Global Green Growth Institute (GGGI)

Energy Efficiency Services Limited

Azadi Ka Amrit Mahotsav

Federation of Indian Chambers of Commerce & Industry

KARNAL RICE MILL CLUSTER



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ABBREVIATIONS

Abbreviation	Full form
BDS	Business Development Services
BLDC	Brushless Direct Current
cfm	cubic feet per minute
CSSRI	Central Soil Salinity Research Institute
DIC	District Industries Centre
DMC	District MSME Centre
EESL	Energy Efficiency Services Limited
ESCO	Energy Service Company
FD Fan	Force Draught Fan
FICCI	Federation of Indian Chambers of Commerce and Industry
GGGI	Green Global Growth Institute
HCCI	Haryana Chamber of Commerce and Industries
HSIIDC	Haryana State Infrastructure & Industrial Development Corporation
HUM	Haryana Udyam Memorandum
ID Fan	Induced Draught Fan
kWh	Kilowatt-hour
MSME	Micro, Small, and Medium Enterprises
MSME-DI	MSME – Development Institute
NDRI	National Dairy Research Institute
PLC	Programmable Logic Controller
PNG	Piped Natural Gas
RCM	Resource Conservation & Management
SEET	Standard Energy Efficient Technologies
Toe	Tons of Oil Equivalent
TPH	tons per hour
VFD	Variable Frequency Drive
WHR	waste heat recovery

KARNAL RICE MILL CLUSTER

Karnal is one of Historical Districts of Haryana. It is also known as a city of 'Daanveer Karn'. It is known all over the world for production of Rice, Wheat and Milk. It is also known for agriculture research Institutions like National Dairy Research Institute (NDRI), Central Soil Salinity Research Institute (CSSRI), and Wheat Research Directorate, National Bureau of Animal Genetics Resources, Sugarcane Breeding Institute etc. The total area of the Karnal district is 2520 sq. km.

Rice milling is one of the major industries in Karnal as well as in rest of Haryana. Karnal is called the rice bowl of India and is famous for the production of the basmati rice. Basmati is a leading aromatic fine quality rice & is traditionally grown in the North & North Western parts of the country. It is a long grained rice with a fine texture and has been favoured by emperors & praised by poets for hundreds of years

The cluster has about 350 rice mills in operation. Most of the rice mills are located in the periphery of Karnal city. Apart from the Karnal city, the major concentration of mills are in Nissing, Jundla, Indri, Gharounda, Nilokhadi, Taraori & Assandh.

India is one of the leading rice exporters, holding 22.6% of the world market, exports to USA, Canada, European Union countries, UAE, Iran, Iraq and other gulf countries. In domestic market, Karnal-based rice units have pan India presence. To cater the demand from domestic and international market, Karnal-based millers buy rice from Punjab, UP, West Bengal and Andhra Pradesh as locally rice produced my Haryana-based farmers fall short of the demand.

CLUSTER ASSOCIATIONS & SUPPORT INSTITUTIONS

Karnal Rice Mill cluster consist of many support institutions and agencies such as industry associations, government agencies, academic/R&D institutes, financial institutions, BDS providers etc. situated within and outside the cluster, which play a key role in developing the cluster. The key stakeholders of Rice Mill Cluster, Karnal are:

Major Industrial Associations

a) **Mr. Nathi Ram Gupta, President, All India Rice Exporters Association**

b) **Mr. Naresh Bansal, President, Karnal Rice Millers & Dealers Associations**

c) **Mr. R L Sharma, Chairman, Haryana Chamber of Commerce & Industry (HCCI), Karnal**

d) **Mr. Praveen Gulati, President, Laghu Udyog Bharti, Karnal**

e) **Mr. Sushil Kumar Jain, President, Haryana Rice Exporter Association, Karnal**

Government Support Institutions

a) District MSME Centre (DMC)

DMC is another major government stakeholder for the cluster. The office of DMC comes under the Directorate of MSME and is headed by the General Manager who is assisted functional managers and technical field officers. DMC promotes and routes subsidies to micro and small enterprises in the region. The Karnal DMC is actively supporting the units in the cluster to register them under central and state government portals like Udyam Registration, Haryana Udyam Memorandum (HUM) etc. The DMC would play a role in facilitation or implementation of any kind of policy, scheme or project in the Rice Mill cluster.

b) MSME-Development Institute, Karnal (MSME-DI Karnal)

MSME- DI, Karnal is a field office of the Development Commissioner (MSME), Ministry of MSME, New Delhi, which is an apex body for formulating, coordinating and monitoring the policies and programmes for promotion and development of MSMEs in the country. The MSME -DI provides a wide range of support services to the MSMEs including implementation of various schemes of central government.

c) Haryana State Infrastructure & Industrial Development Corporation (HSIIDC)

HSIIDC is a major agency in the state to promote the setting up and promotion of small, medium and large scale industrial units. The corporation also acts as a state-level financial institution and provides long term loans for industrial projects. The important activities of the corporation are, development of industrial areas/ estates, support for entrepreneurs for securing registrations/ licences/ clearances from the statutory/other authorities, provisioning of term-loans etc.

RAW MATERIAL & PRODUCT MANUFACTURED

The Rice milling is the process of removal of hull and bran from paddy grains to produce polished rice. Rice is a Kharif crop and in District Karnal, the Paddy / Rice of following varieties is grown/ processed.

A. In wide term the rice is categorised into two kinds

i. Basmati Rice

ii. Non-Basmati Rice.

B. From manufacturing / pricing angle, it is categorized as below:

i. Raw Rice (Processed as raw i.e. without giving boiling/heating treatment to Paddy)

ii. Parboiled Rice (Processed after giving boiling/water heating treatment to the Paddy).

C. The raw or parboiled technique of processing may be applied to both Basmati & Non-basmati Rice.

i. These are also categorized as Grade A (Basmati Rice & superfine quality) & Common rice (Non Basmati Rice Grade B) by the purchasing agencies & both of these kinds can either be Raw or Parboiled.

ii. From marketing & sowing purpose, the varieties are described as below:

Basmati Group	Non-Basmati Group
HBC – 19 (Taraori basmati)	Govinda
CSR – 30	HKR – 120
Haryana Basmati 1 (HKQ-228/IET-10367)	HKR-126 Sharbati
Pusa Basmati –1 (IET 10364)	PR-116
Pusa Sugandha –2	PR – 111
Pusa Sugandha –3	PR – 114
	PR – 113
Basmati 386 & 370	PR 9 & 8
	IR-8 Java
	Pusa –44

Basmati group varieties are called superfine varieties whereas the Non basmati Group PR Varieties are medium fine & other are thick Rice Varieties.

The Basmati Varieties have been standardized & notified vide Seed Act of India 1966. The list of notified Basmati varieties that are exported from Haryana are: Basmati 370 Taraori Basmati (HBC –19), Pusa Basmati –1 Haryana Basmati –1 & Pusa Sungandha 2 & 3.

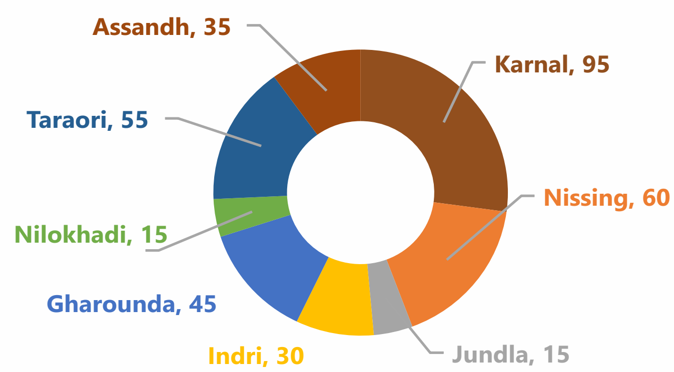
PRODUCT & PRODUCTION CAPACITIES

Karnal cluster presently owns about 350 nos. of Rice Milling Industries located in various blocks/villages of District Karnal like Karnal, Nissing, Jundla, Indri, Gharounda, Nilokhadi, Taraori & Assandh. The production of par-boiled the rice is about 30-35% from the cluster (mainly in Nissing, Taraori, Assandh) and rest 65%-70% of raw rice is produced. About 5-10 hulling units (i.e., units engaged only in removal of husk and polishing activities) produce only raw rice.

There are both small scale & medium sector industries, which includes processing/ milling capacity of these units ranges from 0.5 ton per hour to 10 ton/hour and whereas big units with processing capacity of update 25 T/hr.

Rice Mills Location	No. of Rice Mills
Karnal	95
Nissing	60
Jundla	15
Indri	30
Gharounda	45
Nilokhadi	15
Taraori	55
Assandh	35
Total	**350**

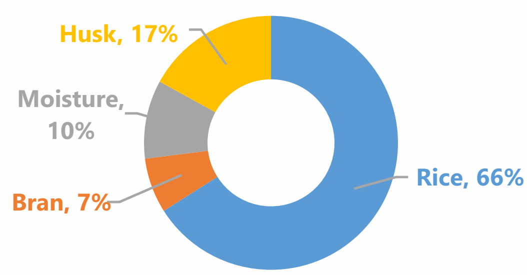
Source: Field survey and interaction with units



The big & medium mills operate round the clock for about 25 days per month (270 days per year) while shall par-boiled units operate for about 12–16 hours per day (200–250 days). The hulling units operate for about 12 hours per day for about 3–4 months in a year.

The average yield ratio of the local paddy is about 65%-67%, which, however varies based on the quality of grains and contaminants present in raw paddy. Apart from rice, the important by-products from rice mills include husk (16%- 18%) and bran (6%-8%). Husk in par-boiled rice mills is used in-house as boiler fuel and the bran is sold for further processing.

Contents of Paddy	Percentage Yield
Rice	66%
Bran	7%
Moisture	10%
Husk	17%
Total	100%



PRODUCTION PROCESS

Rice is basically the seed or kernel of paddy, which is covered by two different layers, namely- bran (inner layer) and husk (outer layer). Literally, paddy becomes rice only when the two layers are removed properly through different milling processes. In the first step, brown rice is extracted by removing hull/husk from the paddy, which contains bran layer still intact around the kernel. In the second step, the bran layer is removed by polishing machine that rubs the grains together under pressure, and the output is the polished white kernel or fine rice, which is ready for cooking. The former process is known as hulling and the latter is known as milling of paddy.

a) Paddy preparation

When paddy comes into the mill, it contains foreign materials such as straw, weed seeds, soil, and other inert materials which are removed from paddy using an air blower and series a of vibrating screens with different cut off sizes. The cleaning of raw paddy, equivalent to one batch capacity, takes around 1-2 hours depending on the production capacity and technology employed. The cleaned paddy after preparation is stored in vertical silos for further processing. The capacity of the paddy pre-cleaner is normally 1.5 times the milling capacity.

b) Parboiling

Parboiling is done in three steps: Soaking, steaming and drying. Parboiling causes a gelatinization of the starch during the boiling and during cooling the amylase molecules re-accociate with each other and form a tightly packed structure. The kernels are harder and appear glassier after the parboiling process. The parboiling process moves micro nutrients contained in the bran, which is usually removed in the whitening process in the rice mill, to the endosperm. Parboiled rice is therefore more nutritious than white rice.

Parboiling also mends little cracks that might have developed in the endosperm during post harvest processing and therefore head rice recoveries of parboiled rice are higher. Parboiled rice takes less time to cook and is firmer and less sticky when cooked

- **Soaking**

  The cleaned paddy is transferred by a conveyor belt from the storage silos to the soaking pits/silos. Typically, there are two soaking pits, each having a holding capacity between 4–10 tonnes of cleaned paddy. Paddy is soaked in raw water at ambient temperature for about 4 hours. The water is drained out by gravity after the soaking. The process of draining water takes about an hour for one complete batch of soaked paddy. The entire soaking cycle takes about 10–14 hours for one batch.

Steaming Process

Soaking tank & Dryer

- **Steaming**

  In the par boiled rice manufacturing process, the soaked paddy is heated using steam from the in boiler house. In case of raw rice, the steaming operation is not required. Soaked paddy from the soaking pits is transferred to a steaming vessel by gravity. During the steaming stage, two steaming vessels are operated alternately for steaming 600–800 kg of soaked paddy in a batch for about 10–20 minutes until steam starts coming out from the vessel indicating it has reached the top surface of the steaming bowl and steaming is completed. The entire batch of soaked paddy from the two bins takes around 4 hours for complete steaming.

- **Drying**

  The steamed paddy is dried by a continuous process in mechanical dryers using hot air. Steamed paddy with around 30–45% of moisture is first transferred to dryer where moisture is reduced to 22%. The hot air is generated in a steam-based heat exchanger with automatic temperature controller to maintain hot air temperature to around 700 oC. Partially dried paddy is then transferred to a second dryer for final moisture reduction to the level of 10–14%. Dried paddy is stored in silos before being transferred to the milling section.

c) Milling

In the milling section, dried paddy passes through processes like screening, dehusking, separation, cone polishing, separation and grading, silky polishing, and so on, depending upon the existing facilities in the rice mill, before it is transferred to a bagging yard for manual or automatic packing of the final polished rice. Husk, the by-product in rice milling, is primarily used as fuel in the boiler. The other by-product, bran, accounting for about 8% by the weight of paddy is sold. The milling section consists of various motive loads connected to operate either single drive or multiple drives with a common shaft using different pulleys and belts. Few new mills have automated the milling section by employing latest imported technologies. The investment in automation has helped to increase the production capacity and product quality.

- **Removing the husk (dehusking or dehulling)**

  Brown rice is produced by removing the husk from rough paddy rice. The husk is removed by friction as the paddy grains pass between two abrasive surfaces that move at different speeds. After dehusking, the husk is removed by suction and transported to a storage dump outside the mill. Husk accounts for 16%- 20% of the paddy weight and an efficient husker should remove 90% of the husk in a single pass.

Dehusking

Paddy separator

Separation of white Rice

- **Paddy separation**

  The paddy separator separates unhusked paddy rice from brown rice. The amount of paddy present depends on the efficiency of the husker and should not be more than 10%. Paddy separators work by making use of the differences in specific gravity, buoyancy, and size between paddy and brown rice.

- **Whitening or polishing**

  White rice is produced by removing the bran layer and the germ from the paddy. The bran layer is removed from the kernel through either abrasive or friction polishers. The amount of bran removed is normally between 6-8% of the total paddy weight. To reduce the number of broken grains during the whitening process, rice is normally passed through two to four whitening machines connected in series.

- **Separation of white rice**

  After polishing, white rice is separated into head rice, large and small broken rice, and "brewers" by an oscillating screen sifter. Head rice is normally classified as kernels that are 75–80% or more of a whole kernel. To attain a higher degree of precision for grading and separation a length or indent grader is used.

- **Rice mixing**

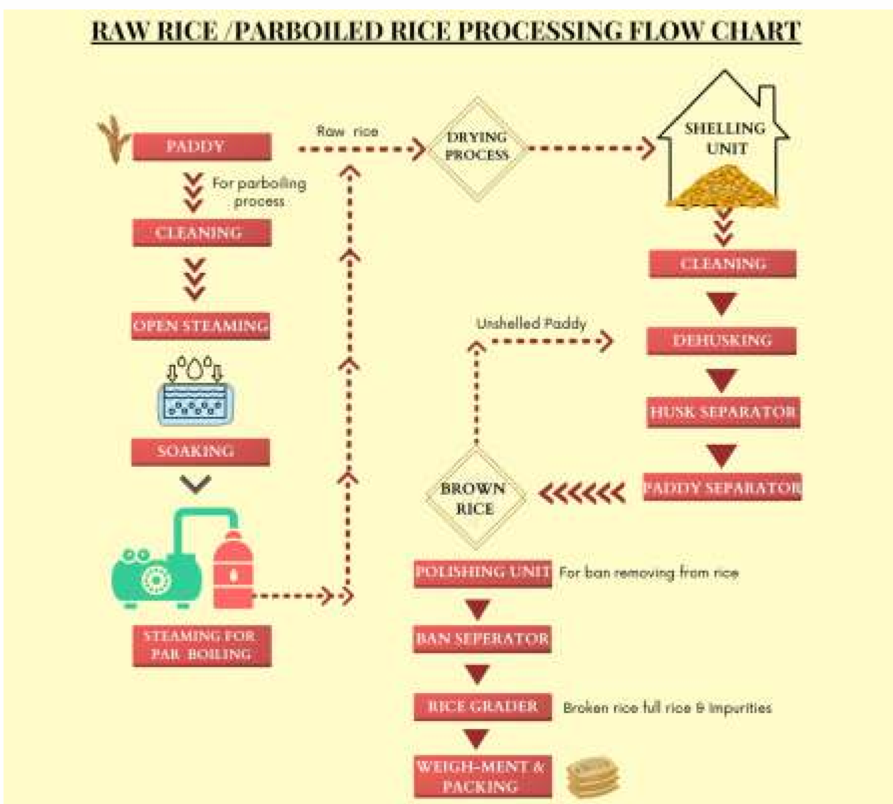
  A good rice mill will produce 50–60% head rice (whole kernels), 5–10% large broken and 10–15% small broken kernels. Depending on requirement, rice grades in the market will contain from 5–25% broken kernels. If rice mixing is to be done properly, then a volumetric mixer is necessary.

- **Mist polishing**

  Mixing a fine mist of water with the dust retained on the whitened rice improves the luster of rice (polishes) without significantly reducing milling yield. A friction type of whitening machine, which delivers a fine mist of water during the final whitening process, is used for "final" polishing before sale.

- **Rice weighing**

  Rice is normally sold in 50 kg sacks which must be accurately weighed and labeled. While most rice mills use a manual mechanical weighing system, very accurate, and fast electronic systems are also available



MAJOR ENERGY CONSUMING EQUIPMENT'S, UTILITIES IN RICE MILLS

a) Boiler for Steam Generation:

Steaming Process

Boiler is used for the generation of steam required for par boiling. The capacity of boilers used in rice mills vary in the range of 2.5–20 tph. Steam is generated at a pressure of about 7–10 kg/cm2(g). Condensate from indirect use points (like mechanical dryers) is recovered and sent back to the boiler feed tanks to utilize the sensible heat. Husk firing leads to a significant generation of suspended particulates in the flue gases, and hence, pollution control systems such as cyclones are needed to trap the suspended particulates. Few units have installed large settling chambers through which flue gases are passed. While particulates are trapped and collected from the bottom of the chamber, the water kept at a tank above the chamber gets preheated in the process. A majority of the boilers do not have any waste heat recovery (WHR) system for preheating the boiler feedwater. A forced draught fan is used both for combustion air as well as husk feeding simultaneously. The medium-sized units use basic boiler instrumentation. However, most rice mills do not have any instrumentation apart from pressure gauge to monitor the operating parameters of the boiler and steam -distribution system.

b) Steaming vessel

Upon the completion of raw water soaking in the soaking tanks, paddy is loaded into the steaming vessels in batches through gravity. Steam is directly injected at the bottom of the vessels by opening a valve till it starts coming out from top. The entire steaming cycles is based on the type of paddy being used. The condensed steam is drained out.

c) Dryer

Traditionally, rice mills were using sun drying. However, sun drying does not support operation, especially during the rainy season. Most mills in the Karnal cluster have adopted mechanical dryers for the drying of steamed paddy. The par-boiled paddy is fed to the dryer. Steam from the boiler exchanges heat with the forced air blown across the heat exchanger to generate hot air. The temperature of the hot air is maintained manually by controlling the opening of the steam valve. Steam traps are used to remove the condensate formed in the steam lines

d) Milling section

The dried paddy is transferred to the milling section and is stored in silos. The milling section comprises the following areas:

- **Destoning:**

  In this pre-cleaning area, the contaminants carriedover along with paddy, such as stones, are removed through vibrating sieves.

- **Dehusking:**

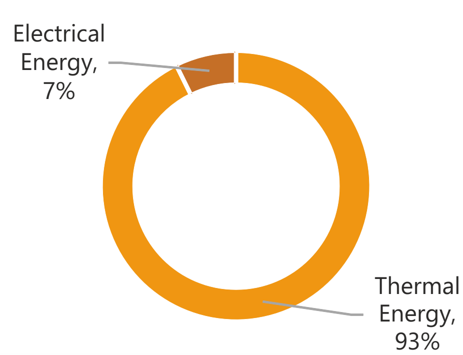
  Husk is removed from the paddy to produce brown rice. The husk generated is used as fuel in the boiler for steam generation.

- **Whitening and polishing:**

  The product from dehusking has a brownish layer called bran. The bran is removed from the brown rice in the polishing area to produce white rice. Bran, which is rich in protein contents, is sold as a by-product for the production of rice bran oil and poultry products.

The utilities used in the rice mills include electric motors, material conveying systems, water pumping systems.

ENERGY SCENARIO IN THE CLUSTER



The primary source of energy in rice mills is husk used in boiler for steam generation. Additionally, electrical sourced from grid is the secondary source of energy for operating electrical utilities such as pumps, motors, compressors etc. Few large units has installed Co-Generation plant to cater steam & power requirement.

Thermal energy in the form of steam is used for soaking of paddy and subsequent drying. Husk, a by-product, is used as a fuel in boiler for generating steam. Generally, 90-95% of husk generated is used in-house for steam generation and the balance 5-10% is sold.

The major energy forms in a rice mill are rice husk and electricity. The hulling units, which do not require soaking and steaming of paddy, and only have husk removal and polishing operations use only electricity. In a par boiled unit, internally generated rice husk constitutes about 93% of the total energy requirement. The balance 7% of the energy is met through grid electricity. The average 'specific energy consumption' (SEC) of parboiled units in the cluster is 0.079 toe per tonne. The typical breakup of energy consumption in a rice mills are shown in the following table.

Particular	ToE/year	SEC	%
Thermal Energy	3313	0.0736	93%
Electrical Energy	261	0.0058	7%
Total Energy	3574	0.0794	100%

The annual energy consumption of the cluster is estimated to be about 5,44,504 toe. The estimated 'greenhouse gas' (GHG) emissions from rice mills at the cluster level is 5,90,400 tonne of CO2 per annum.

Energy type	Annual consumption	Equivalent energy (toe)	Equivalent CO_2 emissions (t Co_2)
Husk	15,85,728 tonne	4,91,576	–
Electricity	615 million kWh	52,929	5,90,400
	Total	5,44,504	5,90,400

Prices of major energy sources is provided below table

Source	Price
Electricity HT Industry (above 50 kW)	Demand Charges: 165 per kVA Energy Charges: @11 kV- 6.55 per kVAh @33 kV-6.55 per kVAh @66/132 kV-6.45 per kVAh
Electricity LT Industry (above 50 kW)	Demand Charges: 185 per kW Energy Charges: @up to 10 kW-6.35 per kVAh @10-20 kW-6.65 per kVAh @20-50 kW-6.40 per kVAh
Rice Husk	By products, available at zero cost (Selling price of excess husk: Rs 3 to 4.5 per kg)
HSD	Rs. 90 per litre (price subjected to market fluctuations)

Source: Field survey and interaction with units

STANDARD ENERGY EFFICIENT TECHNOLOGIES (SEET) ADOPTION POTENTIAL

There is great potential exist in Rice Mills for adoption Standard Energy Efficient Technologies (SEET) through innovative financing mechanism which will Improve Industrial Productivity, Reduce Electricity & Fuel Bills, Control Emission of Pollutants, Access to Technologies at Discounted Price, reducing Operating & Maintenance Cost. The SEET already demonstrated by EESL in other MSME clusters, which are applicable for Karnal Rice Mill textile cluster are as below:

a) Installation of Automation and Control System in Boiler

Existing practice:

Rice Mills are equipped with boilers in the range of 2.5 TPH to 20 TPH which are typically husk fired. Most of these boilers are equipped with air preheater for waste heat recovery system from flue gases. Although, in some cases there are VFDs installed in the FD / ID Fans, the air flow control is manually done in most of the units.

Studies suggest that most of the units fail to maintain the correct amount of air in the combustion chamber, required for optimum combustion. This leads to incomplete combustion with a significant percentage of the heat loss through dry flue gas loss. The excess air flow can be determined by the free oxygen percentage in the flue gas which automatically leads to higher excess air percentage. Also, the draft pressure is not monitored and controlled to the desire level. The blow-down control in the boiler is also manual which leads to a lower boiler efficiency.

Proposed Technology:

Automation and Control system in boiler helps to monitor and analyze various boiler parameters, improve the efficiency of boiler through effective monitoring and control of air-fuel ratio; controlling furnace draft; maintain optimum fuel feed based on steam pressure in boiler and automatic blow-down. Automation and Control system in boiler will:

- Optimize boiler combustion efficiency through effective monitoring and control of Forced Draft (FD), Induced Draft (ID) and Fuel Feeder.
- Monitoring and synchronizing fuel feeder control with respect to instantaneous steam pressure.
- Excess Air monitoring and control based on the fuel feeding rate with the help of feedback from the stack oxygen sensor.
- Furnace draft pressure monitoring and controlling the furnace at slightly negative draft pressure.
- Automatic boiler blow-down based on TDS level monitoring

The proposed technology of automation and control system in boiler not only helps to monitor and analyse various boiler parameters but also can improve the efficiency of boiler through effective monitoring and control of air-fuel ratio; controlling furnace draft; maintain optimum fuel feed based on steam pressure in boiler and automatic blow-down.

Success Story: Demonstration in MSME Clusters

Location of MSME Cluster	:	**Surat**
Type of Cluster	:	Textile
Boiler efficiency (Baseline)	:	62.25
Boiler efficiency (Post Implementation)	:	66.39
Annual Fuel saving	:	248 tonne/year
Annual Cost Savings	:	16 Rs in lakh/year
Investment	:	₹ 12 lakh
Simple Payback	:	0.73 year

Benefits Incurred from the Project

- 2-5 % reduction in specific fuel consumption
- 5-7% Reduction in energy consumption
- 2-5% Improvement in boiler indirect efficiency
- Improvement in boiler blow-down loss
- Improvement in boiler draft pressure

b) Installation of 100% Flash Steam and Condensate Recovery System

Existing practice:

Steam at a working pressure of 7-10 kg/cm2 is used in paddy processing units ie steaming vessel (direct steam) and dryers (indirect heating) for hot air generation. The majority of rice mills in the Karnal cluster do not recover the condensate fully, which is produced during hot air generation. Many of the units have open loop condensate recovery system, resulting in contamination of the water. Even in units that have installed condensate recovery, mainly in the dryer section, the condensate lines are not insulated, thus loading to a loss in the heat availability

Also in typical units, no traps or thermodynamics (TD) traps are used in these pressurized steam machines. TD traps for such applications are not suitable to remove condensate properly. In this process, a significant amount of water and energy is lost into the atmosphere

Proposed Technology

Installation of condensate recovery system to reuse the water and sensible heat contained in the discharged condensate. The system includes a positive displacement condensate pump which can recover (suck) hot condensate and flash steam from the steam pipeline and feed the same into the boiler feed water tank. The pump may also be equipped with an in-built receiver for condensate which eliminates the need for a separate storage tank. The installation of the system will allow 80-100% recovery of condensate formed during the jet dyeing. The technology can be suitably modified for mechanical or sensor based control

Success Story: Demonstration in MSME Clusters

Location of MSME Cluster	:	**Surat**
Type of Cluster	:	Textile
Name of the MSME Unit	:	Pashupati Prints Pvt. Ltd
Coal consumption in boiler (Baseline)	:	18 tonne/ day
Coal consumption in boiler (Post Implementation)	:	17.5 tonne/ day
Annual Coal Saving	:	178 Tonne/year
Annual water Saving	:	8,151 kL/year
Annual Monetary Saving	:	Rs. 10,80,000
Investment	:	Rs 6,50,000
Simple Payback	:	0.6 years

Benefits Incurred from the Project

- Reduction in specific energy consumption by 2-3%
- Boiler Efficiency improvement 2-5 %
- Maintenance cost reduction 20-30%
- Reduction in breakdown 20-30%

c) Replacement of Reciprocating Compressor by Screw Compressor with VFD & Permanent Magnet Motor

Existing practice:

Compressed air is a continuous operating utility in rice mills in the Karnal cluster. It is also one of the highest energy intensive utilities. Different factors influence the performance of compressed air system, such as the intake air temperature and quality, generation pressure, capacity utilization, type of technology used, design of distribution network, and so on.

In the cluster, the maximum pressure requirement at the utilization end is 5.5 bar; whereas, the set generation pressure in the air compressors was observed to be in the range of 7.5–10 bar. As a thumb rule, 1 bar of increased air pressure leads to a 7% additional consumption of electricity. For the optimum utilization of compressed air, it is recommended to keep the set pressure of compressed air at about 1 bar above the pressure requirement at the point of utilization.

In the exiting manufacturing process the compressed air system is distributed in nature and most of the compressed air demand is catered by multiple reciprocating air compressor installed at various location of the plant. In most of the cases separate reciprocating air compressors are installed for individual processes. Generally, these single stage reciprocating compressors work with higher noise and have a relatively high cost of compression. The operational efficiency varies from 22 to 35 kW/100 cfm, based on the age of the equipment.

Proposed Technology:

Based on the detailed analysis of the existing compressed air system, it is proposed to replace the low performing reciprocating compressor with VFD enabled permanent motor based screw air compressor.

The package of **Screw Compressor with VFD & Permanent Magnet Motor** offers flexibility to operate air compressor to meet varying air requirement without compromising on performance and Energy Efficiency. Each component of this technology has added advantages over conventional reciprocating or Screw compressor with standard motor.

- **Permanent Magnet Motors** offer increased efficiency compared to standard motors. The rotor is made up of a permanent magnet.
  - Motor is directly connected to the screw arrangement of the compressor which nullifies the transmission loss of a belt- driven system (3% to 5%). Such a direct drive system enhances the overall efficiency of the system.
  - Permanent Magnet Motor is maintenance free.
  - VFD provides soft starting, enabling controlled acceleration and deceleration.
  - VFD keeps desired line pressure constant, adjusting automatically according to system air consumption by varying motor speed.
  - Through VFD, compressor operating range reduces from 1-2 kg/cm2 to 0.2- 0.4 kg/cm2.
  - VFD with highly efficient rotary screw compressor can cater to fluctuating compressed air requirement efficiently.

Success Story: Demonstration in MSME Clusters

Location of MSME Cluster	**:**	**Bhestan, Gujarat**
Type of Cluster	:	Textile
Name of the MSME Unit	:	Narayan processor
Baseline Specific Energy Consumption	:	0.27 kWh/cfm
Resulted Specific Energy Consumption	:	0.17 kWh/cfm
Annual Energy Saved	:	1,87,651 kWh
Annual Money Saved	:	Rs. 14,20,000
Total Project Cost	:	Rs. 16,00,000
Simple Pay-back Period	:	13 Months
Life of New Technology	:	15 Years

Benefits Incurred from the Project

- Reduction in specific power consumption by 40%
- Replacement of multiple compressors with one compressor
- Reduction in maintenance cost and break-down time by 50%
- Noise free operation

d) Replacement of IE1 or sub IE1 level motors with IE3 motors

Existing practice:

In India, about 40% of the total electricity consumption is contributed by the industrial sector. Electric motor-systems use 28% of total national electricity which is reasonably high. India has banned IE1 motors since October 2017.

Historically, the motors sold (and used by end-users) in India have lower energy efficiencies (IE-1 or less) than the efficient products technologically available and manufactured. Based on estimation, 90- 95% of the current installed stock of motors is at IE1 & sub-IE1 levels. The issue of multiple rewinding in the service life of motor(s) further reduces the efficiency drastically. This results in more energy consumption, hence affects the competitiveness of any business entity.

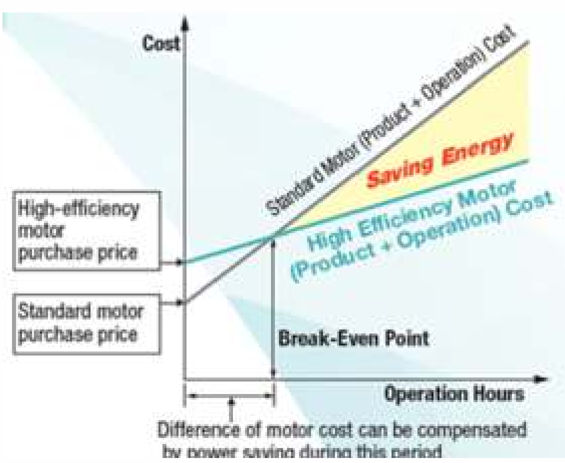
Proposed Technology:

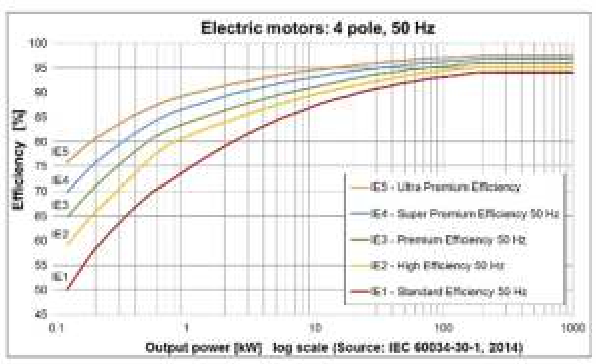
Replacing the existing IE1 or sub-IE1 level motors with IE3 motors can save energy as well as operating cost, which is more than its purchase cost. IE3 motors offers

- Higher Efficiency and hence Lower Power Consumption
- Constructed with superior material
- Longer Insulation and Bearing Lives
- Lower Waste Heat Output
- Less Vibration

Success Story: Demonstration in Textile unit

Year of demonstration	:	**2018**
Location of MSME	:	Banswara, Rajasthan
Type of Cluster	:	Textile
Name of the MSME Unit	:	Banswara Syntex Limited
Annual Energy Saved	:	2,44,094 kWh
Annual Money Saved	:	Rs. 14,64,563
Total Project Cost (125 nos. IE3 Motors)	:	Rs. 35,88,000
Simple Pay-back Period	:	2.4 Years
Life of New Technology	:	15 Years
Warranty of the New Technology	:	3 years





Benefits Incurred from the Project

- IE3 motor provide 2-3% higher efficiency compare to IE2 motor, which even higher compare to IE1 motor
- Suitable for continuous process industries , where high energy saving is essential.
- Short Payback Period, Enhanced motor life, Less maintenance
- Rating-wise energy saving percentage for replacing Standard motors with IE3 motors

  3.7KW - 9.89%

  5.5KW - 7.35%

  7.5KW - 3.29%

  11KW - 2.13%

  15KW - 2.18%

e) Replacement of Regular Fans with BLDC Fans

The fan is a device that delivers the amount of cool air at low pressure. There are many different types of fans and various applications. The fans used in the modern age are the electric fans mostly comprised of a motor connected to blades. The motor blades that move at a fast speed to create a fast flow of air causing the air to cool. In warm places, it is common to see fans to get rid of the discomfort of heat and sweat

Existing practice:

Industries are using ceiling fans with an ordinary induction motor which consumes about 75-80 W power. Such fans are used in the industry for several decades.

Proposed Technology:

It is proposed to replace regular fans with BLDC fans. The term BLDC stands for Brushless Direct Current Motors. It essentially comprises a synchronous motor clubbed with a DC electric source. The windings in the BLDC motor are supported by the housing. This feature allows the motor to cool by conduction. So, no external airflow is required for internal cooling, thus protecting the motor from dirt and foreign substances. Some of the prime benefits of BLDC motor fans can be listed as

- BLDC contains Permanent Magnets while Electromagnet is used in Induction Motors, with Direct Current input
- Super Energy efficient ceiling (BLDC) fan providing 50% savings over regular ceiling fan, consumes about 25-30W power
- Remote integrated ceiling fan with service value > 6.0 (m3/min/watt)
- Fan with wide operating voltage (90 – 300V)
- Capacitive regulator operated BLDC fan
- Lower noise, lower static pressure due lower RPM, and higher airflow(15% more) compared to any other fans
- Runs upto 3X longer on inverter

Success Story: Demonstration in Ceramic unit

Year of demonstration	:	2019
Location of MSME	:	Thangadh
Type of Cluster	:	Ceramic
Name of the MSME Unit	:	Sunrise Pottery Works
Annual Energy Saved (108 ceramic units and 17600 fans)	:	48.2 Lakh kWh
Annual Money Saved	:	Rs. 335 Lakh
Total Project Cost (17600 nos.)	:	Rs. 382 Lakh
Simple Pay-back Period	:	2.4 Years
Life of New Technology	:	15 Years
Warranty of the New Technology	:	3 years

STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS (SWOT) ANALYSIS

A SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis of the Rice Mill units in the cluster has been carried out keeping in mind the energy/environment compliance, marketing, business environment and, skills, inputs, innovation of the units. The SWOT analysis is provided in below table

Area	Strengths	Weaknesses	Opportunities	Threats
Energy/ Environment	• Increased focus on environment due to requirement from buyers • Availability and consumption of husk (by product) as source of energy for boilers	• Lack of energy efficient measures to reduce energy consumption • High energy cost leading to increased production cost and pollution to environment	• Incentive available from government for setting up ETP for individual units and CETP for industrial area • Potential to reduce energy costs by energy auditing	• Increased focus on meeting environment standards • Processing of paddy causes pollution due to ash formation during combustion and particle release during husking impacts environment and require technological • improvement to meet the environment compliances
Market	• Strong presence in local and international market & export support available under various schemes of state and central government • Cluster is located within Karnal town, which has evolved as a rice milling hub in the region • Cluster is located in proximity of Delhi which is a major supply hub • Increased consumer preference toward packaged rice	• Extended period as off season (around 6 months) for non-exporting units • Lack of branding by non- exporting units • Compulsory and controlled marketing for levy rice	• Rising income levels and increasing urbanisation are driving growth of the domestic market • Potential to export products • Support available under government schemes for promotion of clusters • Common branding and exporting under the name of cluster to compete with large players	• Intense competition from Asian rice producing countries • Patent exploitation of Indian Basmati by international market

Area	Strengths	Weaknesses	Opportunities	Threats
Skill/ Manpower	• Workers acquired skills on-the-job using traditional machineries	• Lack of skill up-gradation trainings to existing workforce • Non availability of rice processing training institute in the region • Lack of interaction between SMEs and technical institutes for providing technical training • Lack of mechanism to mobilize local youth for training in the rice milling industry	• Customized training programs on required skills (operations, quality control etc.) • Engagement of technical institutes for skill development programs	• Skill base needs upgrdation to adopt latest technology and management systems may lead to increased labour cost and cost of production • Inclination of youth to work in other lucrative sectors
Inputs	• Availability of raw materials from government procurement agencies and mandis (open market) at competitive prices • Availability of incentives to exporters for purchase of materials on subsidised rates • Availability of raw materials and other inputs • in the vicinity	• Controlled MSP of paddy leads to increased cost of production • Compulsion of processing the levy supply rice from procurement agencies • Lack of common platform to enquire the cost and sources of raw materials	• Availability of inputs in sufficient quantity in domestic market • Potential for non-exporting units to export • Available institutional support for promotion of rice cluster	• Imposition of taxes & levies in comparison to neighbouring states may further lead to closure/shift of industries to neighbouring states • Cost of power in India is higher than competing Asian countries like China, Bangladesh, Vietnam
Innovation	• Ability to produce world class quality of rice in the cluster with lower cost of production • Ability to run non-standardized machines for rice milling profitably	• Lack of facility for specialised processes of rice milling like sorting & grading in vicinity • Lack of willingness to adopt new technology and new production methods	• Participation in Trade fairs, Exhibition, Trainings &Workshops to learn and adopt better QMS	• Lack of innovation may affect the business and unit may lose market share.

Area	Strengths	Weaknesses	Opportunities	Threats
Innovation	• Ability to process customized quality of rice as per buyers' • specifications	• Lack of process automation	• Structured processes for information sharing among SMEs in the cluster	• Competitive manufacturers from countries such as Vietnam, Bangladesh, China may affect the business through innovations
Business Environment	• Steady growth in domestic demand of packaged rice • Cluster well known as a rice milling hub across North India • Availability of government support in terms of encouraging policies and initiatives • Proactive rice millers & dealers association in Kaithal district • Ability of grow export segment & meet International • requirements	• Increased tax/levy & controlled trade has resulted in sustainability issues to rice milling units • Lack of awareness regarding of regulatory frameworks and available incentives to micro & small rice milling units • Lack of common infrastructure/CFC facilities	• Tremendous growth potential due to availability of Institutional & Policy support • Establishment of CFC with latest technologies for • quality improvement	• Imposition of higher tax, levy in comparison to neighbouring states may discourage the industry. • Change in policies and regulatory environment

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About GGGI

The Global Growth Institute (GGGI) organization, headquartered in Seoul, Republic of Korea. dedicated to supporting and promoting strong, inclusive and sustainable economic growth in developing countries and emerging economies.

GGGI's mission is to support the transition of its member and partner countries toward a model of green growth by developing and implementing strategies that simultaneously achieve poverty reduction, social inclusion, environmental sustainability and economic growth. By pursuing this mission, GGGI aims to achieve its vision of a resilient world of strong, inclusive and sustainable green growth.

About EESL

Founded in 2009, Energy Efficiency Services Limited (EESL) is a super Energy Service Company (S-ESCO), which enables consumers, industries and government to effectively manage their energy needs through energy efficient technologies. EESL, a JV of PSUs under the Ministry of Power, Government of India is implementing the world's largest energy efficiency portfolio across sectors like lighting, buildings, industry electric mobility, smart metering agriculture, etc. at an enormous scale. EESL's energy efficiency solutions have saved India over 47 billon Kwh energy annually while reducing 36.5 million tons of carbon emission.

About FICCI

Established in 1927, FICCI is the largest and oldest apex business organisation in India. A non-government, not-for-profit organisation, FICCI is the voice of India's business and industry. FICCI is deeply committed to every aspects of Sustainable Development, Global Climate Change, Energy Efficiency and strategies to suggest global solutions to critical energy & environmental issues.It serves its members from the Indian private and public corporate sectors and multinational companies, drawing its strength from diverse regional chambers of commerce and industry across states, reaching out to over 2,50,000 companies. The Resource Conservation Management (RCM) Division of FICCI works closely with both large industries and energy intensive Micro, Small & Medium Enterprises (MSMEs) to improve their Energy & Environmental Performance.

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