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Cluster Profile Report

Jaipur Glass Cluster

Prepared for

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

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TEAM

Mr Girish Sethi, Project Advisor
Mr Pawan Kumar Tiwari, Team Leader
Mr Piyush Sharma, Sector Expert
Dr Sachin Kumar, Reviewer & Cluster Coordinator
Mr N Vasudevan, Energy Manager/Auditor
Mr Yatharth Kumar Sharma, Graduate Engineer
Mr Kavita Sisodiya, Secretarial Assistance

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The Energy and Resources Institute (TERI)

FOR MORE INFORMATION
Project Monitoring Cell, TERI, Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi 110 003, India
Tel.: +91 11 2468 2100 or 2468 2111 | Fax: +91 11 2468 2144 or 2468 2145
Email: pmc@teri.res.in | **W**eb: www.teriin.org

Contents

List of tables

List of figures

List of abbreviations

Bureau of Energy Efficiency	BEE
Energy Efficiency	EE
Federation of Safety Glass	FOSG
High Tension	HT
Industrial Training Institutes	ITI
Jaipur Vidyut Vitaran Nigam Limited	JVVNL
Low Tension	LT
Malviya National Institute of Technology	MNIT
Micro Small and Medium Enterprises	MSME
Million Tonnes	MT
Rajasthan Renewable Energy Corporation	RREC
Rajasthan State Industrial Development and Investment Corporation	RIICO
Sitapura Industrial Association	SIA
Small Industries Development Bank of India	SIDBI
State Bank of India	SBI
Strengths Weaknesses Opportunities and Threats	SWOT
The Energy and Resources Institute	TERI
Tonnes of Oil Equivalent	Toe

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The study team is thankful to officials of Rajasthan Renewable Energy Corporation Limited (RRECL), Rajasthan, office-bearers of Federation of Safety Glass (FOSG) 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 -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.

2.2 Overview of Jaipur glass cluster

Jaipur glass cluster is one of the important glass clusters in Rajasthan. The cluster houses several micro, small and medium enterprises processing safety glass products including toughened glass, insulating glass, laminated glass, etc. There are about 24 glass manufacturing units in the Jaipur cluster out of which 19 MSME units are in

operation. All these glass manufacturing units are located in Vishwakarma, Sanganer, Sitapura, Mansarover, Bhakrota, and Jhotwara industrial areas. Most of these manufacturing units are operational since 2017.

Some of the leading glass industries in Jaipur are Ridhi Sidhi Glass Pvt. Ltd., Anand Lamps Pvt. Ltd and Jaipur Tuffen Glass Industries Pvt. Ltd. The annual turnover of glass industries in the Jaipur cluster is more than Rs 250 crore. The cluster provides direct and indirect employment to about 0.2 lakh people, of which 80% are locals and the rest are from other states of India.

2.2.1 Classification of glass units

The glass processing units in the Jaipur cluster are located in industrial areas such as RIICO industrial area, Jotwara and Bindayala, Ramchandrapura, VKI area, Bhankrota, Amer Road, and Sushilpura. There are about 19 glass processing MSME units in the cluster primarily processing toughened glass; a few units are fabricating decorative glass/mirror. The glass processing units can be classified based on the glass products and the production capacity.

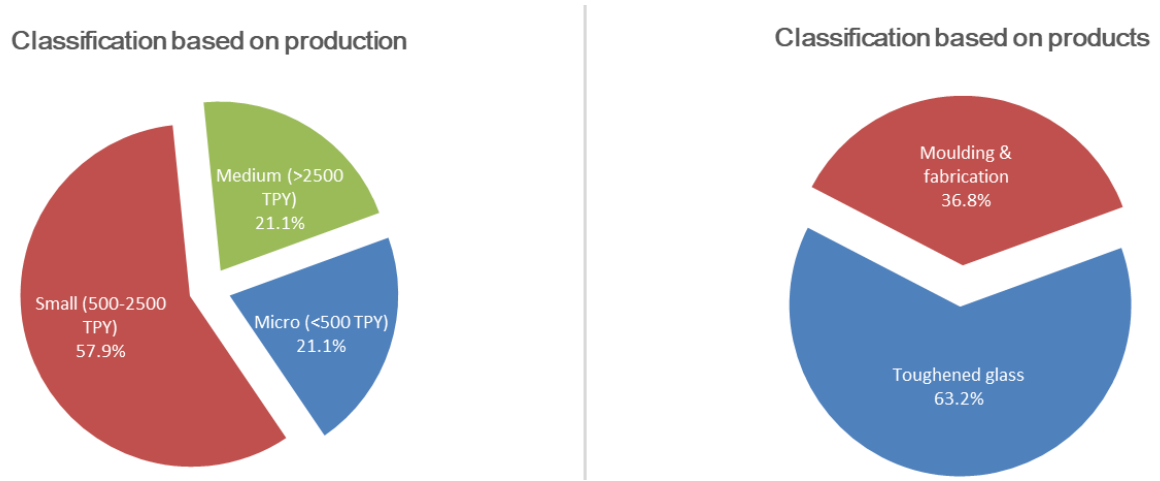

Figure 2.2.1: Classification of glass units based on contract demand

The majority of the units are processing the safety glass products (63%) and the rest are involved in the value-added products.

2.2.2 Major products

The glass units in the Jaipur cluster are primarily processing toughened glass; a few units are fabricating decorative glass/mirrors. Toughened or tempered glass involves a controlled heat treatment process to enhance strength. Toughened glass is made from annealed glass which is reheated up to 650 ^{0}C followed by rapid quenching. The major products of the cluster including:

- Toughened Glass
- Insulated Glass
- Laminated Glass
- Heat Strength Glass
- Specialty glass (ceramic coated glass, bend glass, bulletproof glass, etc.)

2.2.3 Market scenario

The glass processing units of the Jaipur cluster cater to the regional market of the Northern and Western regions of India. The end-user of the safety glass is primarily the construction industry. Toughened and heat strengthened glass is mainly used for floor partition, shop fronts, glass capsules, frameless door and window, and furniture making. Safety and laminated glass are generally used for skylight glazing, curtain glazing, overhead glazing, and in high-security areas like ATMs, jewellery shops. Bulletproof glasses are generally used by security officials.

2.2.4 Raw materials

The raw material for safety glass processing units is float glass and figured (patterned) glass. Raw materials are procured from floating and figured glass manufacturing industries situated in Rajasthan, Haryana, Gujrat, and Tamil Nadu. The majority of raw materials are sourced from big raw floating and figured glass manufacturing giants like Saint Gobain, Modiguard, and Asahi India Glass Ltd.

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 glass manufacturing units. The other stakeholders include industry associations, government agencies including regulatory bodies, research and academic institutions, and testing facilities and training institutes. These cluster-level stakeholders provide a range of services to the glass manufacturing units. Some of the major stakeholders in the Jaipur glass industry cluster along with their roles and activities are briefed below;

3.1 Industries associations

The Federation of Safety Glass (FOSG) is an active association that works dedicatedly working with glass industries to fulfill the following objectives

- Growth of market
- Common Industry Establishment
- Common quality acceptance norms
- Inventory sharing protocols
- Capacity sharing protocols between members
- Trained Manpower
- Input/ Output norms
- Educate the market
- Awareness about the market
- Safety.

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), Jaipur	• 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) Industrial Estate, Geejgarh Vihar Colony, Bais Godam, Jaipur, Rajasthan	• 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.

Name of organisation	Key roles
Rajasthan State Industrial Development and Investment Corporation	Promote industrialisation by developing industrial areas and providing physical infrastructure like road, sewage line, potable water line, electrical infrastructure. Provides financial supports to entrepreneurs to set up industries.

3.3 Technical, academic, and R&D institutions

Both public and private testing laboratories are available in Jaipur and surrounding areas. Some of the major engineering and polytechnic institutes like Malviya Institute of Technology, Rajasthan University, and JECRC University offer a variety of courses in chemical and mechanical engineering which are relevant for the cluster. These institutes provide the technical workforce to the cluster. Several Industrial Training Institutes (ITIs) in Jaipur district offer industrial training courses like Electrical technician, pump operators, laboratory attendants, process attendants, and ETP operators, etc.

3.4 Financial institutions

There are about 25 nationalized, commercial, and cooperative banks operating in the cluster. Some of the important banks in the cluster include State Bank of India, Axis Bank, Vijaya Bank, Punjab National Bank, ICICI Bank, HDFC Bank, and AU Small Finance Bank. Most of these banks provide financial assistance towards expansion and infrastructural up-gradation of chemical units. In addition, a large number of cooperative banks also operate in the cluster to meet the financial requirements of the cluster.

Chapter 4

4.0 Production process and technology use

4.1 Manufacturing process

Toughened glass or safety glass is made from annealed glass sheets treated with a thermal tempering process. The glass surfaces are then rapidly quenched while the inner portion of the glass remains hot. The variation in cooling rates between the surfaces and core produces results in different physical properties and compressive stresses in the surface balanced by tensile stresses in the body of the glass. These counteracting stresses provide increased mechanical resistance to toughened glass.

4.1.1 Washing and Drying

The annealed glass sheet is cleaned to make it free from waviness, distortion, etc., and cut to the required size as per end-use of the product. The edge grinding and polishing is an important process for toughening as it may lead to breakages.

4.1.2 Toughening Process

The glass sheets are fed into the electric furnace for increasing the temperature to the softening point. The toughening process involves heating glass above its annealing point of about 600°C. After attaining the required temperature, the glass sheets are shifted to air-blowing quenching boxes for toughening.

Most of the MSME units further process toughened glass into end-use products such as laminated glass, insulated glass, etc. A process flow diagram for toughened glass as well as insulated and laminated glass is provided in figure 4.1.2.

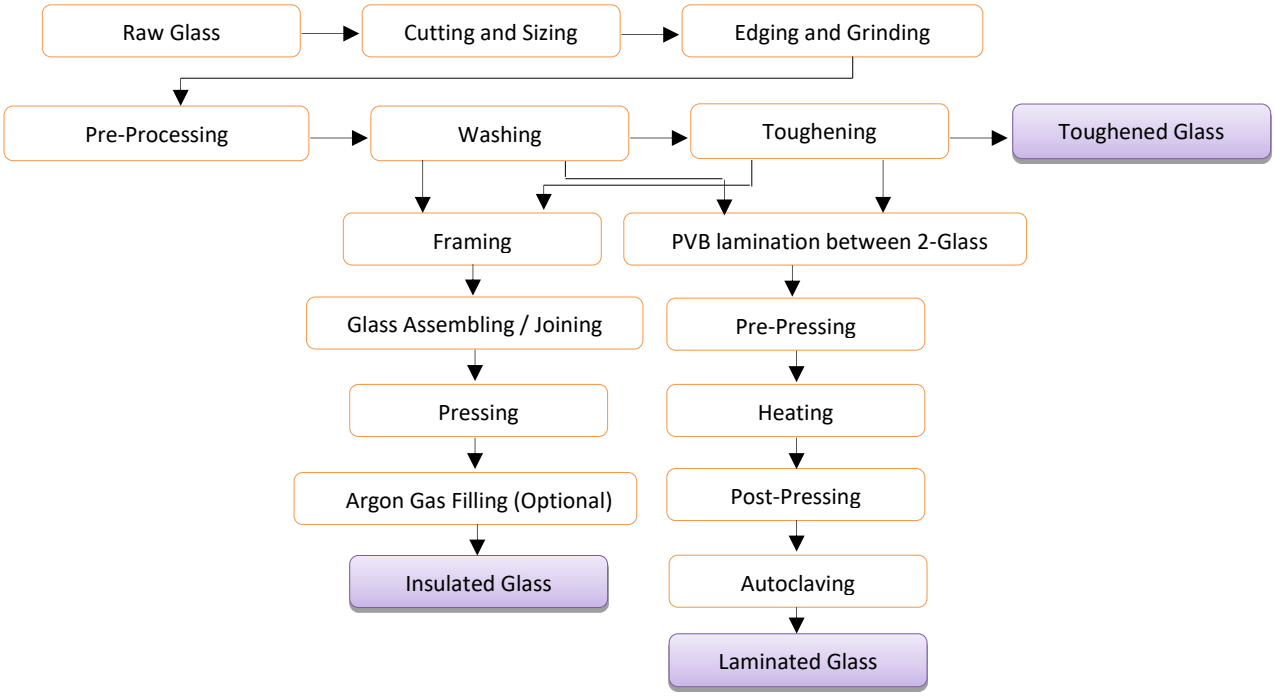

Figure 4.1.2: Production process of toughened glass and associated products

4.2 Technology and equipment used

The main process equipment in toughened glass manufacturing is reheating furnace. The other auxiliaries include quenching blowers, air compressors, and process cooling water, and raw water pumps. CNC machines are mainly used in the sizing and edge grinding process. The major technologies and equipment used in process areas and utility sections are provided in table 4.2.

Table 4.2: Major technologies/equipment used in chemical industries

Manufacturing process	• CNC glass cutting machine • Single or four side edge grinder • Hole drilling machine • Washing machine • Tempering furnace • Insulating glass machine • Autoclave for lamination glass
Auxiliaries/utilities	• Air compressors • Colling tower • Pumps • RO system

Chapter 5

5.0 Energy consumption profile and conservation measures

5.1 Details of energy use

The electricity use as primary energy in the glass processing units of the Jaipur glass cluster. The energy accounts for about 8-10 percent of the total processing costs (varies as per the end-use requirement of the processed glass). Thermal energy in the form of HSD is used in DG sets installed to cater to the essential power requirement during the grid power supply failure. A few industries have installed the backup power DG sets, the rest of the units are not operating processing units during the power cut/failure.

5.1.1 Electricity

The connected electrical load of the glass processing units depends on the product cateries producing. Micro and small category units have taken LT connection, whereas the medium category units use HT connection. Electricity is supplied by Jaipur Vidyut Vitaran Nigam Limited (JVVNL). The applicable tariff of various such categories is given in table 5.1.

Table 5.1.: Electricity tariff plans in Jaipur Glass cluster

Energy source	Tariff category	Tariff details
Electricity (Jaipur Vidyut Vitaran Nigam Limited)	LT CONNECTION: MEDIUM INDUSTRIAL SERVICE (Schedule MP/LT-6) And HT CONNECTION: MEDIUM INDUSTRIAL SERVICE (Schedule MP/HT-3)	• Demand charges: Rs.115/- per HP per month of sanctioned connected load or Rs.230 per KVA of billing demand per month Rs. 270 per kVA (Clause: Maximum recorded demand of 75% of contract demand whoever is higher) • Energy charges: 700 Paise per kWh • Reactive charges/power factor ○ Average PF < 0.90: Surcharge @ 1% of Energy Charges for every 0.01 fall in average power factor below 0.90 ○ PF >0.95: Incentive of 0.5% of Energy Charges shall be provided for each 0.01 improvement above 0.95 till 0.97. ○ PF>0.97: Incentive of 1% of energy charges shall be provided for each 0.01 improvement above 0.97
	HT Connection: LARGE INDUSTRIAL SERVICE (Schedule LP/HT-5)	• Demand charges: Rs. 270 per kVA • Energy charges: 730 Paise per kWh • Reactive charges/power factor

Energy source	Tariff category	Tariff details
		○ Average PF < 0.90: Surcharge @ 1% of Energy Charges for every 0.01 fall in average power factor below 0.90 ○ PF >0.95: Incentive of 0.5% of Energy Charges shall be provided for each 0.01 improvement above 0.95 till 0.97. ○ PF>0.97: Incentive of 1% of energy charges shall be provided for each 0.01 improvement above 0.97 • Time of Day (ToD) Tariff: Rebate @15% on EC during off-peak hours (23:00-06:00)

5.2 Energy consumption pattern

The energy consumption pattern of the glass processing units in the cluster depends on the products manufacturing value-added services and production capacity. The unit-level energy consumption of typical production capacities and cumulative cluster level energy consumption of the Jaipur glass processing industries are summarised below;

5.2.1 Unit level

The major energy consumption is accounted to toughened glass industries which are having high installed production capacity in comparison with other decorative glass 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

Product	Average electricity consumption (kWh/year)	Production (tpy)	Electricity (toe/yr)	GHG emissions (t-CO_2/year)
Toughened glass	10,94,973	2275	94	899
Moulding & fabrication	85,456	543	7	70

5.2.2 Cluster level

Electricity is used for the heat treatment process of annealed glass. In addition, a small quantity of diesel is also consumed for backup power generation. The total energy consumption of the Jaipur glass cluster is estimated to be 1,185 toe (figure 5.2.2). The equivalent GHG emissions are estimated to be 11,274 tonnes of CO_2 per year. A summary of energy consumption breakup for different glass products is provided in table 5.2.2.

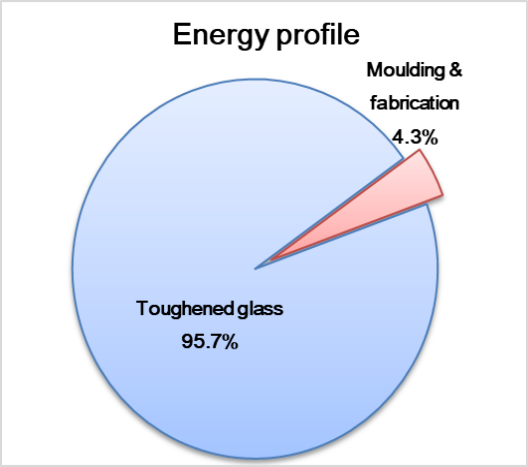

Figure 5.2.2: Share of energy consumption in Jaipur

Table 5.2.2: Energy consumption of Jaipur glass cluster

Product	Number of units	Production (tpy)	Electricity (toe/yr)	GHG emissions (t-CO_2/year)
Toughened glass	12	27,297	1,133	10,784
Moulding & fabrication	7	3,801	51	491
Total	19	31,098	1,185	11,274

The total estimated production of the cluster is 31,098 tonnes per year (FY 2019-20).

5.3 Other resources

The other resources used in the Jaipur glass processing units include treated water for glass washing before the heat-treatment process. The annual consumption of raw water is estimated to be 1,700-3,600 kL per unit per year.

5.4 Energy conservation opportunities

A few selected units are using the PLC controlled heat treatment furnaces which use optimum energy and processing period, however, small size units are using locally fabricated technologies. These locally fabricated technologies are manually operated, thus poor productivity and efficiency levels. A list of different energy conservation measures applicable for Jaipur glass units is provided in table 5.4.

Table 5.4: Major energy conservation opportunities in the cluster

Equipment/section/utility	Energy conservation measures
Heat treatment furnace	• PLC controlled heat treatment furnaces • VFD enabled PLC controlled quenching fans
Mould Furnace	• Improvement in operation practices • Use of thyristor-based controller for auto cut-off
Auxiliaries/Utility	• VFD enabled air compressors • PMSM air compressors • Premium efficiency class (IE3) motors • Energy efficient lighting

Chapter 6

6.0 Major challenges in the cluster

The share of raw material cost in total product cost is highest (up to 80%) in the processing of the safety glass followed by cost towards energy (up to 10%). The cumulative energy consumption of the Jaipur glass cluster is quite significant. Cluster is using primarily domestic technology for tempering furnaces and CNC machines. A few units are also using imported PLC-controlled tempering furnaces.

There exists significant scope for upgrade technology used in the cluster. However, the cluster needs to address several challenges for the large-scale adoption of energy and resource conservation measures. Some of the major challenges related to technology, energy pricing, availability and quality of raw material, manpower skill sets, environmental, etc.

6.1 Technology

Small and micro categories of the units use locally designed/ fabricated technologies that are manually operated, less productive, and consume more energy. The medium size industries use PLC-based control and automation techniques, leading to optimum energy levels as compared to other glass processing categories in the cluster. The barriers in the adoption of automated toughened glass processing are weak linkages with technology suppliers and limited knowledge of local service providers on modern technologies. Initial capital investment toward EE technologies is one of the major bottlenecks hindering technology up-gradation in the cluster.

6.2 Energy pricing

The electricity supply situation in the cluster is quite good. However, the major challenge is the rising price of the per-unit electric energy cost. It has become increasingly difficult for micro-units to sustain and compete with medium-scale glass units.

6.3 Raw material

The rising price of raw materials poses a major challenge to the glass units which directly influences the manufacturing costs. The scale of operation of micro and small-scale units hinders the capacity to purchase raw materials at the most economic price structure. The absence of a big business quantum prevents the cluster units from effective negotiation of terms and prices with raw material suppliers.

Chapter 7

7.0 SWOT Analysis

The glass industries in Jaipur face several challenges that can affect the adoption of energy efficiency measures by the cluster units. The MSME units also face challenges due to the increasing cost of energy and raw materials. Jaipur glass cluster has a regional market advantage that helps the cluster remain at the forefront. There is a need for the glass units to become more efficient and maintain a better profit margin which would require the adoption of energy efficient technologies in their processes and auxiliaries.

A SWOT (Strength, Weakness, Opportunities, and Threats) analysis of the toughened glass manufacturing industries in the Jaipur cluster was performed to understand the cluster situation. The SWOT analysis of the Jaipur glass cluster is given below.

Strength	Weaknesses
• An adequate supply of electric energy • Regional market • Demand growing rapidly • Entrepreneurship zeal in the local community • Locally available skilled manpower	• High capital investment on inventory • Diverse product, thus Low productivity • Escalating raw material prices • Lack of technology developer in the country, thus dependent on imported process technologies
Opportunities	**Threats**
• Potential for process automation and technology up-gradation • Growing end-use segment • Customized product and product development opportunities • Large factory sheds for Solar PV installation	• Competition due to low cost imported products/material • Soaring prices of electricity • No control over the final product price. Hence it becomes difficult for micro-units to sustain

Chapter 8

8.0 Conclusions

Jaipur glass cluster with more than 19 units is an important industry cluster under toughened glass manufacturing segment in the MSME sector in the country. The glass units, producing toughened glass, insulated glass and laminated glass uses electricity to meet their energy demands. The analysis of the Jaipur glass cluster shows that electrical energy accounts for a major share of energy consumption. The energy intensities of these units are also quite high as compared to large units, which may be attributed to the use of inefficient technologies and equipment in both process and utilities. This also results in increased energy costs. Further, limitations such as restrictions on capacity expansions have led to the availability of alternate import products and have reduced the market space for local industries.

Optimum use of energy and resource conservation emerge as appropriate solutions for the Jaipur glass cluster to achieve competitive manufacturing costs through the adoption of new and energy efficient (EE) technologies in processes and utilities. However, to ensure large-scale adoption, the cluster has to address several barriers which include non-availability of energy-efficient technologies, weak linkages with EE technology suppliers, etc.

The technical assistance with the support of the project would help the glass industries in Jaipur cluster to (i) identify potential areas for energy saving, appropriate EE technologies, energy-saving potential through detailed energy audits of cluster units (ii) adopt EE technologies through increased awareness and by strengthening linkages with EE technology providers.

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

- Promoting efficient use of resources
- Increasing access and uptake of sustainable inputs and practices
- Reducing the impact on environment and climate

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TERI, Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi 110 003, India
Tel.: +91 11 2468 2100 or 2468 2111 | Fax: +91 11 2468 2144 or 2468 2145
Email: pmc@teri.res.in | **W**eb: www.teriin.org