Energy Profile

Burdwan Rice Mill Cluster

THE ENERGY AND RESOURCES INSTITUTE
Creating Innovative Solutions for a Sustainable Future

Promoting Energy Efficiency in SMEs
SAMEEEKSHA

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Contents

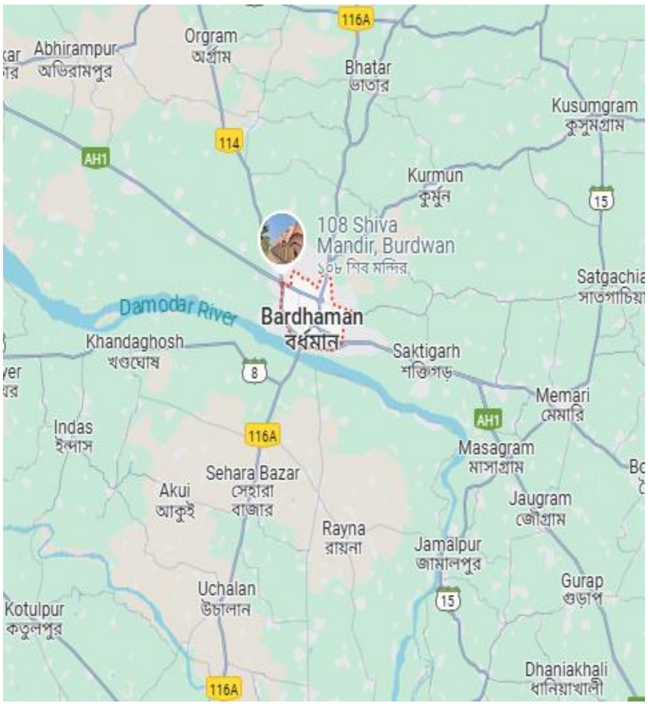
Abbreviations

CO_2	Carbon Dioxide
FBD	Fluidized bed dryer
GHG	Greenhouse Gas
HP	Horsepower
IBR	Indian boiler regulation
kVA	kilo volt ampere
kWh	kilo watt hour
LSU	Louisiana State University
MSME	Micro Small and Medium Enterprise
ROI	Return on investment
SEC	Specific energy consumption
TERI	The Energy and Resources Institute
t-CO_2	Tonnes of carbon dioxide
Toe	Tons of Oil Equivalent
tpa	Tonnes per Annum
tpd	Tonnes per day
TPH	Tonnes per hour
VFD	Variable Frequency Drive
WBSEDCL	West Bengal State Electricity Development Corporation Limited
WHR	Waste Heat recovery

Burdwan Rice Mill Cluster

1.0 Overview of the cluster

West Bengal is the leading producer of rice in the country contrbuting to about 11 % of total rice output[1]. Paddy is the raw material used for the rice production. Burdwan is one of the major rice producing clusters in West Bengal with more than 500 rice mills in operation. Some of the rice-processing units are of the traditional huller type and produce raw rice. The modern rice mills are of high capacity and produce mainly parboiled rice.



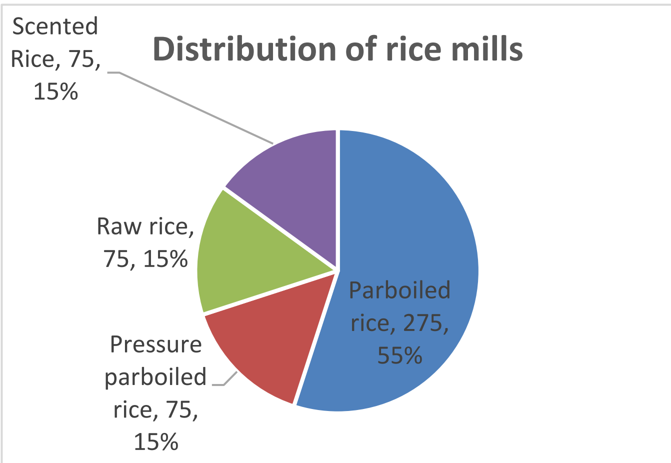
Burdwan District Map

(Source: Google Map)

2.0 Product, market and production capacities

The cluster is estimated to process 11.3 million tonnes of paddy and produce around 7.27 million tons of rice annually. The rice produced in the cluster comprises of parboiled rice (55%), while the rest is evenly distributed among pressure-boiled rice (15%), raw rice (15%) and scented rice (15%).

About 275 rice mills are engaged in the production of parboiled rice. About 75 rice de-husking units (i.e., units engaged only in removal of husk activities) produce only raw rice. There are about 75 rice mills each producing pressure parboiled rice and scented rice respectively. The installed capacity of the rice mills in the cluster typically ranges between 24-150 tonnes per day (tpd) of paddy processing. The medium sized mills operate round the clock while the parboiled units operate for about 12-16 hours per day. The categorisation of the rice mills according to the production capacity is shown in the following table.



Distribution of rice produced in the cluster

[1] https://upag.gov.in/

Categorisation of rice mills

Category	Installed capacity (tpd)	Number of units	Paddy processed, million tpa
Large	> 70	200	7.2
Medium	40-70	150	3
Small	< 40	150	1.1
	Total	**500**	**11.3**

3.0 Production process

Rice milling is the primary processing activity under which hulls and bran are removed from the paddy grain to convert it into polished rice. Hence, rice forms the basic primary processed product obtained from paddy, which may further be processed for obtaining various secondary and tertiary products. Many of the rice mills have installed colour sortex machine and silky polishing machine and the parboiled rice produced by these units are of international standards.

3.1 Paddy cleaning and preparation

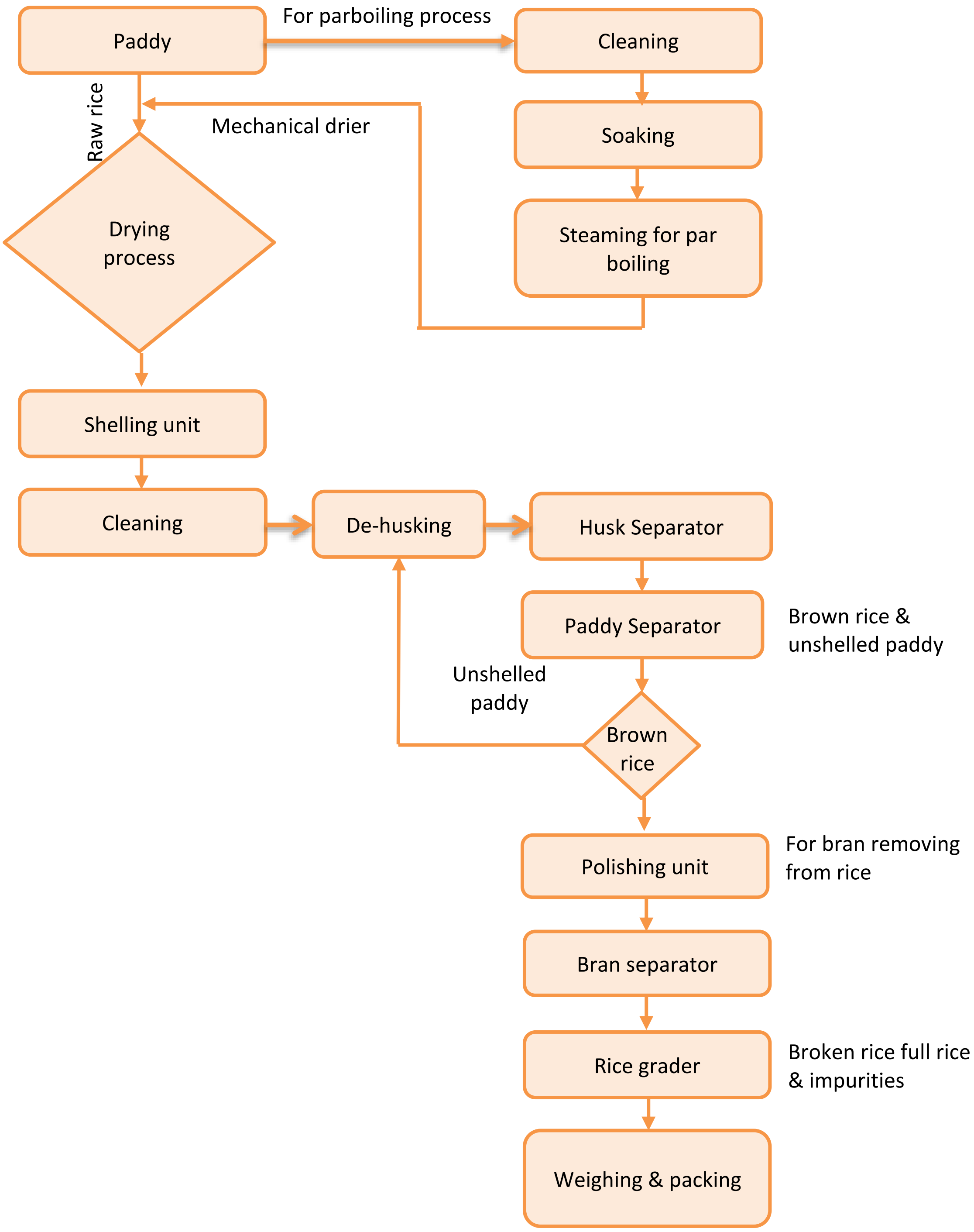
Paddy cleaning is the starting process before processing, raw paddy undergoes thorough cleaning to remove impurities such as straw, dust, stones, sand and immature grains. This is achieved using air blowers and vibrating screens of varying sizes. The cleaning process which typically lasts 1-2 hours per batch depends on the mill's capacity and technology. Once cleaned, the paddy is stored in vertical silos for subsequent processing.

3.2 Soaking and steaming

The cleaned paddy is transferred via conveyor belts to soaking pits or silos. Water is immersed in the soaking pits. After soaking, water is drained naturally, a process that takes approximately an hour per batch. For parboiled rice, the soaked paddy undergoes steam treatment, unlike raw rice, which skips this step. The steaming process is conducted in vessels using steam generated from in-house boilers.

3.3 Drying

Steamed paddy, now containing 30-45% moisture, is dried in mechanical dryers using a controlled hot air-drying process. The paddy is passed through high-capacity continuous flow dryer that blows high-speed hot air through the paddy bed, while the heat generated by the wet grains is recycled. Final moisture levels are achieved to 10-14%, after which the dried paddy is transferred to storage silos for milling.



Rice processing flow chart

3.4 Milling

In the milling stage, dried paddy undergoes a series of processing steps such as screening, dehusking, separation, polishing and grading. The specific processes involved depend on the technology and infrastructure available in each rice mill. The polished rice is finally transferred the packaging section, where it is either manually or automatically packed in bags for distribution.

The milling process generates two key by-products:

- Husk, which is primarily used as a fuel source in boilers.
- Bran, which makes up around 8% of the total paddy weight and is typically sold for further processing.

Steaming vessel

Milling operations rely on various motive loads, which are powered either by single-drive systems or multi-drive systems connected through a common shaft with pulleys and belts.
In recent years, several mills have adopted advanced automation technologies, integrating imported machinery to streamline the milling process. This investment in modernization has led to higher production capacity, improved efficiency and enhanced rice quality.

4.0 Technologies employed

The processing of paddy into different type of rice involves the following technologies/ equipment:

4.1 Boiler

Husk fire boiler

The boiler plays a crucial role in generating steam for the parboiling process. The boiler capacities in rice mills typically range between 2 to 10 TPH, operating at a pressure of 7-12 kg/cm². Husk-fired boilers generate significant amounts of suspended particulates, necessitating the use of pollution control systems such as cyclones to capture these emissions. Some mills have installed large settling chambers, where flue gases pass through, allowing particulates to settle at the bottom. Additionally, water tanks positioned above these chambers get preheated, improving energy efficiency. However, most old rice mills do not incorporate a waste heat recovery (WHR) system for preheating boiler feedwater. The boiler system is equipped with a forced draught fan, which simultaneously supplies combustion air and feeds husk into the system. While medium-sized mills implement basic boiler instrumentation, most rice mills operate with minimal monitoring tools, relying only on a pressure gauge to track boiler and steam distribution performance.

4.2 Steaming vessel

After the soaking process, paddy is transferred into steaming vessels in batches through gravity-based feeding mechanisms. Steam is injected directly at the bottom of the vessel through a controlled valve, continuing until steam visibly escapes from the top. The steaming duration depends on the specific paddy variety being processed. The condensed steam is subsequently drained out, ensuring optimal steaming conditions.

4.3 Drying system

Traditionally, rice mills relied on sun drying, but its limitations—especially during the monsoon season led to the adoption of mechanical dryers in most modern mills. In this system, parboiled paddy is fed into dryers, where hot air is circulated in the dryer through the blower. The steamed paddy is moved to the top of dryer channel arrangement with the help of bucket elevator system for repeated circulation in a counter flow arrangement to ensure complete drying. The dryer comprises of an indirect heat exchanger in which steam is used to exchange heat with ambient air to generate hot air that in turn removes moisture from steamed paddy. Steam traps are used to remove condensate formed in steam lines.

4.4 Milling section

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

a. Destoning: In this pre-cleaning area, the contaminants carried over along with paddy, such as stones are removed through vibrating sieves.
b. De-husking: Husk is removed from the paddy to produce brown rice. The husk generated is used as fuel in the boiler for steam generation.
c. Whitening and polishing: The product from de-husking 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 to produce rice bran oil and other products.

Drying system

5.0 Energy scenario in cluster

The rice mills mainly use by-product husk for meeting the fuel needs of the boiler. Electricity, sourced from girds, is used for operating the electrical loads. Grid electricity is supplied by West Bengal State Electricity Distribution Company Limited (WBSEDCL). The details of the major energy sources and tariffs are shown in the following table.

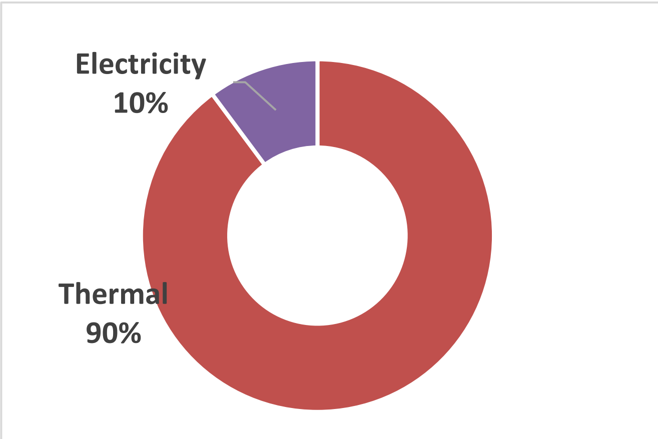
Energy consumption in cluster

<table>
<tr><th>Source</th><th>Remarks</th><th>Price</th></tr>
<tr><td>Electricity</td><td>High voltage consumers</td><td>Tariff category: Rate – E (BT)
Demand charge: INR 384 per kVA per month
Energy charges (in Rs/kWh):
<table>
<tr><th></th><th>Summer</th><th>Monsoon</th><th>Winter</th></tr>
<tr><td>06.00 hrs-17.00 hrs</td><td>6.95</td><td>6.94</td><td>6.93</td></tr>
<tr><td>17.00 hrs-23.00 hrs</td><td>8.37</td><td>8.36</td><td>8.35</td></tr>
</table></td></tr>
</table>

Source	Remarks	Price
		23.00 hrs-06.00 hrs 5.18 5.17 5.16
	Low Voltage consumers	Tariff category: Rate – B-IDIT Demand charge: INR 270 per kVA per month Energy charges: 06.00 hrs-17.00 hrs: 6.83 INR/kWh 17.00 hrs-23.00 hrs: 8.20 INR/kWh 23.00 hrs-06.00 hrs: 5.12 INR/kWh
Rice Husk	By-product	Nil (selling price of excess husk: Rs 2,200 per tonne)

5.1 Energy consumption

The major energy sources utilized in the parboiled rice, pressure parboiled, raw rice, and scented rice mills within the cluster are husk for thermal energy source and electricity. Grid electricity is used to power various motive loads across processing sections, including water pumping and blowers. Thermal energy, in the form of steam, is essential for both paddy soaking and subsequent drying.



Energy share in rice mills

Husk, a by-product of the milling process, serves as the main fuel source for boiler operations to generate steam.

Typically, 85% of the husk produced is used in-house, while the remaining 15% is sold. However, mills operating with older boiler systems often require additional husk, which they procure from the local market to meet their steam generation needs.

5.2 Unit level consumption

The primary energy sources in rice mills are rice husk and electricity. Hulling units, which focus only on husk removal and polishing without requiring paddy soaking or steaming, rely solely on electricity for their operations.

In rice mills, the internally generated rice husk supplies approximately 90% of the total energy requirement, while the remaining 10% is met through grid electricity. The average specific energy consumption (SEC) for a parboiled rice unit in the cluster ranges between 0.058-0.061 toe per tonne. The typical energy consumption of the different capacities of rice mills are shown in the following table.

Typical energy consumption of rice mills in the cluster

Type of unit	Husk (tpa)	Electricity (kWh/year)	Total energy (toe/year)
Large	6,468	2,596,841	2,099
Medium	3,558	1,326,045	1,146
Small	1,320	366,604	414

5.3 Cluster level consumption

The annual consumption of the cluster is estimated to be 653,830 tonnes of oil equivalent. The estimated 'greenhouse gas' emissions from rice mills at the cluster are 553,658 tonnes of CO_2 per annum. The overall energy bill of cluster is estimated to be Rs 10,642 million. Husk is the by-product from paddy processing; hence the selling price of husk from the rice mills is considered for estimated the energy bill. Energy consumption of the Burdwan rice mill cluster is shown in the following table.

Energy consumption of Burdwan rice cluster (2024-25)

Energy type	Annual consumption	Equivalent energy (toe)	Equivalent CO_2 emission (tCO_2)	Annual energy bill (million Rs)
Husk	2.025 million tonne	587,326	-	4,456
Electricity	773 million kWh	66,501	553,658	6,186
	Total	653,827	553,658	10,642

6.0 Potential energy efficient technologies

Parboiled rice mills offer significant scope for energy-efficiency improvements in both thermal and electrical areas. These options are discussed below.

6.1 Replacing existing old boilers with new energy efficient IBR boilers

Some of the rice mills still use old traditional boilers to generate steam. However, the traditional boilers are less efficient, and some other associated losses are mentioned below.

- Poor heat transfer efficiency: The heat transfer is poor due to low heat transfer area which leads to inefficiency and high flue gas losses. Many times, due to delay in periodical removal of ash deposits in the boiler, the heat transfer drops significantly leading to poor output and a drop in efficiency.
- Heat loss from charging door: The fuel charging door remains slightly open during the entire operation due to various reasons.
- No waste heat recovery: The WHR system is not available in smaller sized boilers. There exists enormous potential in flue gases of the boiler as the temperature of the flue gases would be high as the boiler is of single pass system. The high temperature flue gas is vented to the atmosphere without any waste heat recovery.
- Low loading of the boiler: The capacity utilization of the boiler is low and hence considerable reduction in thermal efficiency of the boiler.

- No control on fuel firing in the existing boiler, there is no control over fuel firing in the combustion chamber.
- Poor insulation: The surface temperature of the boiler is high due to poor insulation leading to high radiation losses.

The present inefficient boilers can be replaced with new energy efficient boilers. A comparison between traditional and energy efficient IBR boiler is given in the following table.

Comparison between conventional and new energy efficient IBR boiler

Parameter	Conventional boiler	Energy efficient IBR boiler
Fuel consumption	High	Low
Environmental pollution	High (due to more fuel consumption)	Low (due to less fuel consumption)
Operational cost	High	Low
Availability of local service providers	Yes	Yes
Draught system	Natural	Forced
Fuel combustion	Partial (due to inefficient combustion chamber design)	Complete
Waste heat recovery	No	Yes
Radiation losses	More (due to lack of proper insulation)	Less
Utilization of heat	Less (single/two pass)	Maximum (three pass)
Capacity utilization	Low	Optimum

Replacement of the conventional boiler with IBR boiler will result in surplus rice husk generation which can be sold in the market. The saving will be 813 tonnes per year of husk (235.7 toe). The equivalent monetary value of husk saved is Rs. 1.7 million.

6.2 Installing economizer and condensate recovery system

Conventional boilers have locally designed feedwater heating systems (water tank placed on the top dust collecting chamber). Some of the units have installed condensate recovery systems in their dryer section. However, a large amount of sensible heat is lost during recovery. IBR boilers are better equipped to recover waste from flue gases. For example, an economizer installed in a boiler will utilize the waste heat in flue gases. As a thumb rule, for every 6 °C preheating of feed water results in an improvement in boiler efficiency by 1%. Assuming the feedwater to boiler is preheated up to 85-90 °C, through installation of economizer and improved condensate recovery, it is possible to achieve 5% saving in fuel.

6.3 Replacing fluidized bed dryer with LSU dryer

Drying is a process that reduces grain moisture content to a level where it is safe for storage and processing. The LSU drying system is recognized for its low energy consumption and ability to produce high-quality grain due to its continuous mixing effect. It features an alternating arrangement of open and closed ends that function as air inlets and exhaust ports. Staggered V-ports facilitate effective paddy mixing, enhancing overall drying rates. Unlike Fluidized Bed Dryers (FBD), where the main air blower generates high pressure for fluidization, the LSU dryer utilizes the blower primarily for circulating hot air. This design significantly lowers electrical energy consumption. The specific electrical energy consumption in an FBD dryer ranges between 2-2.5 kWh/bag of paddy, whereas the LSU dryer operates at a more efficient range of 0.7-1.2 kWh/bag. Additionally, the LSU dryer's low-temperature drying process reduces steam consumption compared to the FBD dryer, further enhancing its energy efficiency.

LSU dryer

6.4 Adoption of energy efficient IE4 standard motors

The electricity consumption in a rice mill takes place mainly in motors associated with boiler (fans and pumps), dryers, blowers, milling process associated with machinery, conveyors and other utilities. The motor ratings range from 1 HP to 150 HP, depending on their application, mill capacity and operational requirements. While motors used in milling and finishing operations typically run at higher loads, most others operate under low load conditions.

A significant portion of the motors in the cluster are standard efficiency models, with many having undergone multiple rewinds, leading to efficiency losses. Considerable energy savings can be achieved by replacing standard motors with premium efficiency class (IE4) motors and implementing system-level improvements. Upgrading to higher-efficiency motors can lead to an estimated efficiency gain of 5-10%, while integrating technologies such as variable frequency drives (VFDs), soft starters and optimized gear assemblies can enhance system performance by 10–15%, offering a high return on investment (ROI).

6.5 Optimising compressed air system

Compressed air system offers significant energy saving opportunities. In some cases, energy savings as high as 40% can be achieved by improving the supply side efficiency and reducing end-use demands. Options for improving the supply side efficiency include installing new efficient air VFD compressors and reducing pressure losses in the system. Air demand can be reduced by arrests of air leakages. Some of the potential areas of optimizing compressor systems are mentioned below.

a. Arresting compressed air leakage - Compressed air is an expensive utility in a plant. However, in most mills, air leakages in distribution system are quite high (more than 20%). Leakage of compressed air can be reduced significantly by identifying the leakages in distribution network and arresting them. This measure leads to attractive savings with minimum investment.
b. Reduction in pressure setting of air compressors - The pressure setting of air compressors are often much higher than the air pressure requirement at the point of use in the plant. Reducing the compressed air pressure generation by 1 bar can lead to energy saving of 7-10%.
c. Retrofitting air compressor with variable frequency drive- Compressors operate in two modes - load and unload. When an air compressor is running unloaded, it still consumes a portion of its full-load power, typically 15-35%. This power is used to keep the motor running and for internal operations, even though no air is being compressed.

   Compressors with variable operation and high unloading period can be retrofitted with VDF compressors. This would lead to significant energy savings and results in an attractive payback on investment of less than two years.

6.6 Use of cogged V-belts

The driving motors are generally coupled with flat V-belts. The transmission efficiency of flat V-belt is around 90–92%. It is recommended to use cogged V-belt instead of flat V-belt. The transmission efficiency of cogged V-belt is 3–5% higher than that of flat V-belt. Cogged V-belts use a trapezoidal cross section to create a wedging action on the pulleys to increase friction and the power transfer capability of belts. V-belt drives can have a peak efficiency of 95-98%. They play a very dynamic role in allowing for heat dissipation and better contact with the pulley. They also have less slippage at high torque, require low maintenance. The envisaged energy saving is about 3-5% from the present power consumption.

Cogged V-belt

6.7 Solar air dryer

The adoption of solar air dryers in rice mills presents a significant opportunity for reducing energy consumption and improving drying efficiency. Traditionally, rice mills rely on mechanical dryers or sun drying, both of which have limitations—mechanical drying is energy-intensive, while sun drying is weather-dependent and less efficient.

Solar dryer, particularly the solar bubble dryer (SBD), is promising technology for rice mills. It offers a low-cost, environmentally friendly way to dry paddy. Solar air dryers work by absorbing solar radiation through specially designed collectors, heating the air and then circulating it through the drying chambers where paddy is stored. This method ensures uniform drying, reduces moisture content, and minimizes post-harvest losses.