# Cluster Profile Report
# Pune Forging Cluster

**Prepared for:**

**Small Industries Development Bank of India (SIDBI)**

## Certificate of originality



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| | |
|---|---|
| **AIFI** | Association of Indian Forging Industry |
| **ARAI** | Automotive Research Association of India |
| **BAT** | Best Available Technology |
| **BPCL** | Bharat Petroleum Corporation Limited |
| **CNC** | Computer Numerical Control |
| **CNG** | Compressed Natural Gas |
| **DCCIA** | Deccan Chamber of Commerce Industries & Agriculture |
| **DIC** | District Industries Centre |
| **EE** | Energy Efficiency |
| **FI** | Financial Institution |
| **FO** | Furnace Oil |
| **GEF** | Global Environment Facility |
| **HPCL** | Hindustan Petroleum Corporation Limited |
| **HSD** | High Speed Diesel |
| **IGDPR** | Investment Grade Detailed Project Report |
| **ISO** | International Organization for Standardization |
| **ITI** | Industrial Training Institute |
| **LDO** | Light Diesel Oil |
| **LPG** | Liquefied Petroleum Gas |
| **M&V** | Monitoring and Verification |
| **MCCIA** | Mahrashtra Chamber of Commerce, Industries & Agriculture |
| **MIDC** | Maharashtra Industrial Development Corporation |
| **MSEDCL** | Maharashtra State Electricity Distribution Company Limited |
| **MSME** | Micro, Small and Medium Enterprises |
| **NG** | Natural Gas |
| **Mt** | Million tonne |
| **OEM** | Original Equipment Manufacturer |
| **PCCICSA** | Pimpri–Chinchwad Chamber of Industries, Commerce, Services & Agriculture |
| **SIDBI** | Small Industries Development Bank of India |
| **SWOT** | Strength, Weakness, Opportunity and Threat |
| **TERI** | The Energy and Resources Institute |
| **Toe** | tonnes of oil equivalent |
| **USD** | United States Dollar |
| **WB** | World Bank |

# Acknowledgements

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Last but not the least, the interactions and deliberations with cluster coordinating agencies, industry associations, and Cluster Coordination Committee members, MSME entrepreneurs, technology providers, and those who were directly or indirectly involved throughout the study were exemplary and the whole exercise was thoroughly a rewarding experience for TERI.

TERI Team

# Certificate of originality

This is to certify that this report is the original work of TERI. The study was jointly carried out by experts from TERI New Delhi and the field- based team stationed in the cluster. The teams held detailed discussions and collected data from numerous industry stakeholders, which covered MSME entrepreneurs, senior plant engineers, industry associations, key local bodies, local service providers, suppliers, fabricators, manufactures, experts, testing labs, academic institutes/ITIs, banks/FIs, and local energy distribution companies. In addition to this, the team reviewed secondary literature available on the cluster. The cluster profile is an end product of both first hand interactions/data and secondary literature on the cluster. Appropriate references have been indicated in places where TERI has utilized secondary sources of data and information. A bibliography containing the different references made in the report is provided at the end of the document.

# Executive summary

The Indian forging and heat treatment industry is a major contributor to the manufacturing sector of the Indian economy. Heat treatment is an allied process for treatment of forging and machined components. Some forging units have in-house heat treatment facilities, while others undertake heat treatment from external heat treatment units. The total production from the Indian forging industry during 2010–11 was about 2.3 million tonnes[1] (MT), with a growth of about 27% over the previous year. Pune is one of the prominent forging industry clusters with allied heat treatment and machining processes for manufacturing auto-components in the country. The Pune cluster has developed into a manufacturing hub for many industries like automobiles, chemicals, sugar, and auto allied industries, such as forging industries. As per initial surveys conducted by TERI, there are about 70 MSME forging and heat treatment units operating in the cluster (50 forging units and 20 heat treatment units). The cluster contributes to about 20%–25% of the national production (about 0.4 to 0.5 million tonnes) of the forging sector.

The major raw materials used in the Pune forging units include carbon steel, alloy steel, stainless steel, aluminium, super alloy, special steels, non-ferrous metals, titanium, and so on. The products after forging are heat treated and machined for use in various types of automobile and engineering products. The Pune forging cluster mainly caters to the demands of various large Original Equipments Manufacturers (OEM) like Tata Motors, Mahindra & Mahindra, Mercedes Benz, Force Motors, Bajaj Auto, General Motors, Volkswagen, and Fiat.

The MSMEs in the cluster are spread across various locations. There are four to five major industry associations like AIFI, MCCIA, DCCIA, and PCCICSA, which facilitate the growth of industry in the cluster. There are about 20 commercial, cooperative, and nationalized banks operating in the cluster. Some of the key banks along with Small Industries Development Bank of India (SIDBI) include Bank of Maharashtra, State Bank of India, and ICICI. Specific investments on energy efficiency are generally low in the cluster. There are a number of local service providers present in the cluster, which include fabricators, equipment suppliers, technology providers, and so on. The fabricators generally undertake both furnace design and commissioning activities.

The processes used by the forging and heat treatment units of Pune are highly energy consuming and energy intensive. Different types of energy, such as electricity, Natural Gas (NG), Liquefied Petroleum Gas (LPG), Light Diesel Oil (LDO), Furnace Oil (FO), and High Speed Diesel (HSD) are used in the forging units. Electricity is used for heating in induction furnaces and resistive heating in heat treatment furnaces. Electrical energy is also used in various machines like presses, air compressors, hydraulic systems, and water pumps. Heating accounts for a major share of energy consumption (80% to 90%). The balance 10% of energy is accounted by other equipment, such as hammers, presses, pumps, and air compressors.

[1] The Automotive Horizon

Heating, in forging and heat treatment furnaces, is the major energy consumption source in forging units. The technology used for heating in most units is box type forging furnaces and pit type or pusher type furnaces for heat treatment. The overall energy efficiency of these furnaces is poor. Most of these units use closed die forging technology using forging hammers and presses.

A large number of units in the Pune forging cluster use inefficient systems that offer significant potential for energy saving. The adoption of energy efficient technologies like control systems for furnaces, energy efficient induction furnace for forging heating, use of natural gas for heat treatment, use of screw air compressors, energy efficient lighting, offer significant potential for energy savings.

The units in Pune face numerous challenges due to use of inefficient technologies, lack of awareness regarding productivity improvement systems, squeezed margins from OEMs, and pollution due to old inefficient furnaces. The units also face challenges due to increasing cost of energy and raw materials. In such a situation, it is inevitable for these units to adopt EE technologies so as to maintain a better profit margin and keep the manufacturing costs within limits.

# 1.0 About the project

## 1.1 Project overview

The World Bank, with support from Global Environmental Facility (GEF), has designed the MSME EE project as part of the GEF Programmatic Framework project for Energy Efficiency in India. The objective of this project is "to increase demand for energy efficiency investments in target micro, small, and medium enterprise clusters and to build their capacity to access commercial finance". This project is to be co-implemented by Small Industries Development Bank of India (SIDBI) and Bureau of Energy Efficiency (BEE).

## 1.2 Project objectives

The objectives of this project are as under:

a) To create increased demand for EE investments by adopting a cluster approach to facilitate the development of customized EE products and financing solutions in five targeted industry clusters, and to build the capacity of identified apex organizations to assist MSME units in identifying additional EE projects in the future, thereby aiding in widespread replication.

b) To raise the quality of EE investment proposals from a technical and commercial perspective, and thus to increase the capacity of both project developers and bank loan officers/Branch Managers to help shrink the gap between project identification and successful delivery of commercial finance.

c) To expand the uses of existing guarantee mechanisms for better risk management by banks to catalyse additional commercial finance for energy efficiency.

d) To establish a monitoring and evaluation system for the targeted clusters.

The GEF implementing agency for this project is the World Bank and the executing agencies are Small Industries Development Bank of India (SIDBI) and the Bureau of Energy Efficiency (BEE). The five targeted MSME clusters covered under the project and the indicative information about the clusters collected at the time of project formulation are given in table 1.2.

**Table 1.2:** Five targeted MSME clusters covered under the project and the indicative information

| Cluster | Number of units | Main fuel | Apex organization |
|---|---|---|---|
| **Kolhapur Foundry** | 350 | Coke | Kolhapur Engineering Association |
| **Pune Forging** | 160 | Furnace oil | Association of Indian Forging Industry |
| **Tirunelveli Limekilns** | 100 | Charcoal | Nellie Lime Manufacturers Association |
| **Ankleshwar** | 1200 | Gas/ Electricity | Ankleshwar Industry Association |
| **Faridabad Mixed** | 2000* | Electricity/ oil | Faridabad Small Industries Association |

## 1.3 Major components of the project

The project comprises the following major components:

1) Activities to build capacity and awareness:
   a) Marketing and outreach effort to clusters and capacity building at industry associations
   b) Training of energy auditors/energy professionals
   c) Specialized support to financial intermediaries
   d) Unit-level support to MSMEs in accessing finance
   e) Vendor outreach, enlistment and support, and engagement of a Regional Energy Efficiency Centre of Excellence for specialized technical capacity building activities in the area of furnace optimization

2) Activities to increase investment in energy efficiency:
   a) Energy efficiency project development support
   b) Performance linked grants for demonstration of efficient technologies

3) Programme knowledge management and sharing

# 2.0 Cluster scenario

## 2.1 Introduction

The Indian forging industry is a major contributor to the manufacturing sector of the Indian economy. The industry forges a variety of metals like iron, titanium, aluminium, and so on to manufacture products used in many sectors, particularly in the automotive industry. A large share of the forging industry is made up of micro, small, and medium enterprises (MSMEs). While the total investment in the large and medium sectors is estimated to be about $600 million, the small scale units are also increasing their capital investment to keep pace with the increasing demand, especially in the global markets.

## 2.2 Industry statistics

The total production from the Indian forging industry during 2010–11 was about 2.3 million tonnes[2] (MT), with a growth of about 27% over the previous year. The turnover of the Indian forging industry in 2007–08 was $3 billion (Rs 15,000 crore)[3]. The large scale industries account for about 65%–70% of total forging production of Pune. The remaining 30%–35% is produced by the MSMEs. Pune cluster contributes to about 20%–25% of the national production (about 0.4 to 0.5 MT). A large number of the forging and heat treatment units have become suppliers to 'Original Equipment Manufacturers' (OEMs) in the automobile sector. The industry is increasingly addressing opportunities available with global automotive OEMs, thus, contributing significantly to growing exports of the country. The forging exports from India grew to about $472 million in 2007–08. Technological developments have also contributed to growth of exports in the Indian forging sector. The major markets for Indian forging industry include USA, Europe, and China. However, only about 30–35 manufacturing units in India are currently contributing to exports directly. Few major forging clusters include Batala, Coimbatore, Faridabad, Jalandhar, Ludhiana, Nagaur, and Pune.

## 2.3 Overview of Pune forging cluster

### 2.3.1 Geographical location

Pune is the second largest city in the state of Maharashtra. It is the administrative capital of Pune district. The city is known to have existed as a town since 847 AD. The forging cluster of Pune is located in the Pune district. The geographical location of Pune is shown in Table 2.3.1.

**Table 2.3.1:** Geographical location of Pune

| | | |
|---|---|---|
| Geographical location | : | 17.5° to 19.2° North and 73.2° to 75.1° East |
| Geographical area | : | 700 $km^2$ |
| Population | : | 9.42 million |

[2] The Automotive Horizon
[3] AIFI Pune


**Figure 2.3.1:** Location of Pune forging cluster

Source: http://siib.ac.in/site_images/image/map_pune.jpg

### 2.3.2 History and evolution of the cluster

Pune has developed into manufacturing centre for many industries like automobiles and chemicals and is the agricultural base for sugar industries and auto allied industries, such as forging since 1950s. All sectors of the automotive industry are represented, from two-wheelers, auto rickshaws, cars, tractors, tempos, excavators, and trucks. Large automotive companies like Tata Motors, Mahindra & Mahindra, Mercedes Benz, Force Motors (Firodia-Group), and Kinetic Motors have set ups in Pune. Automotive companies, including General Motors, Volkswagen, and Fiat have set up green-field facilities near Pune. Today, several automotive component manufacturers like Saint-Gobain Sekurit, TATA Autocomp Systems Limited, Robert Bosch GmbH, ZF Friedrichshafen AG, Visteon, and Continental Corporation are located in the area. With the increasing presence of many automobile companies and auto ancillary divisions in Pune, the need for forging and its allied industries is growing in an unprecedented way.

### 2.3.3 Inventorization of units

There are about 70 MSME forging units operating in the cluster. The classification of these forging units on the basis of their size is given in Table 2.3.3a. As it can be seen, the majority of these units fall under the 'small' category of the Ministry of MSME definition, which is classified on the basis of the unit's total investment in plant and machinery.

**Table 2.3.3a:** Distribution of forging and heat treatment units

| Unit type | Number of forging units | Number of heat treatment units |
|---|---|---|
| Micro | 5 | - |
| Small | 35 | 13 |
| Medium | 10 | 7 |
| Total | 50 | 20 |

Source: http://www.indianforging.org/members_directory.aspx.
http://www.dcciapune.org/membership/members-list.html
http://www.mcciapune.com/member-directory.aspx
http://www.justdial.com/Pune/Forging-Manufacturers/ct-112650
Pune MIDC Industrial Directory

These units are spread across different industrial estates developed by Maharashtra Industrial Development Corporation (MIDC), such as Pimpri-Chinchwad MIDC, Chakan MIDC, Bhosari MIDC, and other areas like Kharadi, Alandi, Haveli, Shikrapur, and Sanaswadi. The geographical dispersion is shown in Table 2.3.3b. Heat treatment units are also located in the cluster catering to the needs of the forging units.

**Table 2.3.3b:** Location of forging and heat treatment units

| Location | Number of forging units | Number of heat treatment units |
|---|---|---|
| Bhosari | 20 | 6 |
| Chakan and Talawade | 8 | 3 |
| Pimpri-Chinchwad | 10 | - |
| Others | 12 | 11 |
| Total | 50 | 20 |

These units are generally registered with the Government of Maharashtra and most of them have entrepreneurship memorandum number issued by the Department of MSME. A large number of the units are ISO 9001:2008 certified companies; and few are even ISO – TS 16949:2008 certified units. A majority of these units follow proper procedures for manufacturing processes, accounting, and purchase as per the standards.

Some of the leading MSME forging units based in the Pune cluster include:

- Poona Forge
- Jiteen Engineering Works
- Sachin Forge
- Singh & Sons
- Trishul Forgings
- Duurrgman Engineering Co.
- Mirage Forge Pvt. Ltd
- Chaitali Forge & Machining
- Sanngo Auto Forge Pvt. Ltd
- S B Engineers

These units are major suppliers of automobile and non-automobile components for Tata Motors, Bajaj Auto, Alfalaval, Maruti, Sandvik, and JCB.

The leading MSME heat treatment units based in the Pune cluster include:

- MechaTherm Services
- Jyoti Heat Treat Industries
- Deck India Engineering Pvt. Ltd

Heat treatment units in the cluster are mainly vendors of the forging units.

### 2.3.4 Raw material usage in cluster

The Pune cluster forges a variety of materials. The major raw materials used in the forging units of Pune include mild steel, carbon steel, alloy steel, stainless steel, aluminium, super alloy, special steels, non-ferrous metals, titanium, and so on. Carbon and stainless steel grades are ASTM/ASME SA 182 F, 304, 304L, 304H, 309H, 310H, 316, 316H, 316L, 316 LN, 317, 317L, 321, 321H, 347, 347 H (Prices of stainless steel are between Rs 2,40,000/tonne to Rs 2,80,000/tonne). Most of these raw materials are available locally or obtained from other domestic markets and are manufactured in India. Prices of various grades of carbon steel like 15C8, EN8D, SAE8620, used for forging are between Rs 48,000/tonne to Rs 58,000/tonne.

In most of the MSME units, the size of raw material varies from diameter 8 mm to 150 mm for closed-die forging and diameter 80 mm to 250 mm for open-die forging.

### 2.3.5 Products manufactured

The products forged in Pune are of various types. These include propeller shaft, front axle, upper pin, crown wheels, gears, shafts, connecting rods, forks, camshafts, and wheel hubs. These products are custom made and used mainly in the automotive sector. The production by the MSME units in the cluster is in the range of 50 tonnes/month to about 1000 tonnes/month. The categorization of units by production is given in Table 2.2.5a and 2.2.5b.

**Table 2.3.5a:** Categorization of units by production

| No. of forging units | Production rage in tonnes/annum (TPA) |
|---|---|
| 10 | 500–1,000 |
| 25 | 1,000–2,000 |
| 15 | 2,000–3,500 |

**Table 2.3.5b:** Categorization of units by production

| No. of heat treatment Units | Production tonnes/annum |
|---|---|
| 5 | 500–1,000 |
| 5 | 1,000–1,500 |
| 10 | 1,500–2,000 |

The estimated annual production figures of MSME forging and heat treatment units in the cluster for the past two years are given in Table 2.3.5c. The trends are shown in Figure 2.3.5.

**Table 2.3.5c:** Estimated annual production

| Annual production year | Forging units TPA | Heat treatment units TPA |
|---|---|---|
| 2010–11 | 1,20,000 | 40,000 |
| 2011–12 | 80,000 | 28,000 |

Source : http://www.indianforging.org/
preliminary survey by TERI

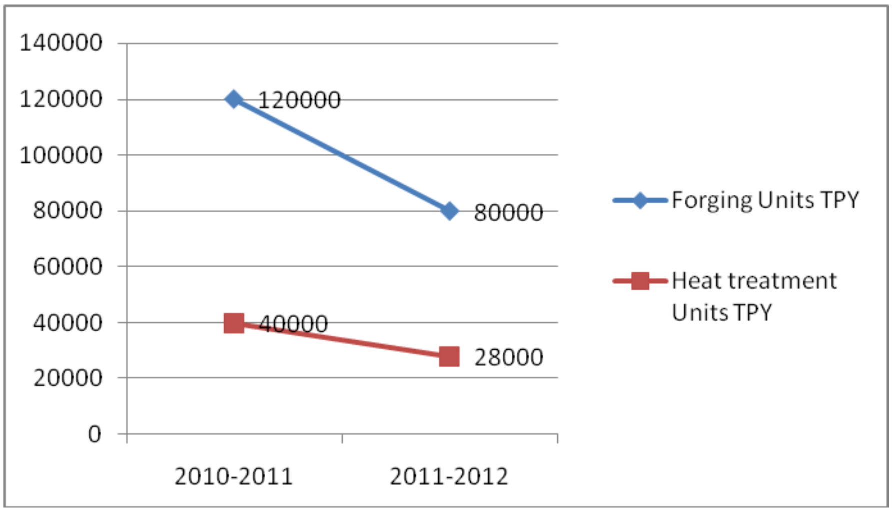



**Figure 2.3.5:** Production trends in tonnes per annum in the cluster

Downward trend of production is due to the slowdown in Indian automobile market as well as slump in exports due to the downturn in US and European economies.

### 2.3.6 Technological upgrades undertaken by units in the recent past

While a few forging units have upgraded their technologies in the recent past, the majority continue to use out-dated technologies. Recent initiatives undertaken by some of the units include the following:

1) The industries are shifting from conventional oil fired furnaces to energy efficient electrical induction furnace for forging heating
2) Heat treatment units are shifting from FO and LDO to natural gas fired furnaces
3) Units are shifting from forging hammers to more precise forging presses
4) For air utility, units are using rotary screw compressors instead of reciprocating compressors
5) Units are shifting from conventional HPMV, metal halide lamps to energy efficient CFL and LED lamps for lighting

### 2.3.7 Current market scenario

The forging industry, like other primary engineering sectors is directly impacted by cyclical market trends occurring in end-user industries. Currently, since the automotive sector is facing slow down due to global recession, the Pune forging units are also feeling the impact on their revenues. Over the past 3–4 months, the forging industry in Pune has observed a slowdown in the domestic as well as export market.

End users of forged components from these MSME units are largely automobiles, including two-wheelers, four-wheelers, cranes, earth movers, mining and oil drilling equipment, pumps and valve bodies, and defence parts. Domestic users of forgings from the cluster are automobile companies like Tata, Mahindra, Bajaj, JCB, Maruti; ordinance factories around Pune; engineering firms like Forbes Marshall, Sandvik, Alfa Laval, and so on. The domestic market constitutes about 80% of the total supply from these MSME units. The industry is increasingly looking for export opportunities. The present market includes USA, Europe, and China.

### 2.3.8 Cluster level turnover, profitability and employment

Discussions with stakeholders revealed that the turnover of the forging units has increased over the past few years. But recently, because of the slowdown in the market, there is a dip in turnover compared to the previous year. The turnover of MSME forging and heat treatment units vary over a wide range of Rs 0.25–25 crore per annum. Estimates of the gross annual turnover of the cluster are provided in Table 2.3.8.

**Table 2.3.8** Estimated gross annual turnover of the cluster

| Type of units | Turnover in Rs crore/annum |
|---|---|
| Forging units | 500–600 |
| Heat treatment units | 80–100 |

The MSME forging and heat treatment units in the cluster provide direct and indirect employment to about 20,000 persons. As major automobile OEMs like Volkswagen, General Motors, Mercedes Benz, and JCB have recently started manufacturing facilities in Pune, the turnover and employment in the cluster is expected to rise sharply in the future. Further, discussions with various key stakeholders indicated that the profitability of individual units/ cluster were not available in public domain.

### 2.3.9 Social and environmental aspects in the cluster

Various initiatives, such as the Auto Cluster Development Centre, which provides facilities like CAD-CAM centre for design of tools and auto components have been undertaken in the cluster. Most of the MSME units avail these facilities. In addition, local bodies also provide infrastructure like training halls for conducting various trainings related to MSME units. Such training includes topics, such as productivity improvement, quality systems, latest market trends, energy efficiency, and so on.

With regard to environmental issues, smoke and emissions emerging from forging furnaces and hammers is a rising concern in Pune. Also, noise levels of hammers in some units are quite high. Use of clean and energy efficient equipment can address concerns of pollution and improve the working condition of workers. Furthermore, plantation of trees near the vicinity of units should also be encouraged for improving the environmental conditions of the industrial areas.

Awareness generation on using personal safety equipment by workers, operators, and helpers is required for the cluster. Use of Personal Protective Equipment (PPE) like ear plugs, mask, hand gloves, safety goggles, safety shoes, and so on is necessary to improve the safety aspects for the workers. Employment of child labour was not observed in these units. The state government strictly prohibits child labour in MSME Pune forging cluster.

# 3.0 Major cluster actors

## 3.1 Industry associations

The Association of Indian Forging Industry (AIFI), located at Pune is the main industry association comprising about 150 members representing both large and small forging units. Other industry associations pertaining to the forging cluster at Pune include (1) Pimpri-Chinchwad Chamber of Industries, Commerce, Services and Agriculture (PCCICSA); (2) Maharashtra Chamber of Commerce, Industries and Agriculture (MCCIA); (3) Chakan Industries Association; (4) Pimpri-Chinchwad Small Industries Association; and (5) Deccan Chamber of Commerce, Industries and Agriculture Pune (DCCIA). Details of the industry associations are given in Table 3.1.

**Table 3.1:** Details of industry associations at Pune forging cluster

| Name of the association | Chairperson |
|---|---|
| Association of Indian Forging Industry (AIFI) | Mr Jinendra Munot |
| Pimpri-Chinchwad Chamber of Industries, Commerce, Services and Agriculture (PCCICSA) | Mr Appasaheb Shinde |
| Mahrashtra Chamber of Commerce Industries and Agriculture (MCCIA) | Mr Anant Sardeshmukh |
| Chakan Industries Association (CIA) | Mr S J S Chatrath |
| Deccan Chamber of Commerce Industries and Agriculture Pune (DCCIA) | Mr Prem Anand |
| Pimpri-Chinchwad Small Industries Association | Mr Nitin Bankar |

The AIFI plays an active role in promoting the forging industry. In developing forging industry as a critical feeder to a number of core industries, AIFI plays an important role. The Pune centre of AIFI takes up issues, such as budget and Exim policies with the Government of India. AIFI also has strong linkages with counterpart forging associations in countries, such as USA, European countries, Japan, and China. These linkages facilitate establishing new business opportunities for the member units. AIFI, with support from Government of India, has set up a Research & Development Centre along with product testing and validation facilities for the forging industry at Chakan, Pune.

## 3.2 Government support bodies

There are government support bodies, such as the Maharashtra Industrial Development Corporation (MIDC), District Industries Centre (DIC)–Pune, and Automotive Research Association of India (ARAI). ARAI's forging division organizes training and undertakes R&D projects as well as testing and validation. The testing facility at ARAI includes fatigue and durability testing of components, sub-assemblies or assemblies in load or displacement control modes, material characterization, vibration testing, and so on.

## 3.3 Academic and R&D institutions

There are various training and academic institutes that support the forging industry either directly or indirectly. There are government and private government engineering colleges, polytechnics, and Industrial Training Institutes (ITIs) in Pune. The Pune University has also initiated post graduate courses (M.Tech and M.Phil Programmes) in energy management.

R&D projects are undertaken primarily by the forging division of ARAI. The Association offers services for design and development of engine components and sub-systems, durability trials, emission controls, and specific power upgrades. The R&D in designing of engines starts from the concept stage to creation of the prototype, for various applications, like HCV, LCV, utility vehicles, tractors, gensets, and two-and three wheelers from 4 to 250 HP. ARAI has successfully developed indigenous CNG and LPG conversion kits for 2 and 3 wheelers and engines for meeting EURO IV emission norms. Currently, ARAI is engaged in designing technology from the concept stage to creating prototype for advanced engine application, meeting EURO IV emission norms with common rail electronic diesel control.

## 3.4 Service/technology providers

There are a number of LSPs present in the cluster. The types of LSPs include fabricators, equipment suppliers, technology providers, and so on. The fabricators generally undertake both furnace design and commissioning activities. The suppliers of induction furnaces have presence at cluster level for installation and maintenance. There are also other LSPs providing related services, such as furnace automation, motor drives, and so on in the cluster. Names of some of the LSPs are provided in Table 3.4.

**Table 3.4: Selected LSPs in the cluster**

| Name of service providers | Description of services |
|---|---|
| Mr HarshadM Bhatkar | Megatherm induction furnace supplier |
| Mr Gaurang Bhatt | Yantra harvest automation service provider |
| Mr Vishwas Kale | Vijayesh instruments provider for furnace automation |
| Mr Murali Nair | Savair energy supplier for compressors automation |
| Mr Ganesh S Dhamnaskar | Wesman burners and temperature controller system provider |
| Mr W N Landekar | Manufacturers of fuel efficient Furnaces |

## 3.5 Financial institutions/banks

### 3.5.1 Lead bank

The Bank of Maharashtra (BOM) is the lead bank in the Pune district with more than 25 branches. IDBI is one of the leading commercial bank with close to 20 branches in the Pune district.

### 3.5.2 Nationalized and commercial banks

There are about 20 commercial, cooperative, and nationalized banks operating in the cluster. Some of the key banks along with Small Industries Development Bank of India (SIDBI) include Bank of Baroda, State Bank of India, and ICICI. A majority of the banks provide support for plant expansion and infrastructure upgradation. A number of co-operative banks like Janta Sahakari Bank, Ichalkaranji Janta Sahakari Bank, Co-operative Bank, Saraswat Bank, Dena Bank, and Abhyuda Bank, are located in Pune. However, specific loans for achieving specific levels of energy efficiency are generally few.

### 3.5.3 Financial institutions

SIDBI is the leading financial institution (FI) in the cluster having several branches in Pune city and MIDC areas.

# 4.0 Technology used and production process

## 4.1 Forging technologies

In forging, the metal is pressed, pounded or squeezed under high pressure into high strength components. Forging involves the following process steps: (1) cutting and heating of billets; (2) forming operations; and (3) final treatments, such as flash removal, punching, and cooling. The equipment/ systems used in Pune forging cluster include the following:

- **Oil fired and gas fired furnaces**

Furnace oil, LDO, natural gas, and LPG are commonly used as fuel in the furnaces. The forging furnaces are used for heating of raw material (billets of various grades of steel) to 1150 °C–1200 °C. The capacities of these furnaces are in the range of 50 kg/hr to 400 kg/hr. Different designs of furnaces are box, 'L', and pusher types. Billets are heated either in batches or continuously. Heat treatment furnaces are used for normalizing, annealing, hardening, tempering, and carburizing of forged and machined components as per requirements of the specific jobs. The temperatures in the furnaces vary widely depending on the treatment and ranges between 250 °C to 930 °C. The oil consumption in the forging furnaces typically ranges between 100–200 litre/tonne, and for heat treatment furnaces the consumption is about 60–80 litre/tonne. Gas consumption for the forging furnaces typically ranges between 100–150 scm/tonne and for heat treatment furnaces the consumption is about 50–80 scm/tonne. Blowers with electrical motors of 3 to 7.5 hp are used in furnaces for providing the combustion air for fuel.

- **Electric furnaces**

Electrical energy is also used for heating the billets for forging and for heat treatment. The production capacities of electrical induction furnaces typically range between 100–500 kg/hr and connected power ranges between 50–300 kW. Specific electricity consumption for these furnaces are about 450–500 kWh/tonne. The electrical resistive heating furnaces used for heat treatment operations typically range in capacities from 200 to 600 kg/batch. The furnaces may be batch (pit type) or continuous (pusher type). The rating of these furnaces varies from 15 kW to 120 kW. The furnaces have recirculating air fans with electrical motors between 3 to 7.5 hp.

- **Close die hammers of belt drop type**

These hammers are used for forging of hot billets into various shapes for shafts, flanges, gear blanks, pipe fittings, rollers, hubs, and so on. The capacity of the forging hammers typically range between 0.5 to 3 tonnes. 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.

- **Pneumatic type screw press**

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

- **Open die hammers**

The capacity of the open die hammers are in the range of 0.5 tonnes to 5 tonnes. Unlike in close die hammers, no top and bottom dies are used in open die. Instead, only the hammer and the base on which the job rests (called anvil) is used. Basic jobs forged on these hammers are certain types of shafts and flats.

- **Automation of furnaces**

Automation is used for burner control and temperature control of furnaces so that a constant temperature is maintained inside the furnace.

## 4.2 Manufacturing process

Different types of manufacturing processes are used in the Pune forging cluster: (1) closed or impression die forging; (2) cold forging; (3) open die forging; and (4) seamless rolled ring forging.

### 4.2.1 Closed or impression die forging

The metal is pressed between two dies (tooling) that contain a pre-cut profile based on product specifications. A temperature of about 1,250 °C is used for the forging operation. In this, metals weighing between a few kilograms to about 25 tonnes are forged. The forgings are generally produced on hydraulic presses, mechanical presses, and hammers. Using impression die forging process, products with complex shapes and closer tolerances can be produced. Metals and alloys that can be forged through the impression-die process includes carbon and alloy steels, tool steels, and stainless, aluminium, and copper alloys, and certain titanium alloys. Figure 4.2.1 shows billet heating furnace[4].

**Figure 4.2.1:**Billet heating furnace

The forging heating is the major energy consumption source in the forging unit, the technology used for heating in most units is box type forging heating furnaces, in which energy efficiency is poor. Few units have shifted to energy efficient electrical induction furnaces and in some cases natural gas for forging heating.

[4] Source: http://www.innotechengineers.com

Almost 80% of energy is used in the forging and heat treatment furnaces. The type of furnaces used in number of units is as shown in Table 4.2.1.

**Table 4.2.1:** Types of furnaces

| Types of furnaces used | No. of units |
|---|---|
| Induction/electrical resistance | 10 |
| FO /LDO fired | 50 |
| LPG/Natural Gas | 8 |

### 4.2.2 Cold forging

In cold forging, a chemically lubricated bar slug is forced into a closed die under very high pressure. The non-heated metal forms into the desired shape. Cold forging includes processes, such as bending, cold drawing, cold heading, coining, extrusions, and so on. These include shaft, cup-shaped components, hollow parts with stems and shaft, and so on. The temperature of metals being cold forged may range from room temperature to several hundred degrees. Materials, such as lower alloy and carbon steels, stainless steel, aluminium alloys, brass, and bronze can be cold forged. Warm forging is preferred over cold forging especially for higher carbon grades of steel or where in-process anneals can be eliminated.

### 4.2.3 Open die forging

Open die forging is done with flat dies with no pre-cut profiles in the dies. Movement of the work piece is important in open die forging. Open die forging can produce forgings from a few kilograms to more than 150 tonnes. It comprises many process variations, thus, allowing a broad range of shapes and sizes to be produced. Practically all forgeable ferrous and non-ferrous alloys can be open-die forged, including age-hardening super alloys and corrosion-resistant refractory alloys. In addition to round, square, rectangular, hexagonal bars, and other basic shapes, open-die processes can produce step shafts, hollow cylindrical shapes, ring-like parts, and contour formed meal shells.

### 4.2.4 Seamless rolled ring forging

Seamless rolled ring forging is typically performed by punching a hole in a thick, round piece of metal and rolling and squeezing the same into a thin ring. Ring diameters can vary from a few inches to 10 metres and weigh from less than one kilogram to about 150 tonnes. These products find applications in energy generation, mining, aerospace, off-highway equipment, and other critical applications.

### 4.2.5 Heat treatment and allied processes

Heat treatment and machining are the associated processes used in the forging industry. The components formed by forging operations are further heat treated for stress relieving, hardening, and tempering. Some forging companies have in-house heat-treatment and machining facilities. In stand-alone forging units, heat treatment is done in ancillary units. Heat treatment is done at about a temperature of about 700–900 $^{o}$C. The machining operations include milling and cutting, which are done in conventional lathe machines or CNC machines. Most of the units use conventional box type and continuous furnaces with FO and LDO for heat treatment, which is inefficient and polluting. Some units have started using NG for heat treatment with proper controls for fuel firing, leading to improvement in efficiency and environmental conditions. Heat treatment is the controlled heating and cooling of metals to alter their physical and mechanical properties without changing the product shape. Heat treatment is sometimes done inadvertently due to manufacturing processes that either heat or cool the metal, such as welding or forming. Heat treatment is often associated with increasing the strength of material, but it can also be used to alter certain manufacturability objectives, such as improve machining, improve formability, and restore ductility after a cold working operation. Thus, it is a very enabling manufacturing process that can not only help other manufacturing processes, but can also improve product performance by increasing strength or other desirable characteristics. The process flow chart of a typical forging operation in Pune forging cluster is shown in Figure 4.2.5.

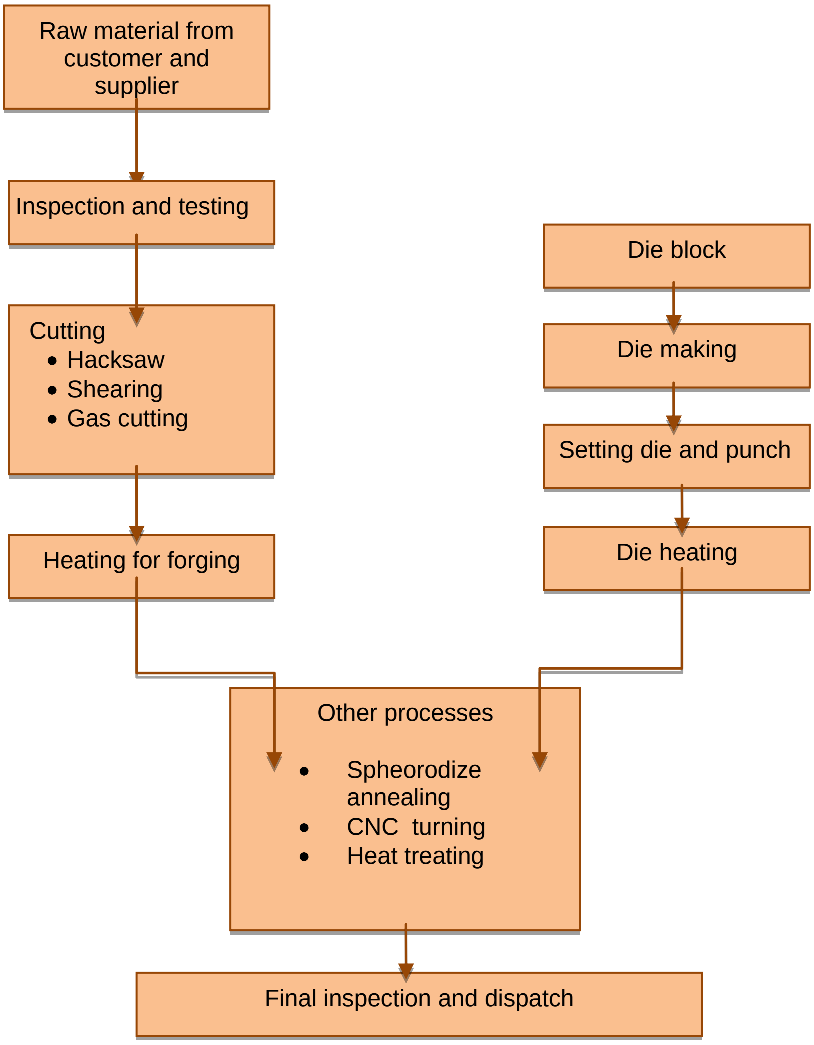



**Figure 4.2.5:** Manufacturing process of a typical forging unit in Pune

# 5.0 Estimated energy consumption pattern and saving potential

## 5.1 Types of fuel and usage in MSME

### 5.1.1 Fuel types

Different forms of energy, such as electricity, Compressed Natural Gas (CNG), Liquefied Petroleum Gas (LPG), Light Diesel Oil (LDO), Furnace Oil (FO), and High Speed Diesel (HSD) are used by the forging units in Pune. Electricity is used for heating in induction furnaces and resistive heating in heat treatment furnaces. Electrical energy is also used in various machines like presses, air compressors, hydraulic systems, and water pumps.

### 5.1.2 Specifications and characteristics

The main fuels used in the cluster and their net calorific value are given in Table 5.1.2 below.

**Table 5.1.2:** Net calorific value of fuels used in Pune forging and heat treatment units

| Fuels | Gross Calorific Value |
|---|---|
| Electricity | 860 kcal/kWh |
| Furnace Oil | 9,850 kcal/kg |
| Light Diesel Oil | 10,287 kcal/kg |
| High Speed Diesel | 10,350 kcal/kg |
| Natural Gas | 80,00–9,480 kcal/SCM |
| Liquefied Petroleum Gas | 11,300 kcal/kg |

### 5.1.3 Price/Tariff

The main fuels used in the cluster and their average costs (Rs/unit) are given in Table 5.1.3a below.

**Table 5.1.3a:** Average cost of fuels used in Pune forging industry

| Fuel Type | Cost (Rs) | Unit |
|---|---|---|
| FO | 44–52 | Rs/litre |
| LDO | 48–55 | Rs/litre |
| HSD | 45–50 | Rs/litre |
| Natural Gas | 47.53 | Rs/SCM |
| LPG | 54.35 | Rs/kg |

Sources: http://www.bharatpetroleum.com/EnergisingBusiness/FIP_Fuels.aspx?id=1
http://www.gail.nic.in/final_site/energyconversionmatrix.html

The electricity tariff applicable for the Pune forging and heat treatment cluster (including both High Tension and Low Tension consumers) is given in the Tables 5.1.3b and 5.1.3c.

**Table 5.1.3b:** Electricity tariff for HT consumers in Pune

| Consumer category | Demand charge | Energy charge (Rs/kWh) |
|---|---|---|
| HT I - Industry | | |
| Continuous Industry (on express feeder) | Rs 150 per kVA per month | 5.27 |
| Non-continuous Industry (not on express feeder) | Rs 150 per kVA per month | 4.8 |
| Seasonal Industry | Rs 150 per kVA per month | 5.9 |
| TOD Tariff (In addition to above base tariff) | | |
| 0600 to 0900 hours | | 0.00 |
| 0900 to 1200 hours | | 0.80 |
| 1200 to 1800 hours | | 0.00 |
| 1800 to 2200 hours | | 1.10 |
| 2200 to 0600 hours | | -0.85 |

**Table 5.1.3c: Electricity tariff for LT consumers in Pune**

| Consumer category | Fixed/demand charge | Energy charge (Rs/kWh) |
|---|---|---|
| LT V – Industry | | |
| (A) 0–20 kW (upto 27 hp) | Rs 150 per kVA per month | 3.9 |
| (B) Above 20 kW (above 27 hp) | Rs 100 per kVA per month | 5.4 |
| TOD Tariff (In addition to above base tariff) | | |
| 0600 to 0900 hours | | 0.00 |
| 0900 to 1200 hours | | 0.80 |
| 1200 to 1800 hours | | 0.00 |
| 1800 to 2200 hours | | 1.10 |
| 2200 to 0600 hours | | -0.85 |

Source: http://www.mahadiscom.com/tariff/Order_111_of_2009.pdf

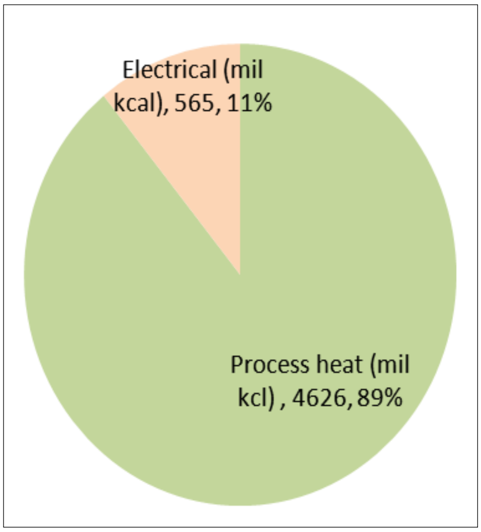
### 5.1.4 Sources/energy suppliers

**Table 5.1.4:** Details of energy suppliers

| Fuel type | Suppliers |
|---|---|
| FO | Hindustan Petroleum Corporation Limited (HPCL), Bharat Petroleum Corporation Limited (BPCL), Indian Oil |
| LDO | HPCL, BPCL, Indian Oil |
| HSD | HPCL, BPCL, Indian Oil |
| Natural gas | Maharashtra Natural Gas Limited ( MNGL) |
| LPG | BPCL, HPCL |
| Electricity | Maharashtra State Electricity Distribution Company Limited (MSEDCL) |

## 5.2 Energy consumption pattern

Electricity or other fuels are used for heating different components in the furnaces for forging as well as for processes like hardening, tempering, and stress relieving in the furnace. Some of the forging and heat treatment units have both oil fired and electrical furnaces for heating. Heating accounts for a major share of energy consumption (80% to 90%). The balance 10% of energy is accounted by other equipment, such as hammers, presses, pumps, air compressors, and so on. A typical energy consumption pattern in a forging unit in Pune cluster is shown in Figure 5.2.



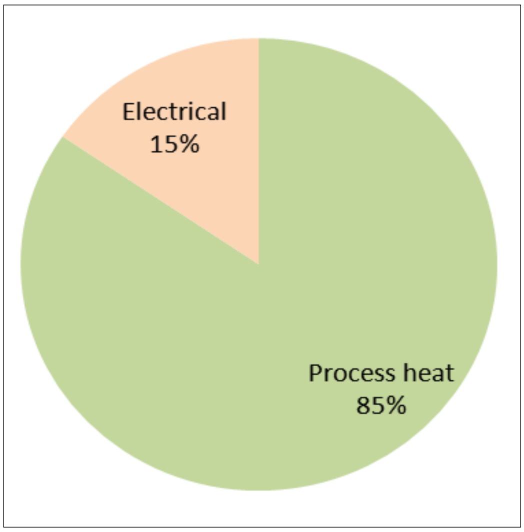



**Figure 5.2:** Energy consumption (left) and cost share (right) in a Pune forging unit

## 5.3 Annual energy consumption pattern

The estimated total annual energy consumption of Pune forging and heat treatment units is estimated to be 24,252 tonnes of oil equivalent (toe) based on data gathered from MSME units in the cluster. Detailed break-up of various sources of energy and the annual consumption by the forging industry of Pune for the year 2011–12 is mentioned in Table 5.3. The graphical representation of annual consumption of various energy sources in the forging and heat treatment units of Pune is given in Figure 5.3.

**Table 5.3:** Annual energy consumption#

| Energy source | Annual energy consumption (toe) | Million (Rs/annum) |
|---|---|---|
| Electricity | 6,794 | 540 |
| Furnace Oil | 11,995 | 841 |
| Light Diesel Oil | 3,044 | 158 |
| High Speed Diesel | 592 | 33 |
| Natural Gas | 1,294 | 62 |
| Liquefied Petroleum Gas | 533 | 24 |
| Total | 24,252 | 1,658 |

# based on 50 forging units and 20 heat treatment units

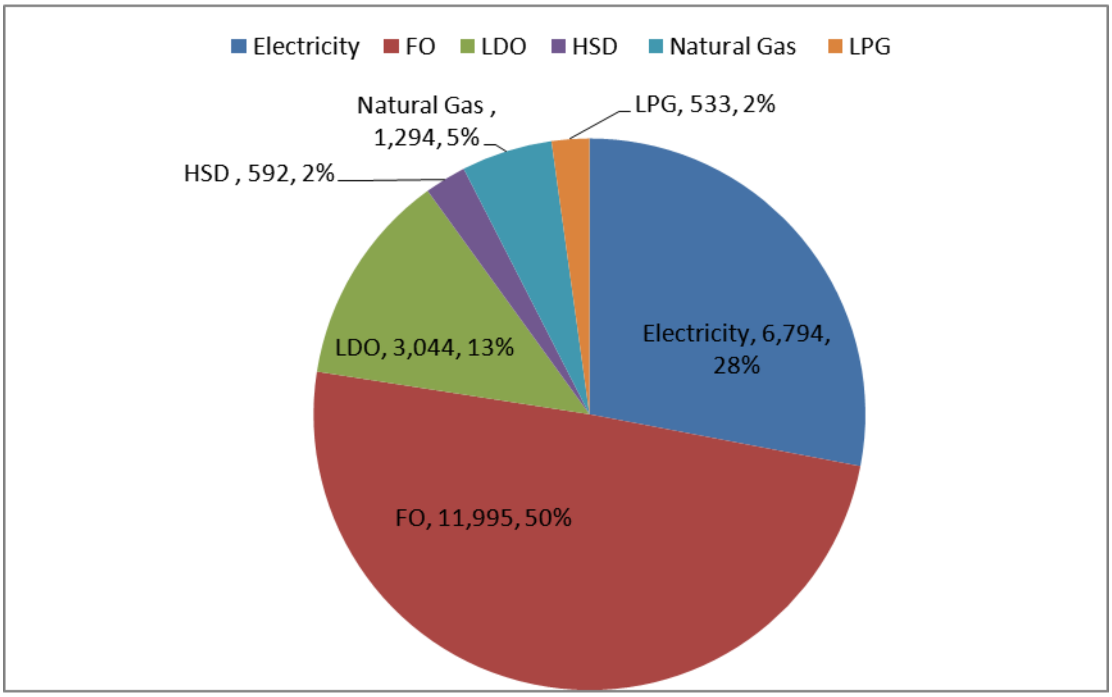



**Figure 5.3:** Annual energy consumption (in toe)

## 5.4 Energy saving potential

The major energy requirement of a forging unit is for heating, which is generally met through oil-fired or electrically heated furnaces. A large number of units in the Pune forging cluster use inefficient systems that offer significant potential for energy saving. The technologies available for energy efficiency improvement are control systems for oil fired forging and heat treatment furnaces, energy efficient induction furnace for forging heating, use of screw air compressors, energy efficient lighting, and so on. Use of natural gas (NG) for heat treatment furnaces also offers scope for energy savings. Walk-through audits will be conducted to identify areas for detailed analysis and detailed energy audits will be carried out to identify implementable EE projects and their energy saving potential.

**Table 5.4:** Energy saving potential

| S. No. | Opportunities for energy savings | Energy saving potential |
|---|---|---|
| 1 | Use of efficient induction furnace instead of old oil fired furnace for forging | 30%–70 % |
| 2 | Use of efficient gas fired furnaces instead of old oil fired furnace for heat treatment units | 10%–20 % |
| 3 | Control systems for oil/gas fired furnaces (burners, blowers, temperature controllers) for forging and heat treatment units | Upto 5%–10% |
| 4 | Controls and operating practices in compressed air systems (use of air guns, low pressure setting, use of screw compressors with VFD) for forging and heat treatment units | Upto 5%–15% |
| 5 | Use of energy efficient motors and pumps | Upto 5%–15% |
| 6 | Use of energy efficient lightings like CFL, LED, T5, and so on | Upto 5%–10% |

# 6.0 Major challenges and suggestions for improvement in the cluster

## 6.1 Technology

The use of outdated and outmoded technologies is a major challenge in the cluster. Presently, most of the units use belt drop hammers for forging and few units use forging presses for precision. Bandsaw used for cutting raw material may be replaced by shearing machines for productivity improvement. Units in forging clusters are using reciprocating compressors for air utility (air blowing); adoption of rotary screw compressors for the same may lead to operational efficiencies. Heat treatment techniques include annealing, normalizing, case hardening, precipitation strengthening, carburizing, nitriding, tempering, quenching, and induction hardening. Mostly, heat treatment units use pit type and pusher type furnaces.

Availability of EE technologies, weak linkages with suppliers, and low levels of knowledge on modern technologies are the main reasons for lack of technology up gradation in the cluster. Enabling policies for technology development and customization; capacity building of local technology providers; and enhanced knowledge dissemination are necessary for facilitating technology up gradation in the cluster.

## 6.2 Energy

The major sources of energy in the Pune forging cluster are FO and LDO. These fuels are used for forging and heat treatment processes, which lead to higher heat losses due to use of poorly designed box type furnaces. This results in poor performance efficiency of furnaces and hence poor productivity in terms of tonnage. This trend is changing and the use of electricity, i.e. induction heating for forging is picking up. There is immense scope for energy savings. Energy audits can recommend significant savings in not only process technologies, but also in auxiliaries, which consume a significant share of energy. However, the forging units in Pune require step-by-step handholding for implementation of EE technologies. The process should involve identification of suitable technologies/practices along with suppliers/fabricators that can provide these technologies through energy audits. The units should then be sensitized on the investments, payback, and returns along with concessional financing options available. The assistance should continue till the implementation stage and even in the post-implementation period to ensure that the technologies implemented are being used along with best operating practices.

## 6.3 Marketing

The major market based challenge facing the Pune forging and heat treatment industry are the cyclical recessionary trends occurring in the major end-use segment, i.e. automotive sector. The demand for forged components has been stagnant for the past few months. The forging units in Pune are mainly supplying their products/forged components to large scale automobile OEMs based in Pune. Each unit is specialized in different types of forged auto components and has a fixed clientele. The units market themselves in terms of their product quality and production capacity. The units need to focus more on reaching out to OEMs located outside Pune and explore opportunities in new international markets.

## 6.4 Raw material and quality

The rising price of raw materials poses a major challenge to the cluster units to keep their manufacturing costs under control. Also, automobile OEMs have made it mandatory for the vendors to buy some raw materials of selected grade from any of their approved suppliers. This leaves units with less bargaining power as these approved raw material suppliers are less. The small scale of operations of the units hinders their capacity to buy raw materials at the most economic prices. Absence of a big quantum of business prevents these units from effective negotiation of terms and price. Joint procurement of raw materials by some units can help them in obtaining a better price from the raw material supplier. While energy is one important parameter, overall resource efficiency through adoption of lean manufacturing practices is critical. For all the heat treatment raw material are forged and finished machine components.

## 6.5 Products and quality

The Pune cluster is renowned for its quality forgings in India. The cluster supplies products to numerous OEMs based in and outside the cluster. However, to progress and move up the value chain ladder, the cluster needs to focus on better manufacturing practices and stringent quality control. The cluster does have testing labs to check metallurgical and hardness properties of materials established at the ARAI forging division in Chakan. This facility is promoted by AIFI and developed by Government of India. Also, many units has developed in-house testing facilities for testing of raw materials and finished products. Majority of the products, after heat treatment, have to undergo metallurgical properties inspection (e.g Hardness, grain size, strength, and so on) for quality purpose. Hence, most of the heat treatments have well-equipped testing facilities.

## 6.6 Manpower and skills

Availability of skilled labour is a major issue, not only in the forgings and heat treatment units, but across the Indian industries in general. Labour retention rates are low and workers tend to shift jobs to large OEMs, which offer better working conditions and cleaner environments. Local ITIs/polytechnics have been unable to meet the rising demand for skilled manpower by the forging and heat treatment units. While several training initiatives specifically focusing on the forging industry are being undertaken by few local institutes and government polytechnics, a need for scaling up such facilities is definitely required.

## 6.7 Environmental control

Leakages of flames/emission of smoke from walls and doors of furnaces are quite common in these units. The major environmental challenge for the forging units is to control smoke and emissions emerging from forging furnaces and hammers. Also, noise levels of hammers in some units are quite high. Ducting for flue gas outlet and proper sealing of doors can control the emission of smoke. Use of clean and energy efficient equipment can address concerns of pollution and improve the working conditions for workers. Furthermore, plantation of trees near the vicinity of units should also be encouraged for improving the environmental conditions of the industrial areas. All the heat treatment units had taken consent from the Maharashtra Pollution Control Board.

## 6.8 Social

On the social side, human resources and labour are provided with basic amenities along with insurance cover for workers. However, most forging and heat treatment units operate with non-mechanized technologies requiring a lot of manual operations. This raises the concern of safety for workers, which is generally inadequate across the units. Measures need to be taken to ensure greater worker safety through provision of safety equipment as well as awareness building on personal safety equipment in the cluster. Use of Personal Protective Equipment (PPE) like ear plugs, mask, hand-gloves, safety goggles, safety shoes, and so on must be encouraged amongst the workers.

# 7.0 SWOT Analysis

A SWOT (Strength, Weakness, Opportunity, and Threat) analysis of the forging industry cluster in Pune was carried out. The forging units need to become efficient to reduce their production costs and maintain profits. For this, the forging units have to adopt energy efficient technologies in their production processes. The SWOT analysis of the Pune forging cluster is as follows:

## 7.1 Strengths

- Locally available raw materials
- Cluster-level availability of technology suppliers and fabricators
- Steady domestic demands
- Increasing demand for quality products
- Key role played by active industry association in technology adoption
- Adequate supply of energy sources like electricity and other fuels
- Forward looking entrepreneurs in the cluster

## 7.2 Weaknesses

- Low level of mechanization and automation among small units
- Inefficient use of production processes leading to higher energy consumption
- Dependency on global majors for technology
- Variations in raw material quality and prices
- Exposure of the industry to cyclical downturns in the automotive industry
- Absense of third party quality testing and certification agencies at cluster level
- Slump in demand by export market
- Non-availability of simulation softwares and computerized design
- Weak institutional mechanism for technical training

## 7.3 Opportunities

- Increased use of process automation
- Strong domestic market
- Development of common platform for export market
- Significant potential for adoption of energy efficient technologies
- Growth of auto sector in India providing boost for upgradation of capacities and improvement of quality

## 7.4 Threats

- Increase in energy costs
- Increase in competition from other countries, such as China
- Need for smaller forging units to upgrade to global standards for their survival
- Delay in responding to market needs

- Reluctance to share information among units
- Non-availability of skilled manpower
- Continuing pressure on prices from OEMs
- Low vision on future needs and business opportunities

# 8.0 Conclusion

Pune is one of the renowned forging clusters in India, comprising about 70 MSMEs with an annual production of close to 2.3 million tonnes (MT). The cluster is well supported by industry associations/bodies, government agencies, and local service providers. Despite being recognized for its quality products, the cluster is highly energy consuming and energy intensive, and offers significant scope for energy savings through adoption of best available technologies and operating practices. An analysis of energy consumption shows that process heating accounts for about 80%–90%, using oil-fired or electric furnaces. AIFI, the main industry association is quite active and has developed linkages with forging associations in countries like USA, European countries, Japan, and China. Thus, new business opportunities would help in development of the Indian forging industry and motivate them to invest in new and energy efficient technological options to become competitive.

However, such adoption requires facilitation support since industries lack the capacity, technical expertise, and financing for carrying out the improvements themselves. The World Bank/GEF/SIDBI project on financing energy efficiency is a timely intervention given the current status of EE in the cluster. The role entrusted upon TERI to conduct walk through audits, detailed audits, and implementation support will directly address the technical, capacity, and financing barriers hindering penetration of EE in the cluster. Activities conducted by other consultants to address knowledge and awareness barriers in the cluster will lend good peripheral support to TERI's efforts. Overall, the holistic approach adopted by the project will be extremely useful in achieving the goal of improving EE in the cluster.

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