Cluster Profile
Ludhiana forging industries

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Ludhiana forging industries

Overview of cluster

Ludhiana city was founded in 1480 under the Lodhi dynasty. The town was originally known as Lodhi-ana, which means the town of Lodhi's. The name later changed to the present name Ludhiana. It lies between north Latitude 30°34' and 31°01' and east longitude 75°18' and 76°20'. It is bounded on the north by River Sutlej which separates it from Jalandhar district. In 1805, during the reign of Maharaja Ranjit Singh, Ludhiana became an important British cantonment.

Ludhiana city is known as the industrial capital of Punjab and quite-often referred as Manchester of India. Post-independence, number of industries started booming in the city to support the agriculturally rich area. Initial development was of agricultural implements, tractor industries; slowly growth was seen in allied industries such as forging, foundry, sheet metal and auto-parts as well. The city is home to some of top national cycle brands such as Hero and Avon. In early 1990s Ludhiana started supplying products not only to entire India but also to Middle East and Europe. Presently, Ludhiana district has about 39,000 industries in over 20 different industry estates. A variety of products such as cycle & cycle parts, sewing machine parts, auto parts, forging, machine tools, hosiery, knitwear and woollen garments, electronics goods, plastic & rubber goods are being produced in the city in big way by small and medium industries. Since 2010, though Punjab is seeing a decline in industrial output but the number of registered units in Ludhiana has seen a growth of above 15%. A few prominent industries in Ludhiana cluster are Vardhman Spinning and Polytex, Oswal Cotton Spinning Mills (Textile) and Hero, Avon, Rockman (Cycle).

The city witnessed lots of battles and clashes between the various empires for power and growth. Forging industry dates back to 15th century, which supported by providing forged tools for city builders and forged weapons for the battles. However, the recent forging industry expansion took place in 1960s to provide forged products to tractor, handtools and agricultural implements manufacturers.

Forging units in Ludhiana
Source: Google map

Presently, there are about 500 forging industries in Ludhiana producing around 1,640 tonnes of forged products per day (492,000 tonnes of forged products per year), of which about 25% is produced by about 10 large forging industries. Forging industy provide employment to about 13,000 people. Units are mainly located in Daba road, Saniwal Delo road, Focal point (Phase I-VIII) and Industrial area A,B and C. Major products of the cluster are crank shaft, connecting rods, brake drum, spanners, special tools, etc. Total annual turnover of forging cluster is Rs 3,200 crores. A few major forging industries in the cluster are Mahadev Forge, Sudhir forge, Kay Jay Forgings and Sarita Forgings. Major customers to forging units are

USHA, Hitachi, Electricity Board, KJ Group, and automibile companies such as TVS, Bajaj & Sons, Sonalika, Swaraj, Mahindra etc.

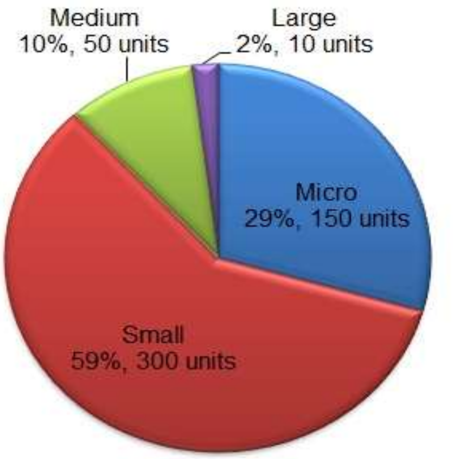
Product types and production capacities

The cluster has about 500 forging industries. The forging units in Ludhiana cluster are principally known for making components catering to industries including cycle, automobile, machinery and engineering and others. There are about 10 large forging industries in the cluster. Based on their average production levels, the MSME forging units can be categorised as follows (see figure):

Micro: 20 tonnes per month
Small: 60 tonnes per month
Medium: 200 tonnes per month

Categorization of forging industries

Type	Production (tonne/month)	Employment (No's.)	Turnover (Rs cr/year)
Micro	20	10	1.0
Small	60	25	5.0
Medium	200	50	15.0
Large	1000	150	75.0



Distribution of forging units in cluster

Majority units (~300) fall under small category, in micro and medium there are 150 and 50 units respectively. The total production of closed or open die forging products in the cluster is about 1240 tonnes per day (about 372 thousand tonnes per annum). Only medium scale forging industries run round-the-clock (three shifts), remaining units are under-utilizing the facility and run at average capacity utilization less than 60%. Major products in cluster include crank shaft, connecting rods, brake drum, auto-parts, spanners, special tools, etc. Photo views of some products are shown in figure.

Crank shaft   Connectors   Spanners

Major products of the cluster

Raw material usage in cluster

The Ludhiana forging cluster produces a variety of materials. The major raw materials used in the forging units include mild steel, carbon steel, alloy steel, stainless steel, aluminium, super alloy and special steel. Different stainless steel grades used by the units are ASTM/ ASME SA 182 F, 304, 304L, 304H, 309H, 310H, 316, 316H, 316L, 316 LN, 317, 317L, 321, 321H, 347, 347H. Most of these raw materials are produced locally or obtained from other domestic markets. Long bars and billets are used as raw materials in forging industries. The main sources of raw materials of forging products are steel rolling mills located in Mandi Gobindgarh.

Raw material used in forging industries

Energy scenario in the cluster

Furnace oil is the major source of energy for the heating of raw material in forging industry. Electricity is used to drive other equipment such as hammer, shearing machine, blower, air compressor, shot blast, motor and lighting system. Diesel is consumed in DG set for backup, but the share is negligible. Furnace oil is procured from local market. Micro and small units get electricity at 400 V voltage and fall under category "industry consumers – medium supply", whereas the medium scale units get electricity at 11 kV voltage and fall under category "industry consumers – large supply". Diesel is procured from local market. All forging units have diesel generator sets, which they run to meet emergency demand in the unit during unscheduled outages, though the consumption of diesel is marginal in total energy consumption. The details of major energy sources and tariffs are shown in table.

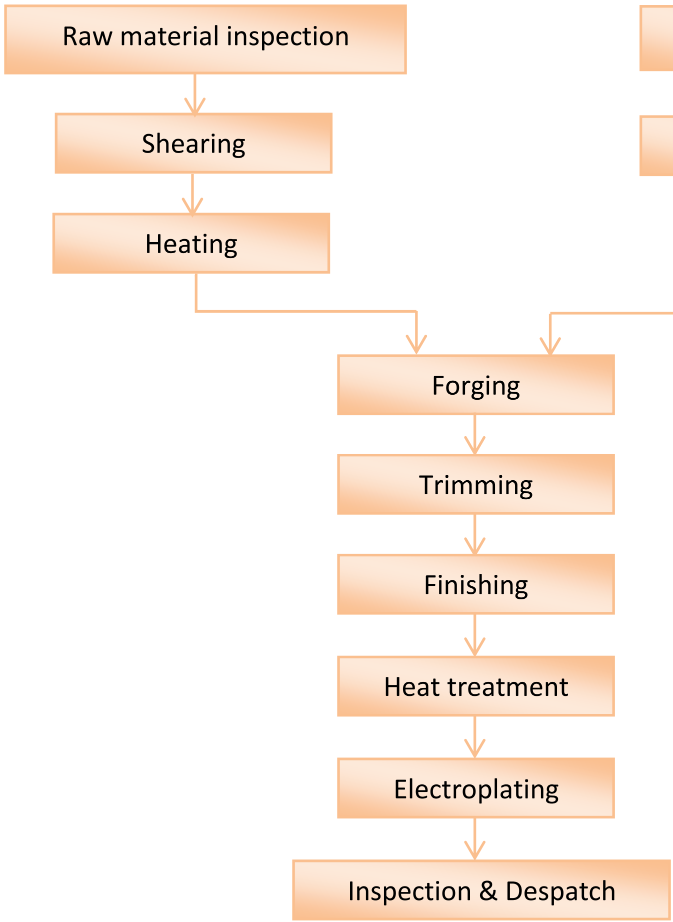
Prices of major energy sources

Raw material	Remarks	Price
Electricity	LT Connection	Energy charge : Rs 5.51 per kWh Demand charge: Rs 188 per kVA per month
	HT Connection	Energy charge : Rs 6.03 per kWh Demand charge: Rs 188 per kVA per month
Furnace oil	Local market	Rs 28,000 - 31,000 per tonne
Diesel	Local market	Rs 60 per litre

Production process

Forging can be performed by open die, closed die or ring forging process. The units in Ludhiana predominantly produce forged components using impression die forging process. The closed die forging or impression die forging is the deformation of metal at forging temperature within one or more die impressions or cavities. It is performed either in presses or hammers. For simple shapes impression die forging can be performed in a single press stroke, but more often however several strokes of different forces are used with multiple dies of different impressions for preforming sequential shaping and finish forging operation.

The major steps of process are "*make ready operation*" for die and raw material followed by heating, forging, trimming, finishing and inspection & despatch. Some products require heat treatment and or electroplating. A simplified process flow diagram of a typical forging industry is given in the figure.



Typical process flow chart - Forging

The steps are explained below.

1. **Die making and setting.** Based on the final product impressions are created in a steel tool die. Majority of units have tool room to do perform minor repair of dies, though not all make their own dies. Once die is ready it is set in a hammer or press to perform forging operation.
2. **Raw material preparation.** The received raw material (rods, bars, or billets) are inspected for physical deformation and tested for chemistry and hardness. Once tested 'OK', the raw material is passes on to shearing. In shearing machine the raw material is sized as per product requirement.
3. **Heating.** The sized raw materials are heated to forging temperature (i.e. 1150-1250 °C). The heating is done in majority of units using a furnace oil fired furnace. A few progressive units have installed induction billet heaters for this purpose.
4. **Forging.** It is performed either in presses or hammers. For simple shapes impression die forging can be performed in a single press stroke, but more often however several strokes of different forces are used with multiple dies of different impressions for sequential preforming and finish forging operation. In sequential forging using hammers

first stroke is *edging* this increases the work-piece's cross section, second stroke is *blocking* to refine the shape for finish forging and final stroke to *finish-forging* to complete the shape. In finish-forging bulk of metal is forced into the impression while a thin layer called flash flows out between the dies at the parting plane.

5. **Trimming.** The thin flash cools rapidly. Once finish-forging is completed, the flash (excess metal) is removed either manually or with trimming dies. Majority of units in Ludhiana use trimming die for this purpose.
6. **Finishing.** It includes sizing and straightening of the forged product. It involves fettling, shot blasting, cleaning and machining (CNC or VMC) of the forged product. A few select products are heat treatment to remove stresses and strengthen. Some special products require electroplating. Heat treatment and electroplating is mostly outsourced.
7. **Inspection and despatch.** The final products are inspected for defects, on passing inspection they are packed for despatch.

Technologies employed

The technology employed in the cluster is out-dated and is one of the major barriers for productivity enhancement and energy efficiency. Some of the major forging processes/ equipment are described below.

(i) Heating furnace

The forging furnaces are used for heating of raw material (billets/ bars/ rods of various grades of steel) to 1150 – 1250°C. The capacities of these furnaces are in the range of 50 – 400 kg per hour. Furnace oil is predominantly used as fuel in the furnace. Different designs of furnaces are box, 'L', and pusher types. Billets are heated either in batches or continuously. The furnace oil consumption in the forging furnaces typically ranges between 100 – 200 litres per tonne. Blowers with electrical motors of 3 – 7½ hp are used in furnaces for providing the combustion air.

Oil fired forging furnace

(ii) Hammers: Belt drop type

The hammer strikes and deforms the work-piece. Belt drop type hammers are used for forging of hot billets into various shapes. The capacity of the forging hammers typically are in range between 0.5 – 3 tonnes. The board drop hammer is a drop forging machine tool that relies on gravity. A hardwood board is attached to the ram, rollers grip the board and can raise the board and ram due to friction forces between the board and rollers. Once the ram is raised to the height needed, the rollers can be pulled apart and the apparatus will be released, sending the forging hammer on its way. Electric motors in the range of 30 to 100 hp are used for driving the hammers. Forging capacity, depending on the number of hammers and their capacities, varies from 300 tpa to 3,500 tpa. The hammer's base is equipped with a rubber padding to act as noise and vibration absorber.

Belt drop hammer

(iii) Screw press

Screw press

The capacity of screw presses is in the range of 100 to 1,500 tonnes. Electric motors used for driving these presses range between 30 – 150 hp. Screw presses with electrical motors of 5 – 30 hp are used for trimming and coining operations. These presses are operated with pneumatic clutch and brake and screw is used for adjusting the height of stroke length. It is used mostly with shaft end heating jobs.

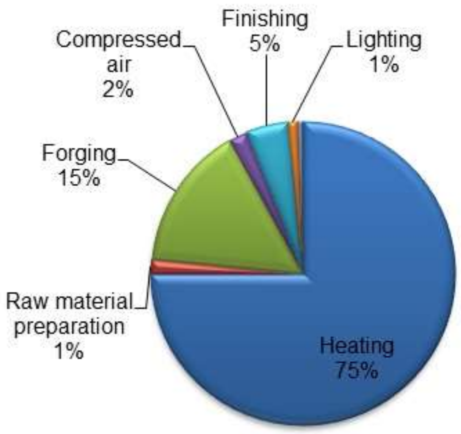
(iv) Auxiliary system

Air compressor

Air compressor: Forging units utilizes compressed air in number of process applications which includes finishing, pneumatic fettling, machining (CNC/ VMC) and general cleaning. Typically forging units have compressor of FAD rating 35 – 100 cfm with power rating of 7.5–22 kW. Majority of micro and small units use reciprocating type air compressors whereas the medium sized units use screw type air compressor. All the compressors are fixed speed type and leakage level in compressed air system is very high.

Energy consumption

Forging uses two main forms of energy: electricity and furnace oil. Heating accounts for a major share of about 70 – 80% of total energy consumed in a forging unit. The other important energy consuming areas include forging hammer, air compressor and finishing. The share of energy usage in a typical forging unit is given in the figure.



Typical energy use in a forging unit

(i) Unit level consumption

The specific energy consumption (SEC) varies considerably in a forging depending on the type of product and degree of mechanisation. The specific energy consumption of furnace oil fired forging furnace for heating varies in range of 100 – 170 litre per tonne. Typical SEC for forging furnace in micro scale units is high, in order of 150 – 170 litre per tonne whereas for medium sized units this figure is about 100 – 130 litre per tonne. A few progressive units have installed induction billet heater and its SEC is 400 – 500 kWh per tonne. Diesel is used in DG set for backup power, but the share is negligible. Typical energy consumption of a forging unit is given in table.

Typical energy consumption

Category	Electricity (kWh)	Furnace oil (tonne)	Diesel (kL)	Total energy (toe)	Annual energy bill (million INR)
Micro	168,000	30	0.5	45.1	2.2
Small	420,000	85	1.0	122.5	5.6
Medium	780,000	240	3.0	311.2	12.9

(ii) Cluster level consumption

The total energy consumption of forging unit in the cluster is estimated to be 59,080 tonnes of oil equivalent. The energy bill of the cluster is around rupees 27.2 crore; which corresponds to about 10% of the total cost.

Energy consumption of the Ludhiana forging cluster (2016)

Energy type	Annual consumption	Equivalent energy (toe)	GHG emissions (tonne CO_2)	Annual energy bill (million INR)
Electricity	190 million kWh	16,360	182,600	1,430
Thermal	40,200 tonne (FO) 525 kL (Diesel)	42,720	131,590	1,290
	Total	**59,080**	**314,190**	**2,720**

Energy-saving opportunities and potential

Some of the major energy-saving opportunities in the forging units in the cluster are discussed below.

(i) Induction billet heater

Induction billet heater in forging is a revolutionary new age technology having potential of about 35% energy savings as compared to oil fired heating for forging. Induction technology not only improves energy efficiency but also improves production efficiency by reduction in scale losses. Due to very low level of surface heat losses, it provides better working conditions as compared to fuel fired furnaces. The specific energy consumption (SEC) for FO fired furnace can be brought down from 0.15 toe/ tonne (150 litre/ tonne) to 0.04 toe/ tonne (450 kWh/ tonne) using induction billet heater. The investment for induction billet heater depending on size ranges from Rs 15 – 50 lakh with a simple payback period of about 1 – 3 years.

Induction billet heater

(ii) Reheating furnaces

Box type furnaces are mainly used in case of closed die forging. Cut billets are heated in reheating furnaces and manually transferred to hammer for forging operation. These furnaces are prone to high flue gas losses and surface heat losses. Normally furnace oil is fuel used in box type forging furnaces and heat treatment furnaces.

Recuperator for waste heat recovery from hot flue gasses of furnace

Many of the forging units use oil fired oil fired forging and heat treatment furnaces. The exit flue gas temperatures of FO fired furnaces are in the range of 450 – 700°C. The waste heat available with high temperature flue gases can be recovered using a metallic recuperator which can preheat the combustion air. The envisaged energy saving with WHR system is 10–15%. Investment for recuperator varies from Rs 1.0-4.0 lakh with a simple payback period of 8 months to 2 years, depending on type of process and temperature.

Insulation for furnace

Forging and heat treatment furnaces used are mostly built with a refractory brick lining which are prone heat losses after a continuous usage over the period and results in fuel loss. There is a huge potential in using ceramic insulations in the box type furnaces, which enables less fuel consumption in cold start in the furnace along with less heat up time. Energy savings of 4 – 6% can be achieved by improving insulation of the furnace. Relining or repairing of furnaces can be carried out with an investment of Rs 0.5 – 2 lakh depending on size of the furnace with simple payback period of 5 – 15 months.

(iii) Variable frequency drive (VFD) in press motors

Motor driven systems often are oversized and inefficiently controlled. Variable Frequency Drives (VFD) can provide a more cost effective method for reducing flow or pressure by varying the speed of the connected load to match the process requirements. Mechanical and hydraulic presses are generally used in forging industries. Presses go under variable load depending on job size and operation to be performed and the jerk load operations are frequent. Energy savings in VFD applications usually range from 8 – 20%. The investment for VFD is around Rs 1 – 3 lakh with simple payback period of 6 – 15 months.

(iv) Compressed air system

Energy savings of about 40% can be realized through improving the supply and reducing demand in compressed air systems. Opportunities can be found in the supply side by installing new or optimizing existing equipment and reducing the system pressure. Demand can be reduced through improving end uses and repairing leaks. Blow-off nozzles can be upgraded to high-efficiency engineered nozzles or replaced with a low-pressure electric blower. Some of the potential areas of compressor system are mentioned below.

Retrofitting air compressor with variable frequency drive

During normal operation, screw air compressor operated on unloading position for more than half the time. Installation of VFD to such compressors will minimize the unload power consumption resulting in energy savings of 20-35%. The investment required is Rs 1 -3 lakhs with a simple payback of 8 – 15 months.

Arresting the compressed air leakage

Compressed air is an expensive utility in a plant. However, in most cases, air leakages in piping system are quite high (more than 20%) and go unnoticed. The compressed air leakage can be reduced to about 5% with better operating practices. The plant can reduce significant energy consumption by controlling compressed air leakages with no or minimum investment.

Reduction in pressure setting of air compressor

The pressure setting of air compressors are often much higher than the actual air pressure requirement at the point of use in the plant. The typical unload and load pressure settings are 8.5 and 7.5 bar respectively. Reducing the compressed air pressure as per end-use requirements will result in high-energy savings. Reduction of generation pressure by one bar can lead to energy saving of 6%.

(v) Replacement of rewound motors with energy efficient motors

Motor burn-out is not a rare phenomenon in foundries; this is a result of number of factors including power quality, overloading, etc. Rewinding of motors is cheap solution followed by foundry-men but it result in a drop in efficiency of motor by 3 – 5%. It is better to replace all old motors which has undergone rewinding two or more times. The old rewound motors may be replaced with EE motors (IE3 efficiency class). This would results into significant energy savings with simple payback period of 2 – 3 years.

(vi) Replacement of inefficient lighting with energy efficient lighting

The forging units use fluorescent tube light with copper ballast (FTL-T12, 52 W) for office and store lighting. Some units were using CFLs. These lighting systems have low lux levels with lower life. Replacing them with FTL-T5 with electronic ballast or LED tube can lead to energy saving of around 30–40%. The forging units use mercury vapour lamp (HPMV 250 W) for shed and factory lighting. Some units were using 85 W CFLs. These lighting systems have low lux levels with lower life. Replacing them with induction lamp of 150 W will not only lead to energy saving of around 40% but all improve light quality in the shed/ factory.

Major stakeholders

The major industry associations related to the forging industry in Ludhiana, Punjab Forging Industries Association. It is located in the Chamber of Industries & Commercial Undertaking (CICU) office in Focal Point – Phase V. The 'District Industries Centre' (DIC), Ludhiana provides several incentives to MSMEs like the Back Ended Interest Subsidy Scheme. Under this scheme, MSMEs can avail 3% interest subsidy (subject to a maximum of Rs 10 lakhs) on term loans loan on technology.

The MSME Development Institute (DI), Ludhiana provides assistance for the promotion and Development of Micro, Small and Medium Scale Industries. They also implement various central and state government schemes for MSMEs including Credit Linked Capital Subsidy Scheme (CLCSS) and Technology Upgradation Scheme (TEQUP) for technology and quality upgradation. They also organize awareness workshops for the forging industries on pollution, environment, energy efficiency and lean manufacturing.

Cluster development activities

Institute for Auto-parts and Hand-tools Technology was set up to a Research & Development Organisation for auto component and hand-tool manufacturing sectors with the aim to uplift technological level of small & medium enterprises of the region. They specialise in tool handling, development and machining training, which is important to forging industries.

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 SDC

SDC (Swiss Agency for Development and Cooperation) has been working in India since 1961. In 1991, SDC established a Global Environment Programme to support developing countries in implementing measures aimed at protecting the global environment. In pursuance of this goal, SDC India, in collaboration with Indian institutions such as TERI, conducted a study of the small-scale industry sector in India to identify areas in which to introduce technologies that would yield greater energy savings and reduce greenhouse gas emissions. SDC strives to find ways by which the MSME sector can meet the challenges of the new era by means of improved technology, increased productivity and competitiveness, and measures aimed at improving the socio-economic conditions of the workforce.

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 are of SAMEEEKSHA platform are (1) SDC (2) Bureau of Energy Efficiency (BEE) (3) Ministry of MSME, Government of India and (4) TERI.

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