be entitled to eligible micro or small enterprise for its approved project.
- Reimbursement of 50% of the expenditure incurred for obtaining ISI/ BIS certification/ ISO 9000/ ISO 14000/ ISO 14001/ ISO 18000/ ISO 22000/ HACCP certification from approved Institutions/ Research Laboratories with a maximum cap of Rs. 5 Lakh will be entitled to eligible micro or small enterprises.

¹⁴⁹ <https://wbexpress.com/bangladesh-micro-small-medium-enterprises/>

Direct loan assistance by SIDBI to MSMEs

Table 111: Schemes by SIDBI supporting technology implementation in MSMEs¹⁵⁰

Scheme	Objective	Eligible Expenditure	Eligible Loan Amount
SIDBI – Loan for Purchase of Equipment for Enterprise's Development (SPEED)	To provide term loan assistance to MSMEs for purchase of Plant and Machinery	Plant, Machinery, Ancillary equipment / MFAs, Second hand machines meeting standard guidelines	Up to 100% finance of the cost of machinery with minimum 25% FD as security (Interest bearing) or Up to 75% of the cost of machinery with 25% promoter contribution with maximum loan amount of INR 50 crore
Assistance to Re-Energize Capital Investments by SMEs (ARISE)	To provide financial assistance to MSMEs engaged in high growth and priority sectors including sunrise sectors	Brownfield / existing entities for undertaking expansion / modernization / capital expenditure in the same line of business	Term Loan up to `5000 Lakh, subject to maximum of 80% of the project cost
SIDBI Thematic Assistance for Purchase of Capital Assets in New Enterprises (STHAPAN)	To provide financial assistance to identified sectors under PLI scheme and other important sectors	Purchase of equipment by greenfield units	Term Loan up to `5000 Lakh, subject to maximum of 75% of the project cost
A Special Dispensation for Nurturing Enterprises Run by Women Entrepreneurs (ARJANA)	To support MSMEs promoted by women entrepreneurs by providing term loan assistance on relatively softer terms	Establishment of new/ greenfield unit or for expansion/ modernization/ other capital expenditure of the existing unit	INR 25 – 300 lakh
SIDBI Assistance and Aid for Thematic Support to MSMEs Promoted by SC/STs (SAATH)	To support MSMEs promoted by SC/ST entrepreneurs by providing term loan assistance on relatively softer terms	Establishment of new/ greenfield unit or for expansion/ modernization/ other capital expenditure of the existing unit	INR 25 – 300 lakh
SIDBI Assistance to Export Oriented MSMEs under UBHARTE SITAARE Programme	To support export oriented MSMEs through term loan	Purchase of machinery or equipment during expansion, modernisation, diversification, technology / capacity upgradation, product R&D, etc.	<ul style="list-style-type: none"> Need based financial assistance, subject to maximum of 80% of the project cost. Joint financing with EXIM Bank available.
SIDBI Term Loan Assistance for Rooftop Solar PV Plants (STAR)	To support MSMEs in reducing their power bill	<ul style="list-style-type: none"> Solar Panels / Equipment's (Including all accessories) from established suppliers, manufacturers, aggregators, etc. Installation cost 	INR 10 – 350 lakh

¹⁵⁰ <https://www.sidbi.in/en/products> (Accessed on 2 November 2023)

Initiatives by IamSMEofIndia supporting EE transition in MSMEs¹⁵¹

IamSMEofIndia is a centre on which MSMEs can rely for tried, tested, credible, affordable, ready-made and guaranteed solutions to save time, energy and costs. IamSMEofIndia is a 14 years old organisation with more than 3000 members and more than 30 services being offered by it.

The 30+ services offered by IamSMEofIndia which are available to all the MSMEs (even the ones who are not members) are as below

Subsidies and incentives	Wealth Management For Business Owners
Credit counselling	Business Networking
Exhibition subsidies	Taxation advice
Up to 90% Discounts on Insurance	IPO Listing
Rs.1.00/L Discount on Diesel	Complete Business Handholding and Consultancy
Advice on Payment Recovery	Nominations to 100% Sponsored International Training Programs
Collective Buying & Discounts	A Bridge between Business Owners & Government Bodies
Placement Services	

Some of the key events organised by IamSMEofIndia in the past are

- **Roadmap ahead for Haryana MSMEs:** Technology and services display, knowledge sessions to support businesses
- **Investment Bazaar:** Technology and services display, knowledge sessions to support businesses in reducing energy costs
- **SIDBI MSME Conclave**
- **MSME Conclave:** Awareness on various incentives & subsidies, Credit Camp, Expert Advice & Various subsidies

¹⁵¹ <https://iamsmeofindia.com/>

D. Other schemes relevant for food processing MSMEs

Schemes by Ministry of New and Renewable Energy (MNRE)

Development of Solar Parks and Ultra Mega Solar Power Projects¹⁵²

With an aim to cut down on the costs associated with setting up a smaller capacity solar project like the expenses incurred for site development, drawing separate transmission lines to nearest substation, procuring water and in creation of other necessary infrastructure, and to reduce the time taken for acquiring land, getting necessary clearances and permissions, etc. the scheme for "Development of Solar Parks and Ultra-Mega Solar Power Projects" was launched in December, 2014.

Under this scheme, it is proposed to set up Solar Parks and Ultra Mega Solar Power Projects having a cumulative installed capacity of 40,000 MW by 2025-26. The States and Union Territories can avail the benefits under this scheme for setting up of Solar Parks at various locations across the country and create the necessary infrastructure for developing a solar power project. These solar parks will provide land with all clearances, transmission system, water access, road connectivity, communication network, among other infrastructure and regulatory things taken care of. The capacity of these solar parks has to be 500 MW and above, however, shorter capacities will be permitted in case of sites with shortage of land.

Under the scheme, the Ministry provides Central Financial Assistance (CFA) of up to Rs. 25 lakh per solar park for preparation of Detailed Project Report (DPR). Beside this, CFA of up to Rs. 20.00 lakh per MW or 30% of the project cost, including Grid-connectivity cost, whichever is lower, is also provided on achieving the milestones prescribed in the scheme.

The respective government of State or Union Territory can set up the Solar Park to supply electricity to MSME Food Processing cluster within the State. This will help in reducing the reliance of the units on grid electricity and also help them in transitioning to cleaner energy usage.

¹⁵² <https://mnre.gov.in/development-of-solar-parks-and-ultra-mega-solar-power-projects/> (Accessed on October 26, 2023)

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