

ENERGY PROFILE

INDORE DAL MILL CLUSTER

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The Energy and Resources Institute

SHAKTI
SUSTAINABLE ENERGY FOUNDATION

Promoting Energy Efficiency in SMEs
SAMEEEKSHA

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Certificate of originality

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Abbreviations

Abbreviation	Full form
AIDMA	All India Dal Mill Association
CFM	Cubic Feet per Minute
DI	Development Institute
DIC	District Industries Centre
EE	energy efficiency
HT	High Tension
kWh	kilowatt-hour
Lit	Litre
LT	Low Tension
MPPKVVCL	Madhya Pradesh Paschim Kshetra Vidyut Vitaran Company Limited
MSME	Micro Small and Medium Enterprise
PMM	Permanent Magnet Motor
SEC	Specific Energy Consumption
SSEF	Shakti Sustainable Energy Foundation
t	tonne
toe	tonne of oil equivalent
tpd	tonne per day
tph	tonne per hour
tpy	tonne per year
VFD	Variable Frequency Drive

Acknowledgements

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TERI team is indebted to the All India Dal Mill Association (AIDMA) and Association of Pulses Manufacturer, Madhya Pradesh, for providing support and information related to pulses-manufacturing units in the Indore cluster. TERI extends its sincere thanks to Mr Manish Agrawal from M/s S R Pulses for facilitating unit visit-and sharing data about the Indore dal mill cluster.

Indore Dal Mill Cluster

Overview of the cluster

India is the largest producer and consumer of pulses (dals) in the world contributing around 25–28% of the total global production. About 90% of the global pigeon pea (*toor* or *arhar dal*), 75% of chick pea (*chana dal*), and 37% of lentil (*masoor dal*) cultivation area falls in India. The major dal producing states in India are: Madhya Pradesh (25%); Uttar Pradesh (13%); Maharashtra (12%); Rajasthan (11%) and Andhra Pradesh (9%). Arhar, chana, masoor, moog, urad, and matar are the major dals grown and consumed in India. The total consumption of dals in India is about 22 million tonnes.

Location map of Indore & Bhopal (Source: Google maps)

A dal mill procures dal from farmers and processes it for end consumers. Processing operations, such as dehusking, splitting, cleaning, sorting, and packing are carried out in a dal mill. Indore is an important dal mill cluster in the state of Madhya Pradesh. The cluster has there as dal is grown extensively around Indore due to favourable soil and weather conditions. Also there also is a high demand of besan (chana dal flour) for making namkeens (savoury snacks) by the local snack-manufacturing units.

The cluster has about 100 dal mills. The estimated production of dal in the cluster is around 1,500 tonnes per day.

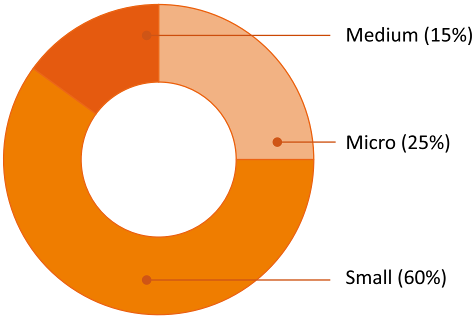
Product, market, and production capacities

The raw material of dal mills is the unprocessed dal, which is acquired from the local farmer or through mandi. Dal is also brought by the mills directly from the other parts of Madhya Pradesh and the nearby states like Maharashtra.

The dal mills in Indore cluster may be categorized as follows:

Categorization of dal mills based on the production

Category	Production, t/yr
Micro	5,000
Small	10,000
Medium	20,000

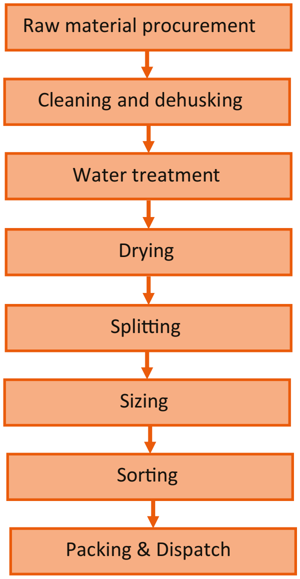


Distribution of dal mills in the cluster

Different types of dal

Production process

The manufacturing of dal encompasses a wide range of processes including raw material procurement, cleaning, separating, drying, sizing, sorting, packing, and despatching. The process steps are summarized below. A simplified process flow diagram of a typical dal mill is shown in the following figure.

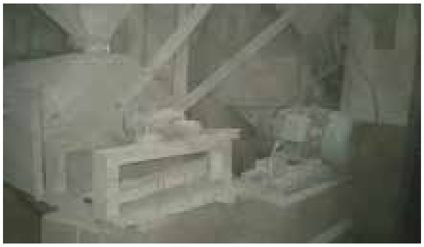


Process flow chart

Raw material procurement

The unprocessed dal is procured either from the farmers or from the mills traders. Some mills process different types of dal as per their availability, while some exclusively process a single variety throughout the year.

Cleaning of impurities and dehusking



Dehusking machine

Gravity separator

Stones and heavy seeds are separated using series of sieves in gravity separators. The gravity separators use motors upto 10 hp Dehusking is done in three stages and the dehusking machines at each stage remove the husk from grains. These machines use motors ranging between 15–30 hp capacity. Variations of the process are used based on the type of dal and their quality. Husk separated is sold as cattle feed.

Water treatment and drying

Sun drying

Small quantities of water are added to the dal to facilitate splitting with less breakage. The moisture content is then brought down by in micro and small units. Medium scale units use wood based dryers for removing moisture during the rainy season. In sun drying, dal is kept on an open surface like terrace or roof.

Splitting, sizing, and sorting

In order to cater to the customer demand, dal is sorted after splitting and sized. The operations are carried out using a number of machines which are belt driven. Conveying of dal is done using, compressed air in some cases.

Sizing and sorting operations

Weighing, packing, and dispatch

The dal is packed in bags of different sizes by weight before it is dispatched.

Technologies employed

Some of the major processes/equipment used in dal mills are described below.

Weighing and packing operation

Milling machines

The dal mills use conventional milling machines for carrying out process operations like cleaning, dehusking, grading, splitting operations. These machines have motors, which are belt-pulley driven. Some units have a network of belts and pulleys for driving multiple shafts and process requirement.

Typical machines like destoner and separator

Drying oven

Some of the medium-scale mills use wood-fired oven for drying the dal. In wood-fired ovens, the hot air generated by burning wood is spread using induced draft fans on trays where the dal is poured or layered. Due to direct contact with hot gases, the moisture is removed. The machines operate on batch mode.

Wood fired oven

Conveying

A mid-sized dal mill usually has three floors. The dal is conveyed between the floors for different operations. Belt conveyers—which are specially designed with small cups attached to canvas belts—are commonly used for conveying the job. The belt conveyors are covered by conduit pipes. Material from an upper floor to a lower floor is conveyed using gravity. A network of pipes can often be seen in a dal mill for this reason.

Belt conveyors for conveying pulses

Fans/blowers

Some of the newer units have installed fans/blowers for removing dust and unwanted particles from the dal. These blowers take out the dust and collect them in bags. The blowers run continuously at constant loads.

Blowers

Air compressor

Dal mills use compressed air for pneumatic actuation and conveying. Electrical rating of the air compressors ranges from 10 hp to 25 hp. Medium-sized mills use screw air compressors, while smaller-sized mills use reciprocating compressors.

Screw air compressor with a receiver and dryer

Energy scenario in the cluster

Electricity and wood are the major sources of energy used in the cluster. Electricity is supplied by Madhya Pradesh Paschim Kshetra Vidyut Vitaran Company Limited (MPPKVVCL). Wood is procured from the local market. The power outage is minimal in the cluster, and hence diesel consumption is insignificant. The details of the major energy sources and tariffs are given in the following table.

Prices of major energy sources

Source	Remarks	Price
Electricity	MPPKVVCL	Rs 7.5 per kWh (inclusive of energy, demand charges, other penalty/rebate and electricity duty)
Wood	From local market	Rs 6 to 8 per kg

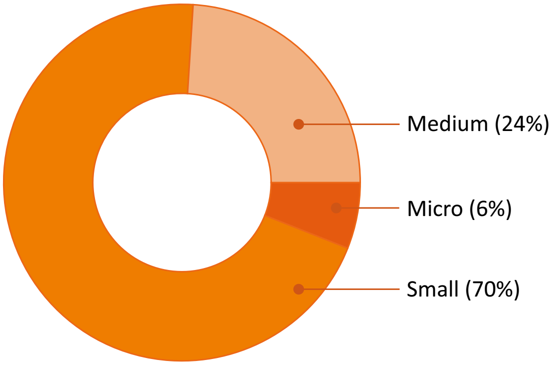
Energy consumption

Unit-level consumption

Electricity is used to run all machinery. Most of the units in the cluster have LT connections.

The major energy consuming areas in units are motors used in various applications, such as destoners, blowers, separators, etc.

The specific energy consumption (SEC) of the units vary considerably depending on the type of products being manufactured. The share of the energy cost in the final product accounts for about 6–8%. The typical energy consumption based on the manufacturing capacity is given in the following table.



Share of energy consumption in the cluster

Typical energy consumption of a dal mill

Production category	Electricity consumption, kWh/yr	Wood consumption, kg/yr	Total energy, toe/yr
Micro	128,000	0	11.0
Small	240,000	71,429	49.2
Medium	320,000	100,000	67.5

Cluster-level consumption

The overall energy consumption of the cluster is estimated to be about 4,241 tonnes of oil equivalent (toe) per annum, which is equivalent to emissions18,368 tonnes of CO_2. The overall energy bill of the cluster is estimated Rs 210 million (approx). The energy consumption pattern in the cluster is given in the following table.

Energy consumption of the Indore dal mill cluster (2017–18)

Energy type	Annual consumption	Equivalent energy (toe)	Equivalent CO_2 emissions (tonne)	Annual energy bill (million INR)
Electricity	22.4 million kWh	1,926	18,368	168
Wood	5,786 tonnes	2,314	0	40.5
	Total	4,240	18,368	208.5

Potential energy-efficient technologies

Some of the major energy-efficient technologies relevant for the dal mill cluster are discussed below.

Energy-efficient IE3 motors

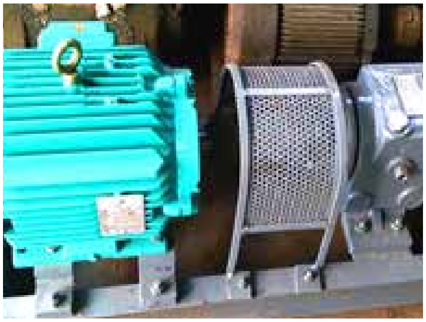
Most of the machines, such as destoners, gravity separators, sorting machines, and blowers use electrical motors. The ratings of these motors vary from 5 hp to 30 hp depending on the capacity of the machine and the operations performed.

Motor rating kW	IE2 Efficiency (2 Pole), %	IE3 efficiency (2 Pole), %	Percentage energy saving, %
2.2	83.2	85.9	2.7
3.7	85.5	87.8	2.3
5.5	87	89.2	2.2
7.5	88.1	90.1	2
11	89.4	91.2	1.8

*Source: Siemens IE3 motors brochure

There is a lack of awareness about the efficiency standards of motors. It was observed that most of the units use low-efficiency standard motors. There is a significant potential for energy savings by replacing low efficiency motors with energy efficient IE3 motors. Depending on the operating period of the machine, payback period for

Standard motors used in the cluster



IE3 motor

EE motors can vary between 10 months to 2 years. Energy saving of 3% can be achieved by replacing the existing IE2 motor with the IE3 motor, thus resulting in savings 7%. This can be achieved by replacing existing IE1 standard motor with the IE3 motor.

Typical cost–benefit analysis for IE3 motors

Parameter	Unit	3 HP motor	5 HP motor
Power consumption of the existing motor	kW/hr	2.4	4.1
Efficiency of existing motor	%	79.7	86.3
Efficiency of the IE3 motor	%	86.7	88.4
Estimated power consumption of IE3 motor	kW/hr	2.21	3.8
Annual energy cost savings	Rs /yr	5,232	8,100
Investment	Rs	4,000	10,000
Payback period	yr	0.8	1.2

Energy-efficient air compressor

Screw compressors are designed to operate at more than 80% load for efficient performance. There is potential for energy saving in the screw compressors by adopting with a variable frequency drive (VFD) and Permanent Magnet Motor (PMM)-based air compressors higher CFM-to-power ratio. The energy savings can range between 15%–40% compared to existing system.

Typical cost benefit of VFD screw air compressor

Parameter	Unit	Value
Annual power consumption of the existing screw compressor (30 hp)	kW/CFM	0.23
Estimated power consumption with PMM and VFD based screw air compressors	kW/CFM	0.15
Annual energy cost savings	Rs/yr	295,773
Investment	Rs	5,00,000
Payback period	yr	1.7

VFDs for motors

Motors running in the plant have variable loading due to differences in grain size. The motor rating, typically, varies between of 5–30 hp depending on the machine capacity. Application of VFD will lead to 6%–8% of energy saving. VFDs will also facilitate soft starting, which will help to increase the life of the motors.

VFDs installed in motors

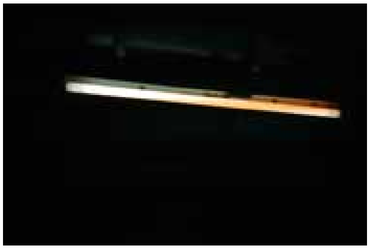
Typical cost benefit of VFDs

Particular	Unit	Value
Power consumption of conventional motor	kW/hr	22
Power consumption of motor with VFD	kW/hr	18
Annual energy cost savings	Rs/yr	43,200
Investment	Rs	60,000
Payback period	yr	1.4

Lighting

T-12 tube lights (52W, including choke) and conventional lamps (150W and 250W) are generally used by units in the cluster. These inefficient lightings can be replaced with energy-efficient LED lighting (LED tube lights of 10W and 20W) and induction lamps (20W, 40W, and 80 W), which would provide better illumination and energy savings. Since a large number of lamps are used in the units, the existing lighting may be replaced with EE lighting in a phased manner.

Conventional lamp replaced with induction lamp



T 12 tube light

Typical cost benefit analysis of energy-efficient lighting

Particular	Unit	Value
Power consumption with 52W T-12 FTLs	Watt/hr	52
Power consumption with EE LED tube light of 20W	Watt/hr	20
Annual energy cost savings	Rs/year	750
Investment	Rs	350
Payback period	yr	0.5

Ovens

Some of the mills in the cluster use drying ovens. In general, the ovens are used in the rainy season for drying. The oven uses wood as the fuel. Insulation improvement, reduction in the heating volume, and, the proper use of air draft will result in fuel savings.

Use of cogged V-belts

The driving motors are generally coupled with flat V-belts or flat belts in most machines. The transmission efficiency of flat V-belt is around 90%–92%. It is recommended to use a cogged V-belt instead of a flat V-belt. The transmission efficiency of a cogged V-belt is 3%–5% higher than a flat 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 dynamic role in allowing for heat dissipation and better contact with the pulley. There are several other potential benefits of using cog belts which include, (i) less slippage at high torque, (ii) low maintenance and re-tensioning, and (iii) suitable for wet or oily environment.

Flat Belt

Cogged V-Belt

Major cluster actors and cluster developmental activities

Industry associations

There are two major industry associations for dal mills in the cluster.

The Association of Pulse Manufacturing Industries, Madhya Pradesh

The Association of Pulse Manufacturing Industries, Madhya Pradesh has around 125 members. It is mainly involved in activities pertaining to addressing the common issues of its members and making representations to government bodies.

All India Dal Mill Association

All India Dal Mill Association (AIDMA) is the apex industry association for dal mills in the country. The association was incorporated with the objectives of providing support for its members on the promotion and development of its manufacturing activities, improving the overall market situation, and to keep it stable. It addresses national-level issues pertaining to the industry with government ministries and other entities.

Government support institutions

The District Industries Centre (DIC), Indore, provides several incentives to MSMEs, such as, capital investment subsidy, interest subsidy, venture capital quality certification, energy and water audit subsidy, and so on. The DIC is also active in creating awareness about trade information, import–export, and, financial rules and regulations for MSMEs.

Cluster developmental activities

There have been limited activities at the cluster level apart from some awareness workshops and few energy audit studies.

About TERI

A dynamic and flexible not-for-profit organization with a global vision and a local focus, TERI (The Energy and Resources Institute) is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to tackling issues of global climate change across many continents and advancing solutions to growing urban transport and air pollution problems, TERI's activities range from formulating local and national level strategies to suggesting global solutions to critical energy and environmental issues.

The Industrial Energy Efficiency Division of TERI works closely with both large industries and energy intensive Micro Small and Medium Enterprises (MSMEs) to improve their energy and environmental performance.

About SSEF

Shakti Sustainable Energy Foundation established in 2009, is a section-25 not-for-profit company that works to strengthen the energy security of the country by aiding the design and implementation of policies that encourage renewable energy, energy efficiency and sustainable transport solutions. Based on both energy savings and carbon mitigation potential, Shakti focuses on four broad sectors: Power, Transport, Energy Efficiency and Climate Policy. Shakti act as a systems integrator, bringing together key stakeholders including government, civil society and business in strategic ways, to enable clean energy policies in these sectors.

About SAMEEEKSHA

SAMEEEKSHA (Small and Medium Enterprises: Energy Efficiency Knowledge Sharing) is a collaborative platform set up with the aim of pooling knowledge and synergizing the efforts of various organizations and institutions - Indian and international, public and private - that are working towards the development of the MSME sector in India through the promotion and adoption of clean, energy-efficient technologies and practices. The key partners of SAMEEEKSHA platform are (1) Swiss Agency for Development and Cooperation (2) Bureau of Energy Efficiency (3) Ministry of MSME, Government of India (4) Shakti Sustainable Energy Foundation, and (5) The Energy and Resources Institute.

As part of its activities, SAMEEEKSHA collates energy consumption and related information from various energy intensive MSME sub-sectors in India. For further details about SAMEEEKSHA, visit http://www.sameeeksha.org

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