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Cluster Profile Report

Ambala (Haryana) Glass Cluster

Prepared for

Bureau of Energy Efficiency (BEE)
Ministry of Power, Government of India
New Delhi

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List of abbreviations

ASIMA	Ambala Scientific Instruments Manufacturers' Association
BEE	Bureau of Energy Efficiency
CFC	Common Facility Centre
DPR	Detailed Project Report
DIC	District Industries Centre
EE	Energy Efficiency
FI	Financial Institute
HSIDC	Haryana State Industrial Development Corporation
HT	High Tension
IPP	Import Parity Price
ITI	Industrial Training Institutes
KPI	Key Performance Indicators
LPG	Liquefied Petroleum Gas
LT	Low Tension
MSME	Micro Small and Medium Enterprises
MT	Million Tonnes
MSME-DI	MSME-Development Institute
SAMA	Scientific Apparatus Manufacturer Association ()
SAME	Scientific Apparatus Manufacturers & Exporters
SWOT	Strength, Weakness, Opportunities, and Threats
toe	Tonnes of Oil Equivalent

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The study team is thankful to officials of MSME Development Institute, Karnal (Haryana), office-bearers of The Ambala Scientific Instruments Manufacturers' Association (ASIMA), Haryana Chamber of Commerce and Industries (Ambala Chapter) for showing keen interest in the study and providing their wholehearted support and cooperation for the preparation of this cluster profile report.

Last, but not least, the interactions and deliberations with the MSME-DI, MSME entrepreneurs, technology providers, and all others who were directly or indirectly involved throughout the study, were exemplary and a rewarding experience on the whole, for TERI.

TERI Team

Certificate of originality

This is to certify that this report is an original work of TERI. The TERI team held detailed discussions and collected data from numerous industry stakeholders, which included MSME entrepreneurs, plant engineers, industries' associations, local energy distribution companies, key local bodies, local service providers, suppliers, fabricators, experts, testing labs, academic institutes/ITIs, and banks/FIs. In addition to this, the team reviewed secondary literature available in the cluster. The cluster profile is an end product of both first hand interactions/data and secondary literature in the cluster. Appropriate references have been indicated in places where TERI has utilized secondary sources of data and information.

Chapter 1

1.0 About the Project

1.1 Project overview

The Micro, Small, and Medium Enterprise (MSME) sector in India is a unique mix of enterprises using conventional as well as modern technologies. Most of the enterprises in the MSME sector are traditional and deploy technologies that are inefficient and resource intensive. The MSMEs are generally located as clusters. There are several such clusters that are highly energy intensive in their operations.

At the national level, the data/information of energy intensive MSME sectors on various parameters like production, type, and quantity of fuel consumption, energy saving potential, details on energy efficient technologies, future growth scenarios, etc. are not readily available. This in a way limits the design of appropriate policy instruments to ensure sustainable growth of these sectors. To address this barrier, the Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India, has initiated an ambitious project of mapping the energy intensive MSME sector across the country. Glass industry is one of the energy intensive sectors identified under the project. The BEE has entrusted The Energy and Resources Institute (TERI), New Delhi to undertake a detailed study of the glass industry sector in India.

1.2 Project objectives

The objectives of the study include the following:

- Map energy intensive glass and refractory manufacturing sector from energy perspective
- In-depth study of existing scenarios on energy consumption and identify opportunities for energy and resource saving
- Prepare a roadmap to develop the intervening sector energy and resource efficient as well as environment friendly

The five targeted glass & refractory clusters covered under the project are shown in table 1.2:

Table 1.2: Targeted clusters under the project

S. No.	Cluster	State	Sector
1	Chirkunda	Jharkhand	Refractory
2	Ambala	Haryana	Glass
3	E & W Godavari	Andhra Pradesh	Refractory
4	Jaipur	Rajasthan	Glass
5	Firozabad	Uttar Pradesh	Glass

1.3 Major components of the project

The major components of the project and their activities are shown in Table 1.3.

Table 1.3: Major component of the project

Components	Major activities
Component-1: Field study and data analysis	• Conduct detailed energy audits covering 10 representative units in each cluster • Conduct benchmark study to develop Key Performance Indicators (KPI) and Energy Efficiency (EE) benchmarks • Develop a sectorial profile for the refractory sector • Develop sectorial brochure
Component-2: Development of roadmap and outreach	• Prepare and publicize sectorial roadmap for refractory industry • Disseminate outreach and knowledge through; • Cluster level workshops • Project inception workshops • Post activities workshops • National workshops • Stakeholder consultation • Result dissemination

Chapter 2

2.0 Cluster Scenario

2.1 Background

Glass is a non-crystalline solid, often transparent, and has widespread practical, technological, and decorative applications in our daily lives. Most of the glasses are generally made by melting basic raw materials of sand, soda ash, and limestone at very high temperatures.

The glass industry in India is quite old and well established. From a humble beginning in 1908 with rudimentary mouth-blown and hand working processes, the industry in recent years has evolved to adopt modern processes and automation in a big way. Accordingly, the Indian glass sector has evolved from a small-scale, decentralized manufacturing business to a relatively organized sector. The growing demand for glass in the automobile and construction sector along with increased use of glass in packaging is expected to result in higher growth in this sector.

The Indian glass industry represents one of the largest markets and the manufacturing capacity for glass products in the Asia region. Apart from few major manufacturers, there are more than 1000 medium and small manufacturers. The majority of these glass manufacturing units are located in Firozabad, which has more than 500 hundred in number and generates huge employment for the unskilled rural population. The primary products of the Firozabad glass cluster include bangle, container glass, glass handicraft products, etc. The large glass manufacturers are mainly located in Baroda, Ahmedabad, Mumbai, Kolkata, Bengaluru, Chennai Bahadurgarh, and Hyderabad.

The Indian glass industry consists of seven segments namely, sheet and flat glass (NIC[1]-26101), glass fibre and glass wool (NIC-26102), hollow glassware (NIC- 26103), laboratory glassware (NIC- 26104), table and kitchen glassware (NIC- 26105), glass bangles (NIC- 26106) and other glassware (NIC – 26109).

The Indian glass sector is growing across all segments. This growth has been driven primarily by India's booming automotive and construction sectors which have been key drivers of the economy for the past few years. It is reported that the Indian glass sector will experience growth of around 12% (CAGR) during 2019 – 2027.

The majority share of the Indian commercial glass market mainly holds by container glass, which is equal to 50% of market value.

[1] NIC 26101 - Division 26 represents National Informatics Centre classification for manufacture of other non-metallic mineral products, group 261 and class 2610 represents manufacture of glass and glass products and 26101, 26102, 26103, 26104, 26105, 26109 represents sub-class for manufacture of different types of glass

2.2 Overview of Ambala glass cluster

Ambala glass cluster is one of the largest laboratory glassware manufacturing hubs in India. The cluster houses a large agglomeration of MSME (Micro Small and Medium Enterprises) units which processing all types of laboratory glassware and apparatus. The MSME units in the Ambala are located in the areas, namely, HSIDC Ambala Cantt, HSIDC, Saha, Ambala city, and Kardhan village. The cluster also finds its prominence because in India, most of the laboratory glassware and apparatus, are exclusively produced in the Ambala cluster. Apart from apparatus and laboratory glassware units located in industrial zones, a large number of micro category glass blowing units are also operating in and around Ambala city.

2.2.1 Classification of glass units

The laboratory glassware units in the Ambala cluster can primarily be classified as (i) medium (apparatus manufacturing with glass blowing and annealing process) (ii) small (glass blowing and annealing process) and (iii) micro (glass blowing units). Most of the glassware units are micro-scale units equipped with glass blowing facilities and producing semi-finished products. The downstream processing and finishing operations of the glassware products are either outsourced or performed by the apparatus manufacturer. Classification of laboratory glassware units in the cluster is given in table 2.2.1.

Table 2.2.1: Classification of glass industries based on the process and product manufacturing

Classification	Criteria	Number of units (Nos)
Medium	Apparatus	7
Small	Laboratory glassware	40
Micro	Glass blowing	450
Total		**497**

2.2.2 Major products

The major product of the cluster is the laboratory glassware including, culture bottle & tubes, assorted laboratory glassware & accessories, jar & flask, vacuum glass desiccators, pharmaceutical bottles, etc. of different sizes and specifications. Some of the units also producing borosilicate glass bottles, baby feed bottles, and other tableware. The estimated production based on the raw material consumption is provided in table 2.2.2.

Table 2.2.2: Production profile Ambala cluster

Classification	Criteria	Number of units (Nos)	Total production (tpy)
Medium	Apparatus	7	950
Small	Laboratory glassware	40	2,997
Micro	Glass blowing	450	8,100

2.2.3 Market scenario

The laboratory glassware units of the Ambala glass cluster find customers in both domestic and international markets. Science and biotechnology laboratories, pharmaceutical industries, and educational institutes are major end-users consumers of dyestuffs. The export share in the cluster is significant through traders however some medium category units are directly exporting as well selling through e-commerce web portals.

Major exports of laboratory glassware are to Latin American, Asian and African countries have also started picking up. A few units that have acquired NABL and international quality certifications are exporting specialty products to European countries, parts of North America, Australia, and Singapore.

2.2.4 Raw materials

The Borosilicate glass tube is used as raw material for the production of laboratory glassware products. The majority of raw material is imported from China (about 80%), Germany, and the Chez Republic.

2.3 Cluster level initiatives

During the stakeholder consultation, it has been learned that there are no cluster level initiatives undertaken on energy efficiency, technology up-gradation, or skill development.

Chapter 3

3.0 Major cluster stakeholders

The primary stakeholder of the cluster is the laboratory glassware producing units. The other stakeholders include industry associations, government agencies including regulatory bodies. These cluster based stakeholders provide a range of services to the MSME units. Some of the major stakeholders in the Ambala glass cluster along with their roles and activities are briefed below;

3.1 Industries associations

There are four major industry associations active in the Ambala glass cluster namely

1. Laboratory glassware and apparatus industry association
   a) The Ambala Scientific Instruments Manufacturers' Association (ASIMA)
   b) Scientific Apparatus Manufacturers & Exporters (SAME)
   c) Scientific Apparatus Manufacturer Association (SAMA)
2. General industry association
   a) Haryana Chamber of Commerce and Industries (Ambala Chapter)

3.2 Government bodies

The government agencies involved in the cluster and their key activities in the cluster are given in table 3.2.

Table 3.2: Government bodies and key responsibilities

Name of organisation	Key roles
District Industries Centre (DIC), Ambala	• Identify the new entrepreneurs and assisting them regarding their start-ups. • Provide financial and other facilities to smaller blocks for industrialization at the district level. • Enhance the rural industrialization and also the development of handicrafts. • Reach economic equality in multiple areas of the district. • Allow various government schemes to the new entrepreneurs. • De-size the regional imbalance of development. • Make all the necessary facilities to come under one roof
MSME-Development Institute (MSME-DI) Karnal	MSME-DIs field offices of the Ministry of Micro, Small & Medium Enterprises provide a wide range of extension/ support services to the MSMEs in their respective state of operation.

3.3 Technical, academic, and R&D institutions

There is no research and development (R&D) organisation providing support to MSME units for product and/or technology development.

3.4 Financial institutions

There are more than 25 nationalized, commercial, and cooperative banks operating in the cluster. The State Bank of India is the lead bank in the Ambala district and having more than 25 branches serving to MSME sector. Some of the important banks in the cluster include Canara Bank, Axis Bank, Punjab National Bank, Vijaya Bank, ICICI Bank, HDFC Bank, and Dena Bank. The Industrial Estate Ambala Cantt branch of SBI is serving the glass industries of HSIDC and Ambala city. In addition, a few cooperative banks also operate in the cluster to meet the financial requirements.

Chapter 4

4.0 Production process and technology use

The glass blowing technique consists of inflating molten glass with a blowpipe to form a glass bubble that can be moulded into a laboratory or industrial process for glass purposes. Borosilicate glass is the common base material for laboratory glassware, mainly because of its chemical and thermal stabilities.

4.1 Manufacturing process

The manufacturing of laboratory and industrial glassware process commonly called glass blowing involves heating of borosilicate glass tubes of different dimensions (thickness and diameter) using an open flame burner and followed by blowing into providing the desired shape and size.

4.1.1 Glass blowing

The blowing units employ an open flame burner using liquefied petroleum gas (LPG) and oxygen to provide a suitable flame temperature for moulding of borosilicate glass. The blowing is either mouth blowing or paddle blowing depending upon the size of ware being produced. The glass blowing process requires skilled manpower to produce glassware using traditional equipment such as single chuck and double chuck lathe.

4.1.2 Annealing

The processed glassware is heat-treated before and after the scaling and printing as per the end-use requirements. During the annealing process, the finished piece must be put to bed in the annealing oven to allow it to cool down to room temperature. The MSME units are using both continuous type (LPG fired) and batch type (electric and annealing) furnaces.

Figure 4.1.2: Glass blowing process

4.2 Technology and equipment used

4.2.1 Glass blowing lathe

The glass blowing lathe is the most commonly used technology in the glass blowing industry. These lathes are electric driven and the most common capacity is ½ hp single phase induction motor or brushless DC motor. Lathe machines are locally made and having a common drive in single and double chuck shaft rotation.

Figure 4.2.1: Glass blowing lathe

4.2.2 Annealing furnace

Annealing furnace is used for the heat treatment of laboratory glass products to relieve induced stresses during shaping and forming operations, which otherwise would make glass products more brittle. Annealing helps in strengthening glass products. Most of the laboratory glassware units employ batch-type annealing furnaces using LPG or electricity. A few units having large production capacities are equipped with continuous type annealing furnaces using LPG for the heating and electricity is used for the operation of air circulation fans and conveyor systems.

Figure 4.2.2: Annealing furnace

Chapter 5

5.0 Energy consumption profile and conservation measures

5.1 Details of energy use

The major cost heads in the glass industries are energy (fuel and electricity), raw material (borosilicate glass tube and oxygen), and manpower. In glass blowing industries manpower and raw material cost is about 80 percent of total production cost, whereas the energy cost is about 20%. The absolute amount of energy consumption in the laboratory glassware producing units is dependent on the size and type of products, annealing requirements, and scale of operation.

The majority of the energy consumption share is thermal, which is around 85%. The source of thermal energy is liquefied petroleum gas (LPG) that is supplied by local authorized distributors of Indane, BPCL, HPCL, etc. Some of the large units are having a bulk supply contract with the parents' company.

5.1.1 Thermal energy

Thermal energy is used to meet the heating requirements of the borosilicate glass tube during the blowing process as well as in annealing (heat treatment) processes. A few industries (medium category) have established bulk storage facilities and local distribution networks within the unit premises to meet the thermal energy requirements. Small and micro category units use LPG cylinders (19 kg) at individual glass blowing.

5.1.2 Electricity

The electricity used in glass units is primarily grid supply. The grid electricity consumption is about 15% of total energy consumption. Electricity is primarily used to run the prime movers connected to the different processes and auxiliary equipment in the plant.
The Different energy forms used in the unit, sources, and price details are given in table 5.1.2.

Table 5.1.2: Energy type, sources, and standard tariffs

Energy source	Availability	Tariff details
LPG	Indane, BPCL, HPCL, etc.	Rs 1,600-1,900/cylinder of 19 kg
HSD	Retail outlets of HPCL, BPCL, IOCL, etc.	Rs. 77 per litre
Electricity	Dakshinanchal Vidyut Vitran Nigam Limited (DVVNL)	Tariff category: LTIS Up to 10 kW – Voltage supply: 0.415 kV – Fixed charges: Nil – Energy charges: Rs 6.35 per kVAh Above 10 kW and up to 200 kW –

Energy source	Availability	Tariff details
		Voltage supply: 0.415 kV – Fixed charges: Nil – Energy charges: Rs 6.65 per kVAh Tariff category: HTS – Voltage supply: 11 kV – Fixed charges: Rs 170 per kVA – Energy charges: Rs 6.65 per kVAh

5.2 Energy consumption pattern

The energy consumption pattern of the glass units varies based on product type, size & shape, and production capacities. The unit-level energy consumption of typical production capacities and cumulative cluster level energy consumption of the Ambala glass industries are summarised below;

5.2.1 Unit level

The major energy consumption is accounted to apparatus manufacturing units which are having high installed production capacity in comparison with other glass blowing and/or processing units. The unit-level gas consumption of each category of units in the cluster is shown in table 5.2.1.

Table 5.2.1: Unit level energy consumption and production profile

Type of unit	Annual energy consumption			Production
	LPG (tonne)	Grid electricity (kWh)	HSD (kL)	(tonne)/ year
Apparatus	105	3,07,289	6.1	135
Laboratory glassware	28	46,910	1.2	75
Glass blowing	8	17,217	0.1	18

5.2.2 Cluster level

LPG is used for heating in the glass blowing process. Both LPG and electricity are used for heat treatment (annealing) of the final products. Apart from LPG, a significant quantity of liquid oxygen is also used in the borosilicate tube heating process. The total energy consumption of the Ambala glass cluster is estimated to be 7,285 toe (figure 5.2.2). The equivalent GHG emissions are estimated to be 26,255 tonnes of CO_2 per year.

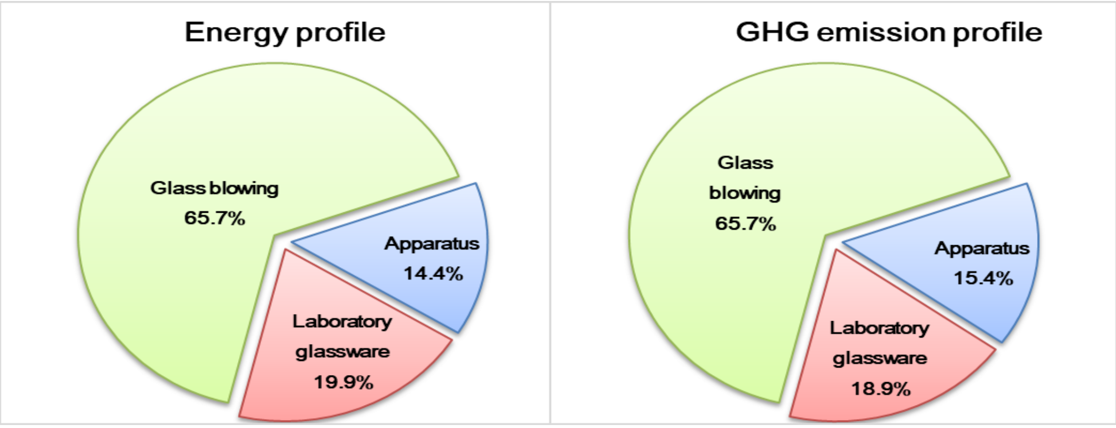

Figure 5.2.2: Share of energy consumption and GHG emissions of Ambala

A summary of energy consumption breakup for different glass products is provided in table 5.2.2.

Table 5.2.2: Energy consumption of Ambala glass cluster

Product	Number of units	Production (tpy)	Energy consumption (toe/year) Thermal	Electricity	Total	GHG emission ($t\text{-}CO_2$)
Apparatus	7	950	827	222	1,049	4,056
Laboratory glassware	40	2,997	1,251	202	1,453	4,962
Glass blowing	450	8,100	4,092	690	4,783	17,236
Total	497	12,047	6,170	1,115	7,285	26,255

The total estimated production[2] of the cluster is 12,047 tonnes per year (FY 2019-20).

5.2.3 Specific energy consumption

The specific energy consumption for laboratory glassware production for different types of units is given in table 5.2.3.

Table 5.2.3: specific energy consumption

Parameters	Unit	Value
Apparatus	GJ/tonne of product	46.2
Laboratory glassware	GJ/tonne of product	20.3
Glass blowing	GJ/tonne of product	24.7

5.3 Other resources

Apart from thermal energy and electricity, the consumption of oxygen is significant in the cluster. The oxygen LPG mixture is used to generate the high-intensity flame in the glass blowing process. The typical LPG to Oxygen ratio varies in the range of 1:1 to 1:2 depending on product size and thickness of the borosilicate glass tubes.

5.4 Energy conservation opportunities

The existing technologies/ equipment used in the glass blowing units are conventional type and production, productivity and quality are depends on the skillset of the operators. A very limited range of products such as culture tubes is normally produced using CNC machines. The downstream processes equipment i.e. annealing furnace and auxiliaries such as air compressors are highly inefficient and offer significant scopes for energy saving. A list of different energy conservation measures applicable for Ambala glass units is provided in table 5.4.

[2] Estimated based on the consumption of raw material (borosilicate tubes)

Table 5.4: Major energy conservation opportunities in the cluster

Equipment/section/utility	Energy conservation measures
Process	• Energy efficient LPG fired annealing furnaces • Energy efficient electric annealing furnaces • Alternative low thermal mass material handling trays in annealing furnaces
Technology Up-gradation	• Electrification of LPG fired annealing furnaces • Installation of the solar PV system
Energy saving options in utilities	• Energy efficient air compressors (PMSM/VFD enabled) • LPG distribution network with a bulk storage facility • Energy efficient BLDC motors for glass blowing lathe • Energy efficient lighting in the process and office section

Chapter 6

6.0 Major challenges in the cluster

The share of energy cost in the production of laboratory glassware in the cluster is not substantial in comparison with costs towards manpower and raw material required. The glass blowing process required skilled manpower with suitable experience in shaping/formation, leading to high manpower costs. Similarly, raw materials used in the manufacturing process (borosilicate glass tubes) are exclusively imported.
Some of the major challenges related to technology, energy pricing, availability and quality of raw material, manpower skill sets, environmental, etc.

6.1 Technology

The glassblowing process uses conventional lathes (single chuck and double chuck). These lathes are electrically driven using a ½ hp motor (single-phase) of standard efficiency class. The production and productivity depend on the product shape & size and skillset of the manpower. To cater to the heating requirement in the glass blowing process a high-intensity flame is required. Oxy-fuel burners are used to meet the desired shape of flame and temperature required for formation/blowing. Apart from few units, all units are using cylinders of LPG and oxygen at the point of use.

The annealing process is required to induce desired physical properties in the final products. Small and medium category units have installed LPG fired annealing furnaces (batch and continuous) and electric annealing furnaces (batch type). Almost all micro category units are either outsourcing the product annealing or supplying un-annealed products to OEM. The operations in the annealing furnaces are manual and no automation/temperatures-based control system is provided in most of the furnaces.

Lack of availability of new and energy efficient technologies (such as automated glass blowing machines, CNC tubing, etc.), weak linkages with technology suppliers, and limited knowledge of local service providers on modern technologies are the major bottlenecks hindering technology up-gradation in the cluster.

6.2 Energy pricing

The primary energy used in the cluster is LPG and almost all units are procuring from local distributors. LPG pricing in India is done based on a formula, import parity price (IPP). The IPP is determined based on LPG prices in the international market, assuming that the fuel is imported into the country. There is no shortage of LPG supply at the cluster level, however, the major challenge for SMEs is the rising price of LPG.

6.3 Raw material

The borosilicate tube is the primary raw material in glass blowing industries. No indigenous manufacturer is producing the desired quality and quantity. The raw material is imported from China, Germany, Chez Republic, etc. either by local traders (majority share) or directly by medium-size units). Most of the micro and small category units procuring imported borosilicate glass tubes from local traders. The rising price of raw materials poses a major challenge to the glass units which directly influences the manufacturing costs. Also increasing freight charges increasing the landed cost of the raw material at the cluster level. The scale of operation of micro and small-scale units hinders the capacity to import or purchase raw materials at the most economic price structure.

6.4 Manpower and skillsets

The glass blowing process requires specific skill sets to ensure specifications and quality of the glassware as per the end-use requirements. It has been learned that no formal training or skill development institute is providing the basic/preliminary training on the glass blowing process. Most of the small and medium enterprises are hiring unskilled/semi-skilled manpower and providing on-job training.

6.5 Environmental issues

The glass blowing process uses clean energy fuel (i.e. LPG) and inert raw material (borosilicate glass tube).

Chapter 7

7.0 SWOT Analysis

The glass industries in Ambala face several challenges about raw material and fuel pricing, as well as the availability of skillsets that can affect the competitiveness of the units in the domestic and international markets. There is a need for the glass units to become efficient and competitive by providing the necessary infrastructure for skill development and raw material. The MSME units also need to adopt the upgraded technology for glass processing and efficient fuel handling systems.

A SWOT (Strength, Weakness, Opportunities, and Threats) analysis of the glass blowing and laboratory apparatus manufacturing units in the Ambala cluster was performed to understand the cluster situation. The SWOT analysis of the Ambala glass cluster is given below.

Strength	Weaknesses
• Unique cluster in India; skillsets and entrepreneurial zeal in the local community • Excellent linkage in domestic and international markets • An adequate supply chain system for raw material, energy and other resources like LPG, oxygen, etc. • Active industry association • Diverse product range and product development capacities	• Dependency on imported raw material • Limited scope for expansion due to lack of skillset available • Lack of development in glass processing equipment; using conventional technologies • Lack of in-house testing facilities and necessary certification for direct export
Opportunities	**Threats**
• Growing market demand • Opportunity for expansion and new product development • Potential for energy optimisation and technology development • Strong domestic and international markets	• Dependency on imported raw material • Soaring prices of LPG and oxygen • Shortage of skilled manpower • The recent entry of substitute products in the market

Chapter 8

8.0 Conclusions

Ambala glass cluster with about 500 glassblowing units is a unique industry cluster under the MSME sector catering for domestic and international markets. The units use both thermal energy and electricity to meet their energy demands. The analysis of the Ambala glass cluster shows that thermal energy accounts for more than 50% of total energy consumption. In addition, resource consumption, i.e., industrial-grade oxygen, is also significant.

The adoption of new technologies and resource conservation emerge as appropriate solutions for the Ambala glass cluster to achieve competitive manufacturing costs. However, to ensure sustainability and competitiveness, the cluster has to address several barriers which include non-availability of indigenous borosilicate glass tubes, lack of automated glass blowing machines, weak linkages with EE technology suppliers, lack of manpower, and skillsets, etc.

The technical assistance with the support of the project would help the glass industries in the Ambala cluster to (i) identify potential process/ utility areas for energy saving, and new and innovating glass blowing techniques/technologies, through detailed energy audits of cluster units (ii) adopt EE technologies through increased awareness and by strengthening linkages with EE technology providers.

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We are an independent, multi-dimensional organization, with capabilities in research, policy, consultancy and implementation. We are innovators and agents of change in the energy, environment, climate change and sustainability space, having pioneered conversations and action in these areas for over four decades.

We believe that resource efficiency and waste management are the keys to smart, sustainable and inclusive development. Our work across sectors is focused on

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