Mapping Energy, Environment and Social Issues among MSME Clusters in India

– Way Forward

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Macro structure of the report

This report is divided into two sections — Section A and Section B.

Section A	Methodology for identifying economically significant, energy, environmentally and socially sensitive clusters in India along with the quantified findings of the study
Section B	Detailed reports on 11 sub-sectors as identified in section A viz.: i Foundry ii Sponge iron iii Leather tanning iv Textiles v Dyes and chemicals vi Electroplating vii Brick kilns viii Ceramics ix Glass and glassware x Cement xi Pulp and paper These reports discuss the economic significance, production process, environmental and social issues, and the institutions which have intervened so far in these sub-sectors at the cluster level through some scheme or programme of the Government of India.

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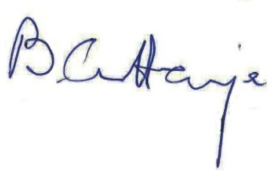
Foreword – IICA

The socio-economic significance of MSMEs in India is well known in terms of output, employment and exports, but they have also led to increased pollution, excessive fossil fuel-based energy consumption and creation of adverse social implications for communities around several towns and cities where they are located in large numbers.

The Government of India and the judiciary have in the past taken special measures to control pollution and combat relevant social issues across different sub-sectors, including leather, textiles, metal working and dyes & chemicals. Beyond the regulatory regime, global and domestic buyers are now increasingly basing their sourcing decisions not only on traditional commercial considerations such as price, quality and delivery commitments, but also on compliance with social and environmental norms in the workplace. Thus, there is a clear business case for MSMEs to adopt responsible business practices.

This study will not only help the MSMEs to understand and illustrate the business case for responsible business practices but also better inform the industry associations, public agencies and the government of the challenges faced by the MSMEs.



Dr. Bhaskar Chatterjee
Director General and CEO
Indian Institute of Corporate Affairs

Foreword – GIZ

With climate change becoming a global challenge there is a mounting pressure on the industry to improve energy efficiency. The problem assumes greater significance for the MSMEs who not only take the hardest hit for being a major contributor to the problem, but also bear the brunt of higher production and distribution costs owing to use of obsolete and inefficient technologies. Adopting responsible social and environmental practices that mitigate operational inefficiencies and increase competitiveness is the logical step forward.

The National Voluntary Guidelines on Social, Environmental and Economic Responsibilities of Business released by the Ministry of Corporate Affairs in 2011 under the aegis of the IICA-GIZ Business Responsibility Initiative encourage businesses, especially the MSMEs, to adopt the triple bottomline approach to become competitive in global and local markets while at the same time minimizing their ecological footprint.

The GIZ attaches significant importance to the issue and is implementing several bilateral projects that handhold the MSMEs to embed Business Responsibility (BR, as enunciated in the NVGs) as a part of their core business strategy. This study furthers the efforts in this direction by generating awareness among MSMEs on BR issues in particular the environmental concerns and establishes the business for adopting BR. Most importantly the study elucidates the challenges faced by the MSMEs and how different stakeholders can contribute in overcoming them.

I congratulate FMC for authoring the study and strongly believe it will contribute immensely in developing a more comprehensive understanding of the energy efficiency issues faced by the MSMEs and throw light on ways in which these can be addressed through collective action.

Manfred Haebig
Director Private Sector Development, GIZ India

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The Foundation for MSME Clusters (FMC) and the 'IICA-GIZ Business Responsibility Initiative' have entered into a partnership towards attaining an understanding of the Business Responsibility (BR) scenario with respect to MSME Clusters in India in order to identify and devise appropriate models of interventions to enable the MSMEs become more responsible and competitive for sustainable development.

The study builds on the work already undertaken by a range of institutions, national and international. The pollution control norms set up by the Central Pollution Control Board were very helpful in categorising the industries with respect to their environment intensity, and we acknowledge the same. Various development initiatives taken by different national and international agencies also provided us benchmarks and understanding of the scope for energy reduction in different sub-sectors. We also acknowledge various academicians and practitioners whose knowledge and expertise gave us an insight into the different environmental, social and energy intensity issues in different sub-sectors. We are sincerely thankful to the Institute of Indian Foundrymen, The Energy and Resource Institute, Sponge Iron Manufacturers Association, Office of Textiles Commissioner (Ministry of Textiles), MSME-DI Ahmedabad, MSME-DI Hyderabad, Central Glass and Ceramics Research Institute, All India Small Agro and Recycled Paper Association, Central Pulp and Paper Research Institute, All India Brick & Tile Manufacturers Federation, Metal Finishers Association of Faridabad and All India Skin & Hide Tanners & Merchants Association for sharing their valuable time and insight on this issue.

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The document has been authored by the FMC team comprising Ms. Sukanya Banerjee, Deputy General Manager; Ms. Neetu Goel, Manager; and Mr. Sanjeev Kumar Fauzdar, Consultant. We also express our special gratitude to Mr. Sudhir Rana for his valuable insights and suggestions on developing the study report.

The authors bear all responsibility for facts presented, errors and omissions as well as value judgments passed, if any.

Mukesh Gulati
Executive Director, Foundation for MSME Clusters

Abbreviations

ACTI	Association of Chemical Technologist India
AEPC	Apparel Export Promotion Council
AISHTMA	All India Skin & Hide Tanners & Merchants Association
ASI	Annual Survey of Industries
ATIRA	Ahmedabad Textiles Industry Research Association
BDS	Business Development Service
BEE	Bureau of Energy Efficiency
BOD	Biochemical Oxygen Demand
BR	Business Responsibility
BTRA	Bombay Textiles Research Association
CAGR	Compound Annual Growth Rate
CAI	Chemical Association of India
CDAs	Cluster Development Agents
CDP	Cluster Development Programme
CECRI	Centre for Electro Chemical Research Institute
CETP	Common Effluent Treatment Plants
CFC	Common Facility Centre
CFR	Coke Feed Ratio
CFTI	Central Footwear Training Institute
CGCRI	Central Glass and Ceramics Research Institute
CII	Confederation of Indian Industry
CLE	Council of Leather Exports
CLRI	Central Leather Research Institute
COD	Chemical Oxygen Demand
COINDIA	Coimbatore Industrial Infrastructure Association
CPCB	Central Pollution Control Board

DA	Development Alternative
DBC	Divided Blast Cupola
DGCI&S	Directorate General of Commercial Intelligence and Statistics
DIPP	Department of Industrial Policy and Promotion
DRI	Direct Reduced Iron
DST	Department of Science and Technology
EG	Expert Group
EIA	Environmental Impact Assessment
ENVIS	Environmental Information System
EPCA	Environment Pollution Control Authority
EPMFAT	Electroplating and Metal Finishers Association of Tamil Nadu
ETPs	Effluent Treatment Plants
FMC	Foundation for MSME Clusters
GCA	Gujarat Chemical Association
GDMA	Gujarat Dyestuff Manufacturers' Association
GDP	Gross Domestic Product
GITCO	Gujarat Industrial and Technical Consultancy Organisation
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoI	Government of India
GSPMA	Gujarat State Plastic Manufacturers' Association
HSD	High Speed Diesel
ICCTAS	Indian Council of Ceramic Tiles and Sanitaryware
ICEF	Indo-Canada Environment Facility
IFC	International Finance Corporation
IIDC	Infrastructure Development Corporation Limited
IIF	Institute of Indian Foundrymen
IIUS	Industrial Infrastructure Up-gradation Scheme
IREDA	Indian Renewable Energy Development Agency
LDO	Light Diesel Oil
LSHS	Low Sulphur Heavy Stock

MANTRA	Man made Textiles Research Association
MCA	Ministry of Corporate Affairs
MoEF	Ministry of Environment and Forests
MSECDP	Micro, Small Enterprises Cluster Development Programme
MT	Metric Tonnes
NCLP	National Child Labour Project
NCM	Normal Cubic Meter
NEAA	National Environmental Appellate Authority
NGO	Non-Governmental Organisation
NIA	Naroda Industries Association
NIC	The National Industrial Classification
NIFT	National Institute of Fashion Technology
NITRA	Northern India Textiles Research Association
NSIC	National Small Industries Corporation
OIA	Odhav Industries Association
OSIMA	Orissa Sponge Iron Manufactures Association
PCRA	Petroleum Conservation Research Association
PNG	Pressurised Natural Gas
PPDC	Process and Product Development Centre
PPP	Public Private Partnership
PSCST	Punjab State Council of State and Technology
RBI	Reserve Bank of India
RFC	Rajasthan Financial Corporation
RIICO	Rajasthan State Industrial Development & Investment Corporation Ltd
RRA	Regional Resource Agency
SBI	State Bank of India
SDC-CCD	Swiss Agency for Development and Cooperation – Climate Change and Development Division
SHGs	Self Help Groups
SIDBI	Small Industries Development Bank of India

SIEMA	Southern India Engineering Manufacturer's Association
SIMA	Sponge Iron Manufacturers Association
SIPCOT	State Industries Promotion Corporation of Tamil Nadu
SITRA	South Indian Textiles Research Association
SME	Small and Medium Enterprises
SPCB	State Pollution Control Board
SPV	Special Purpose Vehicle
TPA	Tonnes Per Annum
TDS	Total Dissolved Solids
TERI	The Energy and Resources Institute
TISCO	Tata Iron and Steel Company Ltd
TPD	Tonnes Per Day
TWRFS	Textile Workers' Rehabilitation Fund Scheme
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organisation
VIA	Vatva Industries Association
WBSIMA	West Bengal Sponge Iron Manufactures Association

Executive Summary

i) Economic significance of MSMEs: Worldwide, micro, small and medium enterprises (MSMEs) have been recognised as engines of economic growth. These MSMEs have been instrumental in generating large-scale employment; contributing towards rise in incomes of labour and returns to capital; promoting regional development; and touching the lives of the most vulnerable and marginalised sections, such as women, backward communities and minorities. In India, MSMEs contribute 45 per cent of the manufactured output, 40 per cent of its exports and 8 per cent of the country's GDP. In terms of social impact, MSMEs provide employment to around 60 million people through 26 million enterprises.

ii) MSMEs' contribution to environmental degradation and social issues: MSMEs are known for being a significant contributor to environmental degradation. The pollution per unit of production is generally higher in MSMEs than in corresponding large units partly due to use of obsolete technologies and poor management practices, and partly because most of these units do not come under the ambit of regulatory authorities.

iii) Selection of sub-sector based on economic significance, energy intensity and environment degradation: The National Industrial Classification 2004 (NIC 2004, 2 digit classifications) has classified the manufacturing sector into 23 divisions (or sectors) under the section 'Manufacturing'.[1] However, the economic significance of all the 23 sectors is not uniform and to list out the significant sectors, one needs to look into the sector's contribution to employment, output, exports and total number of units. Based on the Annual Survey of Industries (ASI) data for 2005–06, these 23 sectors are ranked according to their contribution to employment, output and total number of units. The significance of the sectors is determined on the basis of their ranking. If a sector is ranked between 1 and 10 in three or two of the above-mentioned parameters, then it is considered as a significant sector. For example, the textile products industry ranks between 1 and 10 in all the three parameters whereas tobacco and its related products have a ranking of 7 in terms of employment but more than 10 for the other two parameters.

Apart from employment and output, export is another indicator that determines the economic significance of a sector. The industrial sectors that have been contributing significantly in exports are leather and manufacturers (3.39 per cent), chemicals and related products (20.23 per cent), engineering goods (heavy, medium and light engineering [36.32 per cent]), textile and textile products (18.81 per cent) and gems and jewellery (19.44 per cent). Based on their economic significance, nine sectors have been short listed. The next parameter that is taken for selection

1 Ministry of Statistics and Programme Implementation, NIC- 2004

of sectors is energy consumption. The sectors that are economically significant and energy intensive are:

- Engineering goods
- Food and beverages
- Textile and textile products
- Chemical and chemical products
- Non-metallic mineral products
- Rubber and plastic products
- Motor vehicles, trailers and semi-trailers
- Gems and jewellery
- Leather and manufacturers
- Paper and paper products
- Coke, petroleum products and nuclear fuel

The selection of sub-sectors from the selected list of sectors is based on their contribution to pollution as per the norms issued by the Central Pollution Control Board (CPCB). As inferred from the analysis, the sectors and thereby the sub-sectors that do not contribute to environmental degradation are manufacturer and plastic products, motor vehicles, trailers and semi-trailers, and gems and jewellery. Therefore these three sectors do not fall within the domain of this study. Moreover, coke, petroleum products and nuclear fuel are relevant for large enterprises and given the focus of the study on MSMEs, this sector is also excluded from the list of sub-sectors. The selected list of sub-sectors that have been included in this study is given in the following table.

Sector	Sub sector	Environmental Issues
Engineering	Foundry	Air emissions Solid waste Wastewater
	Sponge Iron	
Leather and Footwear	Leather Tanning	Water pollution Hazardous solid waste
Textile and Garments	Textile and Garments Dyeing and Processing	Water pollution Hazardous solid waste
Chemical	Dyes and Chemicals	Water pollution Hazardous waste
	Electroplating	
Non-metallic Industries	Brick Kilns	Air pollution
	Ceramic Tiles and Sanitary ware	Air pollution Solid waste
	Glassware	Air pollution Solid waste
	Mini Cement Plants	Air pollution
Paper and Paper Products	Paper Industry	Air pollution Water pollution Bio diversity

iv) Selection of Cluster: In this study, we have identified 290 clusters in the 11 sub-sectors which are economically significant, energy intensive and environment sensitive clusters. The detailed secondary study of the selected sub-sectors and their clusters has been done. The major findings of the study are in terms of economic significance, energy intensity and environmental degradation and are as listed below.

Sub-sector	Total production	Employment	Clusters	Estimated Total Energy Consumption			Estimated Pollution (per annum)
				Volume	Energy (% of manufac-turing cost)	Estimated Value (₹)	
Foundry	8.18 mn tonnes per annum	0.65 mn	28	Coke consumption with 12% ash: 0.484 mn tonnes per annum	25%	4.8 bn	Air: CO_2 – 2.36 mn tonnes
Sponge Iron	21.2 mn tonnes per annum	0.52 mn	29	Coal Consumption: 25.68 mn tonnes	12.8%	290 bn	Air: CO_2 – 32.1 mn tonnes
				Gas consumption: 1.848 billion normal cubic meter (ncm)			
Leather Tanning	2,70,000 tonnes per annum	2.5 mn	17	NA		-	Water – 24 mn m^3
Textiles	54.96 bn sq. Meters of cloth	35 mn	113	65.56 bn KWh*	5–17%	295 bn	
Dyes and Chemicals	28.7 MT	NA	12	-	-	-	
Electro-plating	28,000 tonnes	50,000	20	Electricity: 288 mn Units	35 to 50%	1.3 bn	Air: 15.30 bn metre cube of harmful gases Water: 0.36 mn m^3 Solid waste: 365 tonnes
Brick Kilns	140 bn Bricks	10 mn	40	Coal: 40 mn tonnes	35%	260 bn	Air: 59.1 mn tonnes of CO_2
Ceramics	340 mn sq. meters – Ceramic tiles	0.55 mn	16	NA	40%	2.1 bn	NA
Glassware		0.8 mn	1	Coal:– 7.7 mn tonnes(assuming specific energy 8360 KJ per kg for Indian coal)	45%	27.7 bn	Air: 648 tonnes of PM The CO_2 emission is 0.8 mn tonnes

Sub-sector	Total production	Employment	Clusters	Estimated Total Energy Consumption			Estimated Pollution (per annum)
Cement Plants	176 mn MT	0.14 mn	10	Coal: 40 mn tonnes Electricity: 11.44 bn units	25%– 30%	195.5 bn	Air: CO_2 emitted is 192.5 mn tonnes
Paper Industry	10.5 mn tonnes	0.46 mn	4	Coal: 84 mn tonnes State Electricity – 16.80 bn units		381.6 bn	Air: CO_2 emitted is 161 mn tonnes per year Water: 2354.7 mn m^3 Solid waste: 14.2 mn tonnes

v) Suggestions for a Policy Framework: Actionable steps need to be taken up at the policy level to engage MSMEs in fostering development covering environmental and social dimensions.

- *Putting in place a proper management structure:* Business Responsibility (BR) issues should to be tackled by all the relevant ministries through inter-ministerial cooperation, wherein an apex committee/ body should be created. The apex committee/platform should comprise of representatives from all the relevant ministries, with the Ministry of Corporate Affairs or Ministry of MSME as the facilitator wherein information and knowledge related to BR will be shared and discussed. The purpose of the apex committee/body is to provide a platform wherein representatives from the various ministries can discuss their concerns, share their experiences, facilitate cross-learning and provide solutions to the BR issues addressed.

- *Mapping of clusters:* The clusters that significantly contribute towards environmental degradation or have high incidence of social issues like child labour or gender inequality, need to be identified and ranked based on the degree of incidence of such BR issues. This ranking of clusters will be done based on a set of selected parameters like volume of fuel consumed as a percentage of total production, male to female labour ratio, water pollutants present in the water discharged, etc.

- *Selection of cluster for intervention:* Every government programme/scheme has an unique objective, target group and volume of financial support. On the basis of the objective of the support programme/scheme and ranking of the clusters based on BR issues, the typology of clusters to be intervened needs to be selected. The decisions on selection of cluster for intervention can be taken based on the available financial resources and time period of intervention.

- *Implementation of support schemes/programmes:* The implementation at the cluster level should be coordinated by the implementing agency appointed by the state government/ Central government in consultation with the local government. For the selection of the implementing agency, the state/Central government should be equipped with a list of technical institutes or organisations that have worked at the clusters to address the various BR issues. For implementation, a network should be created at the cluster level that comprise of technical institutes, various R&D institutes, educational institutes, NGOs and sector specialists for identification of the pressure points in the cluster, draw the action plan and accordingly implement at the cluster level.

- *Monitoring and evaluation (M&E):* Monitoring systems should be in place at all the levels. At the cluster level, day-to-day monitoring of output will be done by the implementing agency and reported to the local government. The local government will monitor the outcome and the overall monitoring and evaluation will be done by the state/ Central government. The state/ Central government will monitor the support programme in terms of number of clusters supported, financial disbursement, impact of the support, etc. Since dovetailing the BR agenda with competitiveness is an emerging phenomenon, it is important to put in place a system that provides constant learning and inputs to policy makers.
- *Disclosure of BR issues and incentive for such initiative:* It has been observed that the BR issues are addressed by MSMEs when there is buyer pressure or regulatory and judicial pressure, that is, when there is a threat or external pressure. The other approach should be to encourage the clusters through incentivising them for addressing such BR issues in the form of financial loan at a lower interest rate, grant support, etc. Steps should also be taken for disclosure of BR issues.
- *National Voluntary Guideline:* The MSMEs should be made aware of the benefits of following the National Voluntary Guideline (NVG). A proper awareness programme on NVG should be conducted for MSMEs wherein the process and benefits of following the Guidelines will be imparted.
- *Role of cluster associations:* Cluster associations can play a pivotal role in the growth and development of clusters. To address the BR issues existing in clusters, associations can play multiple roles as illustrated below:
    a) Identification of a support scheme/ programme available to address the specific BR issue that is prevalent in the cluster and implement such schemes/ programmes in the cluster.
    b) Identification and linking of proper (Business Development Service) BDS providers to address the BR issue.
    c) Facilitate creation of network of BDS providers, R&D institutes, educational institutes and other related organisations.

However, the government has to take a step towards capacitating the cluster associations by introducing programmes/schemes for training BMO office bearers and executives and handhold them to draw up their business plans and implementation.

- *Cluster Development Agent for cluster intervention:* For addressing BR issues, especially environmental issues that require technical inputs, it is imperative that instead of an individual CDA, a team is constituted comprising of individuals having experience in identifying and addressing energy, environmental and social issues. Cluster development agents (CDAs) will need to be trained through specialised designed training programmes that help him/her to diagnose BR issues better and then design interventions accordingly. Moreover, the cluster key stakeholders should also be trained in the area of BR as this would bring both the implementer and the beneficiary to the same level of understanding and the need to address such issues.

- *Revisiting developmental schemes:* Developmental schemes should be audited by the respective ministries themselves to understand the magnitude of the BR issues addressed and accordingly either revise the existing scheme or design a new scheme as per the requirement.
- *Inclusion of MSMEs under PAT scheme:* MSMEs also contribute significantly to energy consumption, given the traditional method of manufacturing, wherein the per unit cost of fuel consumption is more in comparison to large companies. Therefore the PAT (Perform, Achieve and Trade) scheme should also include MSMEs. Moreover, the scheme should be implementable at the group level as well, like clusters, special economic zones, cooperatives, etc.

Section – A

CHAPTER A1

Significance of MSMEs with special reference to economic, energy and environmental aspects

1.1 Significance of MSMEs in India

1.1.1 Worldwide micro, small and medium enterprises (MSMEs) have been recognised as engines of economic growth. These MSMEs have been instrumental in generating large-scale employment, contributing towards rise in incomes of labour and returns to capital; and promoting regional development, touching upon the lives of the most vulnerable and marginalised such as women, backward communities, minorities, etc. MSMEs are very heterogeneous groups that are grouped together on the basis of a formal definition that vary worldwide depending on the stage of economic development and culture of a country. In India, MSMEs are defined in accordance with the provision of the Micro, Small & Medium Enterprises Development (MSMED) Act, 2006 and are classified into two classes.

- *Manufacturing Enterprises:* Enterprises engaged in the manufacture or production of goods pertaining to any industry specified in the first schedule to the industries (Development and Regulation) Act, 1951. A Manufacturing Enterprise is defined in terms of investment in plant and machinery.
- *Service Enterprises:* Enterprises engaged in providing or rendering services and are defined in terms of investment in equipment.

The definitions of the different categories of MSMEs are shown in Table 1.1.

Table 1.1: Definition of MSME

	Investment in plant and machinery/ equipment (excluding land and building)	
	Manufacturing Enterprise	Service Enterprise
Micro	Up to ₹ 2.25 mn	Up to ₹ 0.9 mn
Small	More than ₹ 2.25 mn and up to ₹ 45 mn	More than ₹ 2.25 mn and up to ₹ 1.8 mn
Medium	More than ₹ 45 mn and up to ₹ 90 mn	More than ₹ 1.8 mn and up to ₹ 45 mn

Source: (Annual Report 2006–07, Ministry of MSME, Government of India)

1.1.2 Micro enterprises also play a pivotal role in generating employment in the country. The MSME "... sector contributes 8 per cent of the country's GDP, 45 per cent of the manufactured output and 40 per cent of its exports. The MSMEs provide employment to about 60 million persons through 26 million enterprises. The labour to capital ratio in MSMEs and the overall growth in the MSME sector is much higher than in the large industries. The geographic distribution of the MSMEs is also more even. Thus, MSMEs are important for the national objectives of growth with equity and inclusion" (Report of the Task Force on MSME). MSMEs are estimated to "... manufacture over 6,000 products ranging from handloom sarees, carpets, and soaps to pickles, papads, and machine parts for large industries..." (Eleventh Five-Year Plan, Government of India). Apart from its economic significance, MSMEs are instrumental in supporting inclusive growth, which touch upon the lives of the most vulnerable, most marginalised and the most skilled.

1.1.3 Though MSMEs are of social and economic significance, there are a few negative aspects that need to be addressed. It has been estimated that 70 per cent of the total industrial pollution is contributed by SMEs in India.[2] The pollution per unit of production is generally higher in SMEs than that of the corresponding large units partly due to the use of obsolete technologies and poor management practices, and partly because most of these units do not come under the ambit of regulatory authorities.

1.2 Selection of significant industrial sectors in India based on contribution to economic development

1.2.1 The National Industrial Classification 2004 (NIC 2004, 2 digit classifications) has classified the manufacturing sector into 23 divisions (or sectors) under the section 'Manufacturing'.[3] However, the economic significance of all the 23 sectors is not equal and to list out the significant sectors, one needs to look into the sector's contribution to employment, output, exports and total number of units. Based on the Annual Survey of Industries (ASI) data for 2005–06, these 23 sectors are ranked according to their contribution to employment, output and total number of units as shown in Table 1.2. The significance of the sectors is determined on the basis of the ranking. If a sector is ranked between 1 and 10 in three or two of the above-mentioned parameters, then it is considered as a significant sector. For example, the textile products industry ranks from 1 to 10 for all the three parameters whereas tobacco and related products have a ranking of 7 in terms of employment but more than 10 in the other two parameters. Hence, in this case we consider textile products as a significant industrial sector but not tobacco and its related products.

2 India: Strengthening Institutions for Sustainable Growth Country Environmental Analysis, World Bank Dec, 2006

3 Ministry of Statistics and Programme Implementation, NIC-2004.

Table: 1.2: Significant industrial sectors in India based on economic indicators

NIC-2004		Total persons engaged	Rank	Gross output (USD in mn)	Rank	No of units	Rank
15	Food products and beverages	1,391,616	1	45,698.762	4	25,725	1
17	Textiles products	1,337,007	2	25,718.79	5	13,810	3
24	Chemicals and chemical products	825,435	3	48,310.802	3	10,995	4
27	Basic metals	643,594	4	51,060.612	2	7,228	8
26	Non-metallic mineral products	579,170	5	11,044.246	9	13,999	2
18	Wearing apparel, dressing & dyeing of fur	541,848	6	5,559.236	15	3,649	11
16	Tobacco & related products	473,608	7	2,679.134	19	3,344	12
29	Machinery and equipment n.e.c.	466,239	8	18,916.15	7	9,531	5
28	Fabricated metal products (except machinery & equipment)	372,726	9	10,188.268	11	8,534	6
34	Motor vehicles, trailers and semi-trailers	359,936	10	24,145.778	6	3,069	14
25	Rubber and plastic products	317,414	11	10,540.15	10	7,353	7
31	Electrical machinery and apparatus, n.e.c	274,467	12	13,558.922	8	4,069	9
35	Other transport equipment	199,230	13	10,020.618	12	1,886	18
36	Furniture & other manufacturing n.e.c.	189,725	14	8,966.612	13	2,562	16
21	Paper and paper products	177,696	15	4,977.522	16	3,749	10
19	Leather & related products	173,892	16	3,064.68	18	2,443	17
22	Publishing, printing and related activities	134,888	17	3,378.79	17	3,319	13

NIC-2004		Total persons engaged	Rank	Gross output (USD in mn)	Rank	No of units	Rank
32	Radio, television and communication equipment	115,890	18	6,819.846	14	1,036	20
23	Coke, petroleum products and nuclear fuel	85,283	19	58,911.808	1	1,037	19
33	Medical, precision and optical instruments	71,015	20	2,062.486	20	987	21
20	Wood and wood products	56,387	21	983.814	22	3,033	15
30	Office, accounting and computing machinery	21,776	22	1,783.532	21	180	22
37	Recycling	2,036	23	76.408	23	88	23
	All industries	8,810,878		368,466.96		131,626	

Source: Annual Sample Survey of India, Ministry of Statistics and Programme Implementation, 2005–06.

Based on the above-mentioned selection criteria, of the listed 23 sectors the most significant top 10 sectors are:

- Food product and beverages
- Textile products
- Chemicals and chemical products
- Basic metals
- Non-metallic mineral products
- Machinery and equipment n.e.c.
- Fabricated metal products (except machinery and equipment)
- Rubber and plastic products
- Electrical machinery and apparatus
- Motor vehicles, trailers and semi-trailers.

1.2.2 Apart from employment and output, export is another indicator that determines the economic significance of a sector. Industrial sectors that have been contributing significantly in exports are leather and leather manufacturers (4.35 per cent),[4] chemicals and related products

4 Council for Leather Exports, 2009.

(24.5 per cent),[5] engineering goods (heavy, medium and light engineering) (36.32 per cent), textile and textile products (12.54 per cent)[6] and gems and jewellery (19.44 per cent).[7]

Therefore, based on these economic performance indicators, the combined list of significant sectors are:

- Food and beverages
- Textile and textile products
- Chemical and chemical products
- Engineering goods (includes basic metal, machinery and equipment n.e.c. fabricated metal products and electrical machinery and apparatus)[8]
- Non-metallic mineral products
- Rubber and plastic products
- Motor vehicles, trailers and semi-trailers
- Gems and jewellery
- Leather and manufacturers

1.2.3 These industrial sectors are significant both in terms of economic (share of exports and turnover) and social (employment) impact to the country. Apart from economic and social significance, the other factors that have been of major concern in all strata of the economy are energy intensity and environmental issues of the sectors.

1.3 Energy intensity of the selected sectors

1.3.1 The energy consumption pattern of the various industrial sectors is not uniform. There are a few sectors that are highly energy intensive in comparison to other sectors. The energy intensity of different sectors is determined by ASI data on fuel consumption for the year 2005–06. Of the selected economically significant sectors, the energy intensive sectors are listed below (this does not represent the ranking of different sectors):

- Engineering goods (includes basic metal, machinery and equipment n.e.c. fabricated metal products and electrical machinery and apparatus)
- Food and beverages
- Textile and textile products

5 ITP Division, Ministry of External Affairs, 2010.
6 Annual Report 2010–11, Ministry of Textiles, Government of India.
7 Eleventh Five-Year Plan 2007-12.
8 Basic metal, machinery and equipment n.e.c. fabricated metal products and electrical machinery and apparatus are listed under Engineering goods.

- Chemical and chemical products
- Non-metallic mineral products
- Rubber and plastic products

1.3.2 Apart from the six sectors listed above, the other sectors that are highly energy intensive are paper and paper products and coke, petroleum products and nuclear fuel. Therefore, the combined list of sectors that are economically significant and energy intensive is:

- Engineering goods
- Food and beverages
- Textile and textile products
- Chemical and chemical products
- Non-metallic mineral products
- Rubber and plastic products
- Motor vehicles, trailers and semi-trailers
- Gems and jewellery
- Leather and manufacturers
- Paper and paper products
- Coke, petroleum products and nuclear fuel

1.4 Selection of significant sub-sectors

1.4.1 Sub-sectors leading to Environmental Degradation: The selection of sub-sectors from the selected list of sectors is based on their contribution to pollution as per the norms of Central Pollution Control Board (CPCB). The CPCB[9] has classified 64 types of polluting industries/ industrial activities as "Red Category" industries on the basis of high emissions/ discharge of significant pollutants or generating hazardous wastes. Industries where the degree of pollution is less, are termed as "Orange" category industries (25 types of industries) and small-scale and cottage/village industries are categorised as "Green" category industries (55 types of industries). Of the selected 64 types of "Red Category" polluting industries, the 17 that have been identified by the Ministry of Environment and Forests, Government of India, as heavily polluting and are covered under the Central Action Plan and have significant presence in the MSME sector include Pulp and Paper (paper manufacturing with or without pulping), Dyes and Dye Intermediaries, Tanneries, Cement and Iron and Steel (involving process from ore/

9 The Central Pollution Control Board (CPCB) is a statutory organisation which serves as a field formation and also provides technical services to the Ministry of Environment and Forests on the provisions of the Environment (Protection) Act, 1986. The principal functions of the CPCB are to promote cleanliness of streams and wells in different areas of the states by prevention, control and abatement of water pollution, and to improve the quality of air and to prevent, control or abate air pollution in the country.

scrap, and integrated steel plants).[10] Table 1.3 provides the list of sub-sectors that leads to environmental degradation from the selected list of sectors.

Table 1.3: Sub-sectors leading to environmental degradation

Sectors	Sub sectors	Industry Category
Food and Beverages	Food processing	Orange
Engineering	Foundry	Red
	Sponge Iron	Red
Leather and Footwear	Leather Tanning	Red
Textile and Garments	Textile and Garments Dying and Processing	Red
Chemical	Dyes and Chemicals	Red
	Electroplating	Red
Non-metallic Industries	Brick Kilns	NA
	Ceramic Tiles and Sanitary ware	Red
	Glassware	Red
	Mini Cement Plants	Red
Paper and Paper Products	Paper Industry	Red
Rubber and plastic products	Rubber and plastic products	Green
Motor Vehicles, Trailers and Semi-Trailers.		NA
Gems and Jewellery	Gems and jewellery making	NA
Coke, petroleum products and nuclear fuel	Coke making, coal liquification and fuel gas making industries	Red

Source: Central Pollution Control Board, CPCB, (http://www.cpcb.nic.in/Industry_Specific_Standards.php)

1.4.2 As inferred from Table 1.3, the sectors and thereby the sub-sectors that do not lead to environmental degradation are manufacturer and plastic products, motor vehicles, trailers and semi-trailers, and gems and jewellery. Therefore these three sectors do not fall within the domain of our study. Moreover, coke, petroleum products and nuclear fuel are relevant for large enterprises and given the focus of the study on MSMEs, this sector is excluded from the list of sub-sectors. The final list of sub-sectors is given in Table 1.4.

10 Central Pollution Control Board, http://www.cpcbenvis.nic.in/newsletter/pollutingindustries/pollutingintro1.htm

Table 1.4: Final list of sub-sectors leading to significant environmental degradation

Sectors	Sub-sectors	Environmental Issues
Engineering	Foundry	Air emissions Solid waste Wastewater
	Sponge Iron	
Leather and Footwear	Leather Tanning	Water pollution Hazardous solid waste
Textile and Garments	Textile and Garments Dying and Processing	Water pollution Hazardous solid waste
Chemical	Dyes and Chemicals	Water pollution Hazardous waste
	Electroplating	
Non-metallic Industries	Brick Kilns	Air pollution
	Ceramic Tiles and Sanitary ware	Air pollution Solid waste
	Glassware	Air pollution Solid waste
	Mini Cement Plants	Air pollution
Paper and Paper Products	Paper Industry	Air pollution Water pollution Bio diversity

Source: Compiled from various sources: CPCB, Ministry of Environment and Forests, CII-MSME and various sectoral reports.

CHAPTER A2

Selection of energy-intensive and environmentally sensitive clusters

2.1 Understanding clusters

2.1.1 Often, MSMEs producing a range of similar or same products are found to co-exist in typical geographical locations for decades and even centuries in many countries. This phenomenon is referred to as clustering of MSMEs. The phenomenon of enterprise clustering is prevalent both in economically developed and developing countries. Geographical proximity of enterprises may give rise to specialised labour, nurture subsidiary industries, stimulate innovations, enable technological spillover, and make economic and non-economic inter-firm linkages feasible.

2.1.2 A cluster is defined as "…a typical geographical concentration of micro, small, medium and large firms producing same or a similar range of products (goods or services). Units in a cluster face same or similar set of threats (e.g., product obsolescence, lack of markets, etc.) and opportunities (e.g., increasing turnover through quality up-gradation or introduction of new products or markets, etc.)" (FMC: 2007).[11] However, there does not exist any guiding principle regarding the generality of products or geographical spread of the cluster. The definition should not include too wide a product range as the common opportunities and threats lose their sharpness or specificity and too narrow a definition can create difficulty in finding a sizeable number of similar firms with commonalities that enable inter-connectedness. Similarly, while defining geographical spread of a cluster, too wide an area hinders the units from exploiting developmental potential through proactive joint action. In India, it has been estimated from various sources that there are around 6,600 clusters spread across the country. According to the estimation of the Foundation for MSME clusters through Cluster Observatory, around 4,700 clusters have been mapped, of which 1,122 are industrial clusters as on November 2011. This is perhaps the largest number of industrial clusters in any single country.

2.1.3 The spread of industrial clusters confirms the broad industrialisation trend among states in India. Table 2.1 provides the geographical spread of some of the industrial clusters in India.

11 Policy and Status Paper on Cluster Development in India, FMC 2007.

Table: 2.1: Geographical spread of industrial clusters in India

State (Clusters)	District 1	District 2	District 3	District 4	District 5
UP (169)	Kanpur (18)	Meerut (11)	Gautam Buddha Nagar (8)	Allahabad (4)	Agra (9), Ghaziabad (6)
Maharashtra (100)	Mumbai (13)	Nagpur (11)	Pune (12)	Kolhapur (8)	Thane (9)
Gujarat (96)	Ahmedabad (34)	Rajkot (17)	Bhavnagar (6)	Surat (6)	Vadodara (4)
Tamil Nadu (109)	Coimbatore (13)	Chennai (11)	Virudhnagar (9)	Madurai (9)	Erode (8), Salem (4)
Arunachal Pradesh (90)	Hyderabad (12)	E. Godavari (9)	Guntur (7)	Krishna (7)	Chittoor (6), Kurnool (4)
Kerala (87)	Ernakulam (16)	Khozikode (10)	Thrissur (11)	Kannur (6)	Malappuram (10)
Punjab (64)	Ludhiana (15)	Jalandhar (12)	Amritsar (8)	Gurudaspur (4)	Kapurthala (4)
West Bengal (68)	Kolkata (9)	Howrah (10)	Nadia (2)	Bankura(3)	Bardhaman (6)
Rajasthan (48)	Jaipur (16)	Ajmer (2)	Alwar (4)	Bikaner (3)	Nagaur (3)
Haryana (43)	Gurgaon (7)	Faridabad (4)	Panipat (6)	Karnal (5)	Ambala (3)
Karnataka (77)	Bangalore (17)	Belgaum (7)			
Delhi (24)	West Delhi (9)	South Delhi (8)	North West Delhi (2)	North Delhi (3)	East Delhi (2)
Bihar (20)	Muzaffarpur (2)	Patna (5)	Samastipur (2)	Bhagalpur (1)	Nalanda (1)
Madya Pradesh (53)	Gwalior (3)	Indore (9)	Jabalpur (7)	Satna (4)	Bhopal (3)
Orissa (39)	Rayagada (50	Koraput (4)	Cuttack (5)	Rourkela (2)	Ganjam (3)
1087	172	123	89	52	85

Source: Cluster Observatory, http://clusterobservatory.in/cluster/index.php

India has 1,156 industrial clusters. Of these, the above-mentioned 15 states command 94.03 per cent of the total clusters in India. Table 2.1 shows that out of 1,156 clusters in India, 534 are located in above mentioned districts of respective states.

In this chapter, we will analyse the total number of clusters of the selected sub-sectors (sub-sectors selected in Chapter 1) that are present across the country. These industrial clusters are also confronted with a number of environmental and social issues like inefficient utilisation of energy, shortage in the supply of cleaner fuels, environmental pollution caused due to inefficient combustion and clustering of units, occupational health hazards, child labour, women empowerment, etc. In the following sections, our focus will be to address the energy intensity, environmental and social issues that are prevalent cluster wide. The objective is to explore and understand the intensity of the existing issues and thereby identify areas for intervention.

2.2 Geographical spread of clusters of selected sub-sectors

2.2.1 As mentioned earlier, based on the economic, energy and environmental issues sectors, and thereby 11 sub-sectors, have been selected. These selected sub-sectors have clusters spread across the country. The numbers of clusters that are present in the country also vary from one sub-sector to another. The geographical expanse and the number of clusters that are present in India of the selected sub-sectors are as shown in Table 2.2.

Table 2.2: Geographical spread of clusters[12] of selected sub-sectors

Sectors	Sub-sectors	Total number of clusters	State-wise spread of the clusters
Engineering	Foundry	28	Andhra Pradesh-2, Chhattisgarh-1, Gujarat-4, Haryana-1, J&K-1, Jharkhand-2, Karnataka-1, Madhya Pradesh-1, Maharashtra-4, Orissa-2, Punjab-4, Rajasthan-1, Tamil Nadu-1, Uttar Pradesh- 2, West Bengal-1
	Sponge Iron	29	Chhattisgarh-3, Maharashtra-3, Orissa-4, West Bengal-4, Jharkhand-3, Karnataka-2, Goa-1, Gujarat-6, Andhra Pradesh-2, Tamil Nadu-1
Leather and Footwear	Leather Tanning	17	Andhra Pradesh-1, Bihar-1, Karnataka-1, Punjab-1, Tamil Nadu-9, Uttar Pradesh-3, West Bengal-1
Textile and Garments	Textile and Garments Dying and Processing	113	*As per the list given after this table
Chemical	Dyes and Chemicals	12	Gujarat-9, Maharashtra-5
	Electroplating	20	Andhra Pradesh–1, Delhi-4, Gujarat-3, Haryana–1, Himachal Pradesh–1, Karnataka-1, Maharashtra–3, Punjab-2, Tamil Nadu-3, Uttar Pradesh-1

12 The cluster list is compiled based on secondary sources through consultation with cluster experts. Hence subject to changes with identification of new clusters and closing of existing clusters over time.

Sectors	Sub-sectors	Total number of clusters	State-wise spread of the clusters
Non-metallic Industries	Brick Kilns	49	Assam–1, Bihar-2, Chattisgarh-3, Gujarat-1, Haryana-5, Jammu and Kashmir-2, Karnataka-1, Kerala-1, Madhya Pradesh-6, Maharashtra-2, Orissa-2, Punjab-4, Rajasthan-2, Tamil Nadu-4,Tripura-1, Uttar Pradesh-10, West Bengal-2
	Ceramics	16	Andhra Pradesh-6, Gujarat-6, Maharashtra-1, Rajasthan-1, Uttar Pradesh-1, Tamil Nadu-1
	Glassware	4	Rajasthan–1, Uttar Pradesh-3
	Mini Cement Plants	10	Andhra Pradesh–2, Gujarat–1, Madhya Pradesh–2, Maharashtra–1, Orissa–1, Jharkhand-1, Karnataka–1, Rajasthan–1.
Paper and Paper Products	Paper Industry	4	Gujarat-1, Tamil Nadu-1, Uttaranchal–1, Uttar Pradesh-1.
Total		293	

Note: Detailed cluster lists are provided sub-sector wise in Section B of this report.
Source: Compiled from data available with FMC and discussion with cluster experts.

The details of the textile sub-sector are as follows:

Sector	Number of Clusters	Locations with Maximum concentration
Spinning mills	20	Coimbatore, Maharashtra, Punjab
Composite mills	14	Maharashtra, Gujarat, Punjab
Powerloom	45	Maharashtra, Surat, Uttar Pradesh
Readymade Garments	18	Bangalore, Indore
Wet Processing	16	Maharashtra, Gujarat, Tirupur, Punjab
Total	113	

* It is difficult to segregate the textile clusters state wise as this sector is diverse

2.3 Energy, environmental and social issues prevalent in the existing clusters

2.3.1 A particular sector or sub-sector comprises large, medium, small and micro units. Therefore, while categorising a sub-sector as energy intensive or environmentally polluting, all the typology of firms whether large or small are taken into consideration, whereas clusters mainly comprise of medium, small and micro units (except high-tech clusters). Therefore, to understand the energy and environmental issues that are prevalent in clusters and the degree of intensity, it is imperative to look into the various facets of functioning of a cluster. Detailed cluster studies of the identified sub-sectors are provided section wise later in this chapter. The various sections of the detailed cluster study include:

- General cluster information in terms of total number of clusters and location

- Overall cluster scenario in terms of energy intensity
- Production process
- Overall cluster scenario in terms of environmental degradation
- Overall cluster scenario in terms of prevalent social issues

Table 2.3 provides an overview of the degree of energy intensity, environmental degradation and social impact of the identified clusters.

Table: 2.3 Energy, environment and social issues prevalent in identified sub-sectors

Sub-sector	Energy Intensity	Environment			Social Issues
		Air	Water	Solid Waste	
Foundry	High	High	Low	Moderate	The foundry industry is mainly related to occupational health and safety issues.
Sponge Iron	High	High	Low	Moderate	The sponge iron industry is mainly related to occupational health and safety issues of the workers
Leather	Low	Low	High	Moderate	The social issues pertaining to the leather tanning sector are mainly related to occupational health and safety issues associated with the construction and decommissioning of tanning and leather finishing facilities
Textile	High	Low	Moderate	Moderate	The social issues pertaining to the textile sector include the occupational health and safety hazards during the operational phase of textile manufacturing projects
Dyes and Chemicals	Moderate	Low	High	Low	The social issues in this sector are mainly related to the occupational health and safety of the workers as well as the women labourers employed during packaging. They mostly face respiratory problems due to the presence of various chemical substances.
Electroplating	Moderate	High	High	High	The social issues in electroplating industry are mainly related to occupational health and safety issues

Sub-sector	Energy Intensity	Environment			Social Issues
		Air	Water	Solid Waste	
Brick	High	High	Low	Moderate	The social issues pertaining to brick kilns are related to the occupational health and safety of the workers as well as the child and women labour employed in this sector.
Ceramics	High	High	Low	Moderate	The social issues pertaining to the ceramics sector are mainly related to occupational health and safety issues arising during the construction and decommissioning of ceramic tiles, sanitary wares and pottery.
Glassware	High	Moderate	Moderate	Moderate	The social issues pertaining to the glassware sector are mainly related to occupational health and safety issues and low wages paid to the labourers.
Mini Cement Plants	High	High	Moderate	Low	The social issues pertaining to the mini cement plants sector are mainly related to occupational health and safety issues
Paper Industry	High	High	High	Moderate	The social issues pertaining to the paper sector are mainly related to occupational health and safety issues

Source: Compiled based from the sector studies and inputs from experts.

The energy, environmental and social impact of the clusters from the selected 11 sub-sectors are further illustrated in the following chapter based on the detailed sub-sector study provided in Section B of the report.

CHAPTER A3

Economic significance and major BR issues in select sub-sectors

3.1 Introduction

3.1.1 The fading national boundaries for trade and investment have opened significant opportunities not only for large firms but also for the medium, small and micro enterprises (MSMEs) to grow and be a part of the global value chain. However, for sustainability it is imperative that the clusters look beyond economic competitiveness to include business responsibility (BR) through addressing the energy, environmental and social issues prevalent in the cluster. To address the BR issues, identification and analysis of the existing BR issues in MSMEs is vital.

3.2 Economic significance of sub-sectors

3.2.1 The economic significance of the sub-sectors that have been identified for the study is as mentioned in Table 3.1.

Table 3.1: Economic significance of identified sub-sectors

Sub-sectors	Total Production	Employment[13]	Total Clusters	International Significance
Foundry	8.18 mn tonnes per annum	0.65 mn	28	India ranks second in the world based on the number of foundry units present after China and fourth in terms of total production.
Sponge Iron	21.2 mn tonnes per annum	0.52 mn	29	India ranks 1st in terms of total production.
Leather Tanning	2,70, 000 tonnes per annum	2.5 mn	17	The leather industry ranks 8th in term of foreign exchange earnings of the country and has 3% share in global trade.

13 This includes total employment in the sub-sectors irrespective of the size of unit.

Sub-sectors	Total Production	Employment[13]	Total Clusters	International Significance
Textiles	54.96 bn sq. metres of cloth	35 mn	113	The Indian textile industry is the second largest in the world.
Dyes and Chemicals	28.7 MT	NA	12	The global market share of Indian dyes industry is between 5 and 7%
Electroplating	28,000 tonnes	50,000	20	World share is very low.
Brick Kilns	140 bn bricks	10 mn	40	The Indian brick kiln industry is the second largest in the world after China.
Ceramics	340 mn sq. metres- ceramic tiles	0.55 mn	16	India ranks 5th in the world in terms of production of ceramic tiles and is growing at a healthy 15% per annum
Glassware		0.8 mn	4	The exports in 2008–09 (April–Dec) was $ 0.00294 mn
Cement Plants	176 mn MT	0.14 mn	10	India is the second largest producer of cement in the world after China
Paper Industry	10.5 mn tonnes	0.46 mn	4	The Indian paper industry accounts for about 1.6% of the world's production of paper and paperboard

Source: Compiled from the cluster study of the 11 sub-sectors identified.
*data is available in monetary terms in the study

3.2.2 As inferred from Table 3.1, the textiles sector employs the maximum number of people followed by the brick kilns and leather sub–sectors, with textiles constituting the maximum number of clusters. In terms of international significance, the sponge iron industry of India is the largest in the world while textiles, brick kiln, foundry and cement plants rank second largest in the world.

3.3 Energy intensity in sub-sectors

3.3.1 The cost of energy as a percentage of the total manufacturing cost of the selected sub-sectors ranges from 5 per cent to 50 per cent. The sub-sectors wherein the cost of energy is 30 per cent, or above, of the total manufacturing cost are paper, electroplating, ceramics, brick, glassware and mini cement plants. The cost of energy consumption is the maximum in mini cement plants constituting 45 per cent of the total production cost. The sectors that are low in energy consumption are leather tanning and dyes and chemicals. In terms of coal consumption, the maximum amount of coal is consumed by the paper industry, 84 million tonnes, followed by cement and brick consuming 40 million tonnes per annum. Table 3.2 provides a consolidated picture of the major findings of the 11 sub-sector studied for energy consumption.

Table 3.2: Energy intensity in clusters of identified sub-sectors

	Total Energy Consumption			Major Source of Energy
Sub-sector	Volume	Energy as a per cent of manufacturing cost	Estimated Value (in ₹)	
Foundry	Coke consumption with 12% ash – 0.484 mn tonnes per annum	25%	4.8 bn	Coke, Natural Gas
Sponge Iron	Coal consumption – 25.68 mn tonnes Gas consumption – 1.848 billion normal cubic meter (ncm)	12.8%	290 bn	Coal, gas
Leather Tanning	NA	NA	-	
Textiles	65.56 bn KWh*	5–17%	295 bn	Electricity, Diesel Generator
Dyes and Chemicals		5–8%	-	Electricity, coal/ Hard Coke
Electroplating	Electricity – 288 mn Units	30%	1.3 bn	State Electricity, Diesel
Brick Kilns	Coal – 40 mn Tonnes	35–50%	260 bn	Coal, Biomass
Ceramics	NA	35%	2.1 bn	LPG, Natural Gas, Coal
Glassware	Coal – 7.7 mn tonnes(Assuming specific energy 8360 KJ per kg for Indian coal)	40%	27.7 bn	Coal, Natural, Gas.
Cement Plants	Coal – 40 mn tonnes Electricity – 11.44 bn units	45%	195.5 bn	State electricity, Coal

	Total Energy Consumption			Major Source of Energy
Paper Industry	Coal – 84 mn tonnes State Electricity - 16.80 bn units	25%– 30%	381.6 bn	State Electricity, Coal

Source: Cluster study of the identified sub-sectors
*This does not include readymade garments as the data is not available.
Assumptions: (i) Coal @₹ 4 per kg (ii) Cost per unit electricity- ₹ 5, (iv) price of 12% ash coke – ₹ 20 per kg

3.4 Environmental issues in sub-sectors

3.4.1 The environmental degradation of the selected sub-sectors is either in the form of air pollution, water pollution or soil contamination (solid waste). The paper industry and the mini cement plants contribute 161 and 192.5 million tonnes of CO_2 per annum, respectively.

3.4.2 Maximum waste water is discharged by the paper sector which is 2.35 mn m^3 followed by textiles and leather which is 58 mn and 24 mn m^3, respectively. Electroplating is the most hazardous water polluting cluster followed by dyes and chemicals clusters. Solid waste is largely generated in the paper clusters in India. Table 3.3 provides the estimated pollution figures based on the sub-sector studies provided in Section B of the report.

Table 3.3: Environmental issues in clusters of identified sub-sectors

Sub-sectors	Estimated Air Pollution	Estimated Water Pollution	Estimated Solid Pollution
Foundry	CO_2 – 2.36 mn tonnes	NA	NA
Sponge Iron	CO_2- 32.1 mn tonnes	NA	NA
Leather Tanning	NA	24 mn m^3 per annum	NA
Textiles	NA	NA	NA
Dyes and Chemicals*		NA	NA
Electroplating	Air pollution emitted is 15.30 bn metre cube of harmful gases per year.	Water discharged with toxins is 0.36 mn m^3 per year.	Solid waste (toxic) generated is 365 tonnes in a year.
Brick Kilns	59.1 mn tonnes of CO_2 is emitted per annum	NA	NA
Ceramics*	NA	NA	NA

Sub-sectors	Estimated Air Pollution	Estimated Water Pollution	Estimated Solid Pollution
Glassware	MSMEs produce around 648 tonnes per annum of PM The CO_2 emission was 0.8 mn tonnes.	NA	NA
Cement Plants	CO_2 emitted was 192.5 mn tonnes	NA	NA
Paper Industry	CO_2 emitted was 161 mn tonnes per year	Waste water generated was 2354.7 mn m^3 in the year 2008-09.	14.2 mn tonnes of solid waste is generated per annum

Source: Cluster study of the identified sub-sectors
* The textiles, dyes and chemicals and ceramic tile-making sub-sectors are also highly polluting, but given the limitation of the study, i.e., secondary analysis, appropriate data for calculating the emission and solid waste generation was not feasible.

3.5 Social issues in sub-sectors

3.5.1 Occupational Health and Safety (OHS) is the main social concern that prevails in the identified 11 sub-sectors, which includes exposure to harmful gases, heat, obnoxious smell, hot water, molten metal and unhygienic working environment leading to various diseases like skin irritations, weakening of eye sight, lung congestion, body ache and various other health problems. Apart from OHS, some of the other issues that are prevalent in a few of the selected sub-sectors are child labour, low wages to labour, undefined working hours, lack of labour security in terms of insurance, pension and others.

Table 3.4: Social issues prevalent in clusters of identified sub-sectors

Sub-sectors	Most Significant
Foundry	Contact with hot metal or hot water resulting in severe burns as the workers are not properly guarded The workers wear loose garments to work and some are also bare-chested, which is a safety hazard. The workers are not aware of the safety measures that need to be followed at work.
Sponge Iron	Heavy metals which are released into the air from the sponge iron plants are highly toxic and increase the risk of cancer. Air pollution has a great impact on plant and vegetation as well, particularly pollutants like sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and particulate matter are the primary pollutants
Leather Tanning	Workers are exposed to disease agents such as bacteria, fungi, mites and parasites which are present in the hide or as part of the manufacturing process. Some allergic reactions develop due to these diseases agents Obnoxious smells come from the hide and skins which makes breathing difficult for workers Child labour is said to be employed in the tanneries.
Textiles	The exposure of workers to dust from material such as silk, cotton, wool, flax, hemp, sisal and jute which occur during weaving, spinning, cutting, ginning and packaging, cause nasal or bladder cancer Manual handling, lifting, holding, putting down, pushing, pulling, carrying or movement of a load is the largest cause of injury in the textiles sector In some of the units, child labour is also said to be employed.
Dyes and Chemicals	Depletion of groundwater due to large volumes of water usage in the process of dyeing resulting in water-related problems in the community. Contamination of groundwater due to wastewater discharge into the ground leads to health-related problems. Since the workers are working with different dye colours, it is usually found that their skin colour changes to the colour of the dyes
Electroplating	The workers are exposed routinely and persistently to pollutants in the environment of the electroplating unit and suffer from various health problems. The employed labourers are mostly illiterate and are not aware of the safety procedures or the impact of pollutants on their health In some of the units, women labour is also employed.
Brick Kilns	The major social issue is related to occupational health and safety of the workers In the brick kilns industry, child labour and bonded labour is the problem

Sub-sectors	Most Significant
Ceramics	The main occupational hazard is the exposure to fine airborne particulates in the form of silica dust (SiO_2), deriving from silica sands and feldspar in the workplace. Exposure to heat during operation and maintenance of furnaces or other hot equipment results in severe burns.
Glassware	The workers are exposed to heat, dust and noise pollution Low wages is another social issue of the glassware industry.
Cement Plants	The workers are exposed to fine particulates of dust, heat, noise and vibration The workers are also exposed to unhealthy practices like lifting of heavy weights and over-exertion in the polluted environment
Paper Industry	The workers are exposed to air pollution.

Source: Cluster study of the identified sub-sectors.

3.6 Addressing the identified BR issues

3.6.1 Various institutions, both public and private, have taken strides towards addressing the environmental and social issues that have been identified in the study. For example, in the foundry sub-sector sector, around 28 clusters have been identified of which 14 are supported under any schemes or programmes on cluster development. However, one needs to ponder on the fact that given the number of existing clusters, there exist a tremendous scope and scale of intervention to address the environmental and social issues.

3.6.2 Moreover, there exist various governmental support schemes of 'social sector ministries' dealing with environment, women and child, non-formal education, social justice and empowerment, etc., that can be applied in clusters to address the environmental and social issues prevalent in the cluster. An illustration of some of the schemes that could support BR initiatives in clusters is noted below.

- Special Health Scheme for Rural Areas (NRHM) under the aegis of the Ministry of Health and Family Welfare promotes outreach services in rural and high density urban slum populations of the country. Financial assistance is available to voluntary organisations for encouraging them to set up new hospitals/dispensaries in rural areas or to expand and improve the existing hospital facilities. In association with local NGOs, clusters located in rural areas can work towards providing a better access to health care by utilising the assistance under the scheme. This can lead to economic payoffs to cluster firms by way of reducing the incidence of absenteeism.
- Industrial Pollution Abatement through Preventive Strategies under the aegis of the Ministry of Forest and Environment provide assistance to SMEs who do not have access

to the requisite technical expertise. The assistance is towards building capacities of SMEs to tackle pollution-related issues. This can lead to economic pay-offs to cluster firms by way of reduction in process wastage and potential for recycling.

- Scheme of Support to Voluntary Agencies for Adult Education and Skill Development under the aegis of the Department of Elementary Education & Literacy and the Department of Secondary & Higher Education helps improve the occupational skills and technical knowledge of the neo-literates and trainees and to raise their efficiency and increase their productive ability. This can lead to economic pay-offs to cluster firms by way of a better supply of skilled personnel.

The list of relevant social sector schemes that are applicable in MSME clusters are provided in Annex 1.

CHAPTER A4

Way forward

4.1 MSMEs in India are economically significant and play a pivotal role in the social development of the country in terms of development of backward areas, large-scale employment, touch upon the lives of most vulnerable and marginalised such as women, backward communities, minorities, etc. However, in terms of business responsibility, the incidence of consumption of fossil fuel, environmental degradation and social issues like child labour, OHS, etc., are similarly significant in MSMEs and need attention both at the policy and implementation levels. The government along with the support of the private sector have to play a pivotal role in addressing the energy, environmental and social issues that are prevalent in the clusters since, at times, addressing these issues require investment that is beyond the capacity of MSMEs, no direct impact on profit and the gestation period is high.

4.2 This chapter attempts to provide some actionable agenda for policy makers, the private sector and other knowledge-based institutions that have a role to play in addressing the business responsibility issue in MSMEs. The following actionable steps need to be taken at the policy level to engage MSMEs in fostering development covering environmental and social dimensions.

- *Putting in place a proper management structure:* Business responsibility (BR) is unique and does not fall under the ambit of any particular sector or theme. Therefore, at the policy level, BR issues should to be tackled by all the relevant ministries through inter-ministerial cooperation, wherein an apex committee/ body should be created. The apex committee/ platform should comprise of representatives from all the relevant ministries, with the Ministry of Corporate Affairs or Ministry of MSME as the facilitator wherein information and knowledge related to BR will be shared and discussed. The purpose of the apex committee/ body is to provide a platform wherein representatives from the various ministries can discuss their concerns, share their experiences, facilitate cross learning and provide solutions to the BR issues addressed.
- *Mapping of clusters:* In India it has been estimated that there are around 6,500 clusters. However, the status of the identified clusters in terms of environmental degradation, energy consumption and incidence of social issues is not mapped. The clusters that significantly contribute towards environment degradation or have high incidence of social issues like child labour or gender inequality, need to be identified and ranked based on the degree of incidence of such BR issues. This ranking of clusters will be done based on a set of selected parameters like volume of coal consumed as a percentage of total production, male to female labour ratio, water pollutant present in the water discharged, etc.

- *Selection of cluster for intervention:* Every government programme/ scheme has a unique objective, target group and volume of financial support. On the basis of the objectives of the support programme/ scheme and ranking of the clusters based on BR issues, the typology of clusters to be intervened needs to be selected.

  Similarly, decisions on the selection of clusters for intervention can be taken based on the available financial resources and time period of intervention.

- *Implementation of support schemes/programmes:* Implementation at the cluster level should be coordinated by the implementing agency appointed by the state government/ Central government in consultation with the local government. For the selection of the implementing agency, the state/ Central government should be equipped with the list of technical institutes or organisations that have worked with the clusters to address the various BR issues. For implementation, a network should be created at the cluster level that comprise of technical institutes, various R&D institutes, educational institutes, NGOs and sector specialists for identification of the pressure points in the cluster, draw the action plan and accordingly implement at the cluster level.

- *Monitoring and evaluation (M&E):* Monitoring systems should be in place at all levels. At the cluster level, day-to-day monitoring of the output will be done by the implementing agency and reported to the local government. The local government will monitor the outcome and the overall monitoring and evaluation is to be done by the state/Central government. The state/ Central government will monitor the support programme in terms of the number of clusters supported, financial disbursement, impact of the support, etc. Since dovetailing BR agenda with competitiveness is an emerging phenomenon, it is important to put in place a system that provides constant learning and inputs to policy makers.

- *Disclosure of BR issues and incentive for such initiative:* It has been observed that the BR issues are addressed by MSMEs when there is buyer pressure or regulatory and judicial pressure, i.e., when there is a threat or external pressure. The other approach should be to encourage the clusters through incentivising them for addressing such BR issues in the form of financial loan at a lower interest rate, grant support, etc. Steps should also be taken for disclosure of BR issues.

- *National Voluntary Guideline (NVG):* The MSMEs should be made aware of the benefits of following the National Voluntary Guideline (NVG). A proper awareness programme on NVG should be conducted for MSMEs wherein the process and benefits of following the National Voluntary Guidelines will be imparted.

- *Role of cluster associations:* Cluster associations can play a pivotal role in the growth and development of the clusters. To address the BR issues existing in clusters, associations can play multiple roles as illustrated below:

  a) Identification of support scheme/ programme available to address the specific BR issue that is prevalent in the cluster and implement such schemes/ programmes in the cluster.

  b) Identification and linking of proper BDS providers to address the BR issue.

c) Facilitate creation of network of BDS providers, R&D institute, educational institute and other related organisation.

However, the government have to take a step towards capacitating the cluster associations through introducing programmes/ schemes for training of Business Membership Organisation (BMO) office bearers and executives and handhold them to draw up their business plan and implementation.

- *Cluster Development Agent for cluster intervention:* For addressing BR issues, especially environmental issues that require technical inputs, it is imperative that instead of an individual Cluster Development Agent (CDA), a team is constituted comprising of individuals having experience in identifying and addressing energy issues, environment issues and social issues. CDAs will have to be trained through specially designed training programmes that will help him/ her diagnose BR issues better and then design interventions accordingly. Moreover, the cluster key stakeholders should also be trained in the area of BR as this would bring both the implementer and the beneficiary at the same level of understanding and the need to address such issues.
- *Revisiting developmental schemes:* Developmental schemes should be audited by the respective ministries themselves to understand the magnitude of the BR issues addressed and accordingly either revise the existing scheme or design to a new scheme as per the requirement.
- *Inclusion of MSMEs under PAT scheme:* MSMEs also contribute significantly to energy consumption given the traditional method of manufacturing, wherein the per unit cost of fuel consumption is more in comparison to large companies. Therefore the Perform, Achieve and Trade (PAT) scheme should also include MSMEs. Moreover, the scheme should be implementable at the group level as well, like clusters, special economic zones, cooperatives, etc.

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Section – B

CHAPTER B1

Foundry

1.1 Economic significance

1.1.1 The impetus of the Foundry sector in India was provided by machinery manufacturing for the jute industry in Bengal and the cotton textiles machine industry in Bombay in the late 19th century. The establishment of TISCO, Bengal Iron Company and IISCO led to a remarkable use of castings in both domestic and industrial areas. A foundry is a factorywhich produces metal castings from either ferrous or non-ferrous alloys.

The typology of products produced under this sector is:

- Automotive/oil engines/diesel engines
- Pumps/valves/fans
- Electric motors
- Machine tools/machine parts
- Tractors parts /agricultural implements/chaff cutters
- Food processing industry/sugar industry
- Textile machinery
- Others

1.2 Geographical concentration of foundry sub-sector

1.2.1 The foundry units in India are mostly located in clusters; notable among them are Howrah, Rajkot, Agra, Jamnagar, Belgaum, Kolhapur, Coimbatore and Hyderabad. Foundry units are concentrated in the states of West Bengal, Gujarat, Haryana, Maharashtra, Punjab, Tamil Nadu, Karnataka, Andhra Pradesh and Jharkhand. The concentration of foundries is correlated to the spread of engineering and automobile industries.

1.2.2 Typically, each foundry cluster is known for catering to some specific end-use markets. For example, the Coimbatore cluster is famous for pump-sets castings, the Kolhapur and Belgaum clusters for automotive castings and the Rajkot cluster for diesel engine castings. The number of units range from 100 to 700 at different foundry cluster. The foundry produces a wide variety of castings used in the automobile industry, flour mill parts and components, electric motors, manhole covers, oil engines, pump sets, sanitary items, pipe and pipe fittings, sugar machinery, etc. Table 1.1 provides the list of significant clusters (clusters with registered units), number of units, production and the typology of products manufactured in each cluster.

Table: 1.1 Spread of foundry sub-sector in India

Name of Cluster	Total Unit	Approx. Production (tonnes/ annum)	Typology of Products
North			
Registered			
Jalandhar	350	240,000	Agricultural implements, machine tools
Agra	125	315,000	Generator set parts, engine parts and agricultural implements
Batala	200	150,000	Agricultural implements, machine tools
Faridabad	140	204,000	Auto components, agricultural implements
Samalkha	30	36,000	Chaff cutters, auto components, manhole covers, oil engines, pump sets, sugar/textile machinery
Kaithal – Narwana	25	25,000	Centrifugal pumps, agricultural implements
Goraya	30	45,000	Chaff cutters.
Jaipur	96	100,000	Agricultural implements and machinery, sanitary fittings special water pumps and CID joints, civil machine stands, ceiling fan bodies, flour mills, granite and marble cutting and polishing machine, railway inserts, transmission hardware, automobile components, etc.
Others (Panipat, Karnal, Mandi Gobindgarh, Bahalgarh, Gurgaon, Bahadurgarh, Rohtak etc.)	100	72,000	-
Unregistered units in North	250	180,000	Producing low-end products.
Total (North)	1,346	1,367,000	

Name of Cluster	Total Unit	Approx. Production (tonnes/ annum)	Typology of Products
West			
Ahmedabad	250	300,000	Pumps and pump parts and auto components.
Rajkot	400	250,000	Auto components, textile machinery, machine tools, diesel engines.
Pune	100	370,000	OEM Auto components.
Kolhapur	300	200,000	Auto components, pumps.
Baroda	70	135,000	
Others (Mumbai, Nagpur, Aurangabad, Kirloskarvadi, Indore, etc.)	530	1,026,020	-
Unregistered units in West	430	309,600	
Total (West)	2,080	2,590,620	
East			
Howrah	300	1,200,000	Manhole covers, sanitary fittings
Others (Kharagpur, Uttarpara, Liluah etc.)	249	482,036	-
Unregistered units in East	370	266,400	
Total (East)	919	1,948,436	
South			
Belgaum	250	360,000	Auto components, pumps, machine tools
Chennai	105	250,000	
Coimbatore	400	372,000	Pumps and pump parts, textile machinery
Others (Hyderabad, Bangalore, Shimoga, Mysore, Dindigul, Nallore, etc.)	500	967,944	-
Unregistered units in South	450	324,000	
Total (South)	1,705	2,273,944	
Total India	6,050	8,180,000	

Source: IIF, New Delhi and primary survey.
*Others include clusters like Hyderabad, Bangalore, Nagpur, Mumbai, Jaipur, etc., geographically spread across the southern, eastern and western parts of the country.

1.2.3 India ranks second in the world based on the number of foundry units present (4,550 units) – after China – and fourth in terms of total production (7.8 mn tonnes) (42nd Census of World Casting Production, 2007). Apart from the 4,550 registered units, there are several unregistered units which, according to various sources, range approximately from 1,500 to 5,000 units. According to the IREDA-CII Report[14] 2004, there are around 10,000 foundry units present in India, including registered and unregistered units. Considering that 4,550 units are registered, the total number of unregistered units is around 5,450 units. According to the estimation of experts in the foundry sector, there are around 1,500 unregistered foundry units that are scattered across the country. This discrepancy in unregistered units is mainly due to the fact that the 5,450 units include all kinds of micro and small units engaged in castings. Whereas data of the 1,500 units incorporates only those foundry units that are engaged in grey iron casting and use conventional cupola, it excludes those units that are too micro in nature and use crucibles for melting of metals. Also, several foundry units had closed down due to non-compliance with the pollution standards set by the government, for example in Howrah, Agra and nearby areas. Of the total foundry units present, 90 per cent are small and micro units. Most of these units are situated in clusters, with the cluster size ranging from 30 to 500 units.

1.2.4 Similarly, discrepancies exist in total production figures where, as per the 42nd Census of World Casting Production–2007, there are 4,550 units producing 7.8 mn tonnes of castings whereas according to the Indian Institute of Foundrymen (IIF) data, there are 4,550 units producing 7.1 mn tonnes of casting. In our study, we will consider the data provided by IIF. Considering there are 1,500 unregistered units producing grey iron castings, the total production capacity of the unregistered unit is 1.1 mn tonnes per annum. Therefore, the total casting production in India, including both registered and unregistered units, is 8.2 mn tonnes. The industry is labour intensive and employs around 0.5 mn people directly and around 0.15 mn indirectly. The labour intensity depends on the size of the firm, which is inversely related. The small units mostly depend on manual labour in comparison to medium and large units that are semi or fully mechanised. The export of castings from India was worth ₹ 87,291.6 mn for the financial year 2010–11. These exports are mainly to the USA and European countries.

1.2.5 Of the total number of registered units, 800 units are engaged in the production of non-ferrous alloy, 700 units are engaged in steel castings and the rest (around 3,050) are engaged to grey iron casting. The total production of castings of these units is approximately 7.1 mn tonnes per annum. Of the total production of registered castings, 72 per cent are grey iron, 10 per cent steel casting, 10 per cent SG iron and 8 per cent non-ferrous castings.

1.3 Production process

A typical foundry process includes the following activities: melting and metal treatment in the melting shop; preparation of moulds and cores in the moulding shop, casting of molten metal into the mould, cooling for solidification, and removing the casting from moulds in the casting shop; and finishing of raw casting in the finishing shop, as shown in Figure 1.1.

14 Indian Renewable Energy Development Agency Limited (IREDA) and Confederation of Indian Industry (CII), 2004.

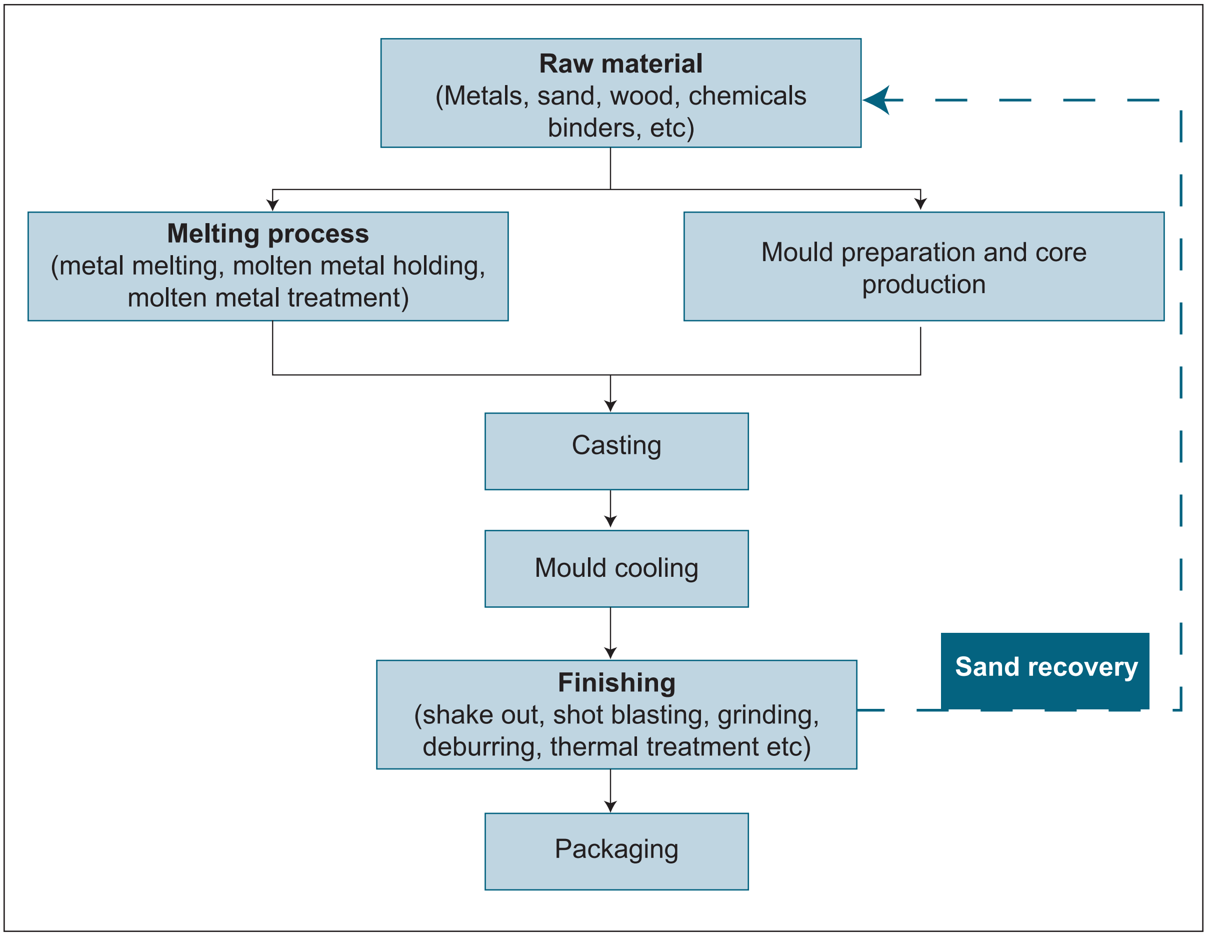

Figure 1.1: Process flow diagram of foundry sub-sector

1.4 Energy intensity in Indian foundries

1.4.1 The foundry industry of India is highly energy intensive and accounts for almost 25 per cent[15] of the manufacturing cost. It has been estimated that the total energy cost in the Indian foundry industry is around ₹ 40,500 mn. In the foundry production process, the energy consumption pattern differs at the various stages of production and the maximum energy is consumed in the process of melting of metals. To understand the energy intensity of the foundry sector, it is important to understand the production process.

1.4.2 Melting of metal in cupola furnaces is the most energy intensive operation in a foundry unit. Table 1.2 provides an estimate of the distribution of energy consumption in the foundry process.

15 IREDA Report

Table 1.2: Distribution of energy consumption

Sections	Energy Consumption (%)
1. Melting	70
2. Moulding and core making	10
3. Sand plant	6
4. Lighting	5
5. Compressor	5
6. Other	4

Source: Arasu & Jeffrey, 2009, Indian Foundry Congress.

1.4.3 The energy consumption pattern in Indian foundries varies according to the size of the unit, i.e., for medium and large-scale units, the major energy usage is electrical energy used for induction and arc furnaces whereas in small and micro units, coke is used for melting metal in the cupola furnace. Most of the small and micro foundry units are family owned and managed and the awareness level on energy conservation is very limited. The production processes of these small units are highly energy inefficient and have a large potential, in the range of 25–65 per cent, to save energy through adoption of an improved cupola design. Coke is the main source of energy in cupola furnaces and its energy efficiency is measured in terms of the amount of metal charged/ molten metal produced by one tonne of charged coke. In a cold blast cupola furnace for molten metal, the temperature in the range of 1,380–1,410°C the coke consumption is about 150–200 kg/ MT of molten metal. This is known as CFR or coke feed ratio and is denoted either by a ratio or as a percentage. The lower the CFR, the more efficient is the cupola. It has been generally observed in the case of conventional cupola that the CFR ranges from 1:4 to 1:6 and in case of divide blast cupola (DBC) the range is from 1:8 to 1:10 based on the field experience in foundries clusters like Samalkha, Faridabad, Batala, etc. However, energy audits conducted by TERI in 1993–94 in representative units in Agra foundry cluster reveal that the CFR ranges from 1:3.2 in conventional cupolas and 1:5.3 in DBC.[16]

1.4.4 Power consumption in induction melting furnaces of 12–15 tonne capacity is in the range of 625–650 kWh/ tonne of metal (cast iron) melted and 1–3 tonnes is in the range of 700–725 kWh/ tonne of metal melted. In induction furnaces, electric loss consist of losses in transformer, frequency converter, capacitor banks cable and coil losses and heat losses from the furnace wall to the coil side (carried away by cooling water), radiation from melt surface and from slag removal. The efficiency of medium frequency furnaces (operating efficiency in the range of 55–60 per cent) is higher compared to main frequency furnaces (operating efficiency in the range of 45–50 per cent).[17]

16 TERI, 1993-04, Towards Cleaner Technologies
17 IREDA Report

1.4.5 The type of furnaces used for melting of metal varies according to the type of castings produced in the foundry. Table 1.3 provides the types of furnaces used for various types of castings.

Table 1.3: Production of different castings

Typology of casting	Production (tones)	Type of furnace
Grey Iron	5,112,000	Cupola/ Electric arc furnace
Steel Casting	710,000	Electric arc furnace
SG Iron	710,000	Electric arc furnace
Non-ferrous	568,000	Crucibles/ furnace
Total	7,100,000	

Source: On the basis of discussions with the experts

1.4.6 Of the types of furnaces listed, cupola is most polluting in comparison to the other types of furnaces. Coke is mainly used for cupola furnaces. Depending on the ash content in the coke, it is classified into two types—coke with 12 per cent ash content and coke with 24 per cent ash content. Most foundry clusters in the southern and western regions of the country use coke with 12 per cent ash content whereas clusters in the northern and eastern regions use coke with 24 per cent ash content or a mix of both (depending on the type of casting). However, in some units using conventional cupola, the type of energy used for melting metal is oil.

1.4.7 It has been estimated that of the total grey iron castings in the registered units, 75 per cent castings are done by using conventional cupolas and the remaining 25 per cent use other types of furnaces for melting of metals. Thus, the total casting production using cupolas is estimated to be around 3.834 mn tonnes per annum. Apart from the registered units, there are around 1,500 unregistered units operating in different parts of India. Estimation reveals the production capacities of these units are around 720 tonnes per unit per annum. Therefore, the total production of the unregistered units amounts to around 1.08 mn tonnes per annum. As revealed by experts, the unregistered units are engaged in the production of grey iron casting using conventional cupola furnaces. Therefore, considering both registered and unregistered units, the total production of grey iron using conventional cupola is approximately 4.91 tonnes per annum.

1.4.8 In Agra, there are around 125 units producing 0.315 mn tonnes of casting per annum and the energy utilised for casting is oil. As the main focus of our study is on the reduction of coke consumption, we are excluding the production of castings done in Agra from the total castings production using conventional cupolas. Therefore, the total production of castings in India using conventional cupolas and coke as energy is approximately 4.59 mn tonnes per annum. Now, considering the two types of coke used for melting of metals in conventional cupolas, there may arise two possible cases, as illustrated below.

Case 1: Using cold blast cupola with coke having 24 per cent ash content.

In case coke with 24 per cent ash content is used, the coke feed ratio (CFR) is 1:5.[18] Now, considering that all the casting production of 4.59 mn tonnes per annum is done with this type of coke, the coke consumption will amount to 0.92 mn tonnes per annum. If a cupola is upgraded to DBC (CFR 1:7) then the total coke consumption will be 0.65 mn tonnes per annum. This will result in saving of approximately 0.26 mn tonnes of coke per annum (28.6 per cent) and production costs will be reduced by ₹ 3,547.8 mn per annum. Therefore, the equivalent carbon emission[19] reduction will be 0.65 mn tonnes of CER.

Case 2: Using cold blast cupola with coke having 12 per cent ash content.

In case coke with 12 per cent ash content is used, the coke feed ratio is 1:7. Now, considering that all the casting production of 4.59 mn tonnes per annum is done with this type of coke, the coke consumption will amount to 0.65 mn tonnes per annum. If the cupola is upgraded to DBC (CFR 1:9.5) then the coke consumption will be 0.48 mn tonnes per annum. The estimated value of energy consumption will be ₹ 4.8 bn {(0.0484*10000)}. Approximately 0.172 mn tonnes (26.3 per cent) of coke will be saved and the production cost reduced by ₹ 2,333.7 mn. Therefore, the equivalent carbon emission reduction is 0.432 mn tonnes of CER.

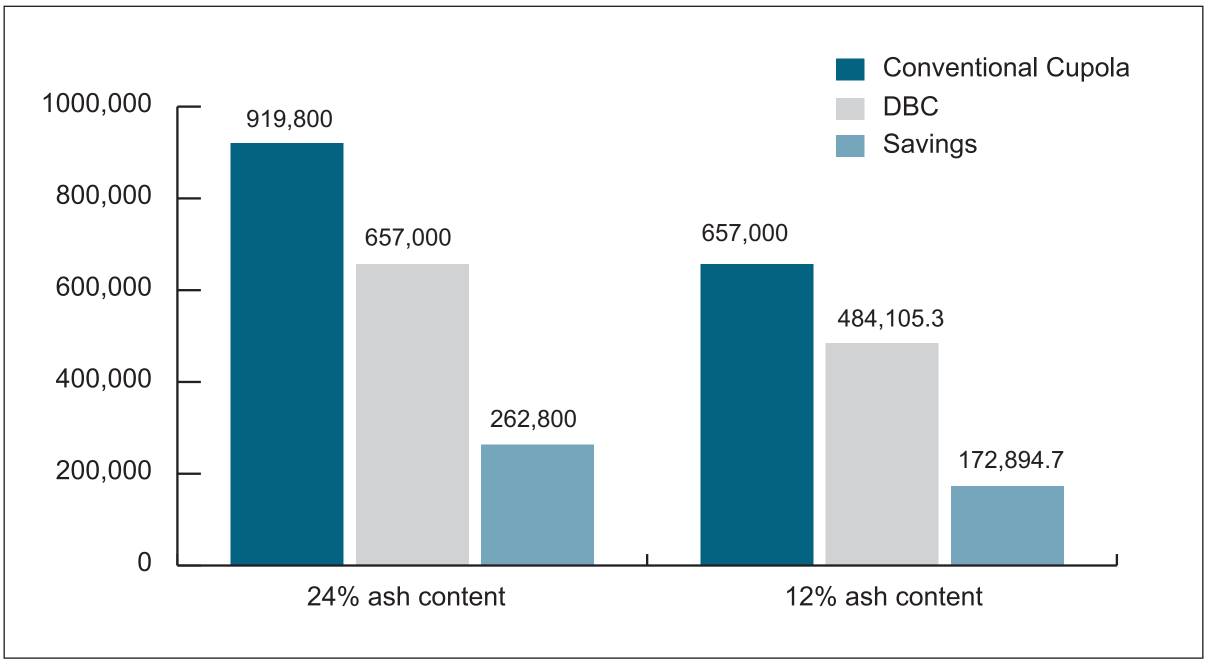

Figure 1.2: Coke consumption in conventional cupola and DBC with coke having 24% and 12% ash content

Source: On the basis of above estimations

18 Inferred from field experience and discussion with foundry experts.

19 Carbon emission is calculated on the basis of carbon content in CO_2, 1:3.6. Now considering other ingredients like ash 24%, sulphur 3% and moisture 6% approximately, the ratio is revised to 1:2.5.

1.5 Environmental issues in Indian foundries

Foundry has been listed under the “Red Category” industries on the basis of its emissions/discharges of high/significant polluting potential or generating hazardous wastes. The Central Pollution Control Board (CPCB) has set a standard for industry-specific emission norms both for effluents and emissions. In the case of the foundry industry, the standard is set for emissions, which is given in the Table 1.4.

Table 1.4: Emission standards for foundries

Typology of furnace	Pollutant	Concentration (mg/Nm^3)
Cupola Capacity (melting rate): Less than 3 tonne/hr	particulate matter	450
Cupola Capacity (melting rate): 3 tonne/hr & above	particulate matter	150
Arc Furnaces Capacity: All sizes	particulate matter	150
Induction Furnaces Capacity: All sizes	particulate matter	150

Note: (i) It is essential that a stack is constructed over the cupola beyond the charging door and the emissions are directed through the stack which should be at least six times the diameter of the cupola.
(ii) In respect of arc and induction furnaces, provision has to be made for collecting the metal fumes before discharging through the stack.

Source: (CPCB)

The environmental issues associated with this sector primarily include the following:

- Air emissions
- Solid waste
- Wastewater

Table 1.5: Environmental issues prevalent in the foundry sub-sector

	Environmental Issues
1.	Air Emission
(i)	*Dust and particulate matters:* These are generated at each step of the production process with varying levels of mineral oxides, metals and metal oxides. These also arise from thermal (e.g., melting furnaces) and chemical/ physical processes (e.g., moulding and core production), and mechanical actions (e.g., handling of raw materials, mainly sand, and shaking out and finishing processes). In the melting process, particulate matters (PM) are emitted, varying according to the type of furnace used. Cupola furnaces produce the most significant amount of PM. In an electric furnace, PM is emitted during charging at the beginning of melting, during oxygen injection, and during the decarburising phases. Lower emission rates are associated with other types of melting furnaces, particularly induction furnaces. Dust and fumes are also generated when metal is poured into moulds and during mould cooling, punch out and shake out, hot sand cleaning, casting cleaning and sand handling.
(ii)	*Nitrogen Oxide:* These emissions are caused by high furnace temperatures and the oxidation of nitrogen.
(iii)	*Sulphur Oxides:* These emissions are generated from waste gases in cupola furnaces. Other sources of emission include gas hardening processes in mould- and core-making with chemically bonded sand, and in magnesium (Mg) melting.
(iv)	*Carbon Monoxide (CO):* This gas is generated from cupola furnaces and electric arc furnaces (EAFs). This is due to the cupola process itself. In EAFs, CO is generated from the oxidation of the graphite electrodes and the carbon from the metal bath during the smelting and refining phases. CO is also emitted when sand moulds and cores come into contact with the molten metal during metal pouring activities.
(v)	*Chlorides and fluorides:* These exist in small quantities in waste gases from melting furnaces and are generated from flux.
(vi)	*Volatile Organic Compounds (VOCs):* Mainly consisting of solvents (e.g., BTEX – benzene, toluene, ethyl benzene, and xylenes) and other organic compounds (e.g., phenols and formaldehyde), these are primarily generated by the use of resins, organic solvents, or organic based coatings in moulding and core making. Organic hazardous air pollutant (HAP) emissions may also be released during the pouring, cooling, and shakeout of either green sand or no bake moulds resulting from the thermal decomposition of organic compounds (carbonaceous additives contained in green sand moulds and different core binders) during metal pouring.
(vii)	*Metals:* Such emissions are caused by the volitisation and condensation of metals when pouring molten metal into moulds. The presence of metal in particulate emissions can be especially significant during alloying activities and during the introduction of additives.
(viii)	*Greenhouse Gases (GHGs):* The foundry process is energy intensive and a significant emitter of carbon dioxide (CO_2), primarily associated with fuel combustion. The total amount of GHG emitted is 2.36 mn tonnes (assuming: 24% ash, 6% moisture, 70% coke)

	Environmental Issues
2.	**Solid Waste**
(i)	*Sand Waste:* Sand waste from foundries using sand moulds is a significant waste in terms of its volume. Moulding and core sand make up 65 to 80 per cent of the total waste from ferrous foundries. Sand that is chemically bound to make cores or shell moulds is more difficult to reuse effectively and may be removed as waste after a single use.
(ii)	*Slag Waste:* Slag waste often has a complex chemical composition and contains a variety of contaminants from scrap metals. Common slag components include metal oxides, melted refractories, sand, and coke ash (if coke is used). Slag may be hazardous if it contains lead, cadmium, or chromium from steel or non-ferrous metals melting.
(iii)	*Other Solid Waste:* Solid waste is generated from storage areas of sand, carbon powder, coke and other additives used in foundries. Wooden chip and dust are released in the pattern shop.
3.	**Waste Water**
	The most significant use of water in foundries is in the cooling systems of electric furnaces (induction or arc), cupola furnaces, and in wet de-dusting systems. In high-pressure die casting, a wastewater stream is formed, which needs treatment to remove organic (e.g., phenol, oil) compounds before discharge. Wastewater containing metals and suspended solids may be generated if the mould is cooled with water. Wastewater with suspended and dissolved solids and low pH may also be generated if soluble salt cores are used. Wastewater may be generated by certain finishing operations such as quenching and deburring, and may contain high levels of oil and suspended solids.

1.6 Social issues in Indian foundries

1.6.1 The social issues pertaining to the foundry industry are mainly related to occupational health and safety issues due to the typical characteristic of the industry which demands handling of heavy and hot material, exposure to radiation and unhealthy gases, noise from various sources, and so on. Some of the more serious issues are:

- In foundries, high temperatures lead to fatigue and dehydration in the workers. There is also the risk of injury from flying fragments or from metal scrap during charging, or in the yard adjacent to the charging machinery. Men handling raw materials should wear protective gloves and boots.
- Direct infra red radiation during the process of melting leads to eye diseases as most workers in foundry units do not use any kind of protective shield for eyes.
- Contact with hot metal or hot water result in severe burns as the workers are not properly guarded.
- Exposure to respiratory hazards due to inhalation of dust and gases that include metallic dust and metallurgical fumes. Cupolas generate large quantities of carbon monoxide, which is a highly poisonous gas. Protective breathing apparatus should be available in case of emergencies.

- Workers wear loose garments to work and some are also bare-chested, which is a safety hazard. They are not aware of the safety measures that need to be followed at work. Proper training of the workers regarding health hazards and safety measures is necessary.
- In many foundries, the charge materials are lifted manually for loading into the cupola. This is not only physically taxing but poses major hazards for workers as they are exposed to heat and high levels of CO_2 at the cupola charging door.
- The units are very poorly lit.
- Cupola repair and refractory lining maintenance workers are susceptible to accidents. The workers generally do not wear the any safety helmets or safety belts when working in the upper portions of the furnaces.
- Exposure to electrical hazards due to the presence of heavy-duty electrical equipment throughout the foundries.
- Handling of liquid metal may expose workers to the risk of explosion, melt run out, and burns, especially when humidity is trapped in enclosed spaces and exposed to molten metal.
- Raw and product material handling (e.g., waste metals, plates, bars), sand compacting, wood-model manufacturing, fettling and finishing may generate high levels of noise.
- Most workers are contract workers and are employed through contractors. These workers therefore do not enjoy the facilities (e.g., leaves, bonus, health facilities, etc.) that permanent workers have.
- Given the typology of work environment prevailing in the foundry units in India, foundry workers are mainly male labourers, except in Coimbatore where female labourers are also present.

1.7 Institutions/associations

Table 1.6 shows the list of institutions and associations in the foundry sub-sector.

Table 1.6: Technical institutions and associations in the foundry sub-sector

Technical Institutions	Financial Institutions	Associations	Government Bodies	Ministries
National: The Energy and Resources Institute (TERI) Petroleum Conservation Research Association (PCRA) National Productivity Council National Metallurgical Laboratory Engineering Export Promotion Council *Regional:* Bengal Engineering & Science University, Shibpur, Howrah, W.B. Jadavpur University, W.B. Central Institute of Tool Design, AP Defence Metallurgical Laboratory, AP National Small Industries Corporation Limited (NSIC) Sree Nidhi Institute of Science and Technology (SNIST) Chaitanya Bharati Institute of Technology (CBIT) A P Productivity Council Belgaum Material Testing Centre Product and Process Development Centre, Agra Field Testing Station National Test House MNIT	State Bank of India Federal Bank, Howrah Branch Indian Overseas Bank, Kadamtala Branch	*National:* The Institute of Indian Foundrymen (head office in Kolkata and IIF chapters in Ahmedabad, Mumbai, Coimbatore, Kolhapur, Delhi and Pune). *Regional:* Howrah Foundry Association Indian Foundry Association Federation of Andhra Pradesh Small Scale Industries Association Belgaum Coal & Coke Association Belgaum SSI Association. The Southern India Engineering Manufacturer's Association (SIEMA) Coimbatore Industrial Infrastructure Association (COINDIA) Rajkot Engineering Association. Foundry Cluster Development Association, Kolkata. (SPV formed under IIUS) Foundry Owners' Association, Rajasthan	Central Pollution Control Board Bureau of Energy Efficiency Punjab State Council for Science and Technology. Bureau of Indian Standards Commissioner of Industries Rajasthan State Industrial & Investment Corporation (RIICO) Rajasthan Chambers of Commerce and Industry	Ministry of Coal Ministry of Power – Bureau of Energy Efficiency Ministry of MSME Ministry of New and Renewable Energy Ministry of Petroleum and Natural Gas

1.8 Cluster interventions

Table 1.7 shows the list of interventions in foundry clusters in India.

Table 1.7: Interventions in foundry clusters in India

Funding Agency/ Donor	Name of Cluster/ places intervened/	Year of Intervention	Type of Intervention	No of units intervened	Implementing Agencies
SDC	Howrah, Agra, Ahmedabad, Belgaum, Coimbatore, Rajkot, Vijaywada, Bangalore, Mangalore, Bhavnagar, Nadiad	Initiated in 1998	Energy saving by converting the cupolas to DBC, technical support in design, fabrication, operation, troubleshooting for adaptation of cleaner technologies.	50	TERI
PCRA	Ahmedabad	2008	A workshop was organised and design, development and demonstration of an 18-inch DBC to be initiated.	4	TERI
PSCST	Punjab, Haryana, Himachal Pradesh, Uttar Pradesh & Andhra Pradesh		Consultancy to 500 cupola furnaces (air pollution control), 25 induction furnaces (air pollution control) and setting up of DST-sponsored demonstration units in Bihar, Tamil Nadu and Jammu & Kashmir for pollution control, process modification and energy conservation. 2 units converted to DBC (Samalkha and Kaithal).	502 (500 soft and 2 hard intervention)	PSCST
SBI	Belgaum		Detailed studies were carried for technology up-gradation, organised technical seminars and training shop floor personnel, under this scheme. ₹ 4.5 mn was given to a testing centre to acquire radiograph equipment.		

Funding Agency/ Donor	Name of Cluster/ places intervened/	Year of Intervention	Type of Intervention	No of units intervened	Implementing Agencies
SIDBI	Belgaum, Andhra Pradesh		Setting up of Belgaum Testing Lab		
Ministry of Science and Technology	Samalkha, Haryana	2008	Changed conventional cupola to DBC and introduced best practices.	Cupola changed in 11 units and soft intervention in another 9 units.	Foundation for MSME Clusters
Ministry of Commerce and Industry, under IIUS Scheme	Howrah, Belgaum, Batala, Coimbatore,	2004 (Belgaum), 2005 (Howrah, Coimbatore), 2009–12 (Batala).	Provided funds for infrastructure development of the foundry clusters in Belgaum and Coimbatore, Foundry Park in Howrah and CFC for foundry technology development in Batala.	12 units to form SPV, Cluster Approach	Infrastructure Development Corporation Limited (IIDC), Govt. of West Bengal, Foundry Cluster Development Association (FCDA), Batala Udyog Limited (yet to be notified), COINDIA
Ministry of MSME under MSECDP Scheme	Hyderabad	1999–2000	Soft	Cluster Approach	IIF, Hyderabad chapter
	Ahmedabad	2005–06 (H) & 2007–08 (S)	Soft & Hard (CFC)	Cluster Approach	GITCO, Ahmedabad/ MSME-DI, Ahmedabad
	Belgaum	2003–04	soft	Cluster Approach	MSME-DI Bangalore Soft
	Agra	2003–04	Hard	Cluster Approach	PPDC, Agra
	Howrah	2007–08	Soft	Cluster Approach	MSME-DI, Kolkata

Source: Individual websites and discussion with cluster experts.

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CHAPTER B2

Sponge iron

2.1 Economic significance

2.1.1 Sponge iron, also called Direct Reduced Iron (DRI), is a metallic product formed by direct reduction of iron ore at temperatures just below the fusion point of iron. The name sponge iron is derived from its porous nature. Recently the use of sponge iron has increased in the manufacture of wrought iron and is used as a substitute for scrap during steel making.

2.1.2 India is the largest producer of sponge iron in the world, accounting almost 30.97 per cent[20] of the global output, i.e., 68.45 mn tonnes. The three main producers in the world are shown in Table 2.1.

Table 2.1: Three top producers of sponge iron in the world

Country	Production (in mn tonnes)
India	21.2
Iran	7.46
Venezuela	6.87

Source: (SIMA)

Figure 2.1 shows the growth trend in the production of sponge iron in India.

20 SIMA

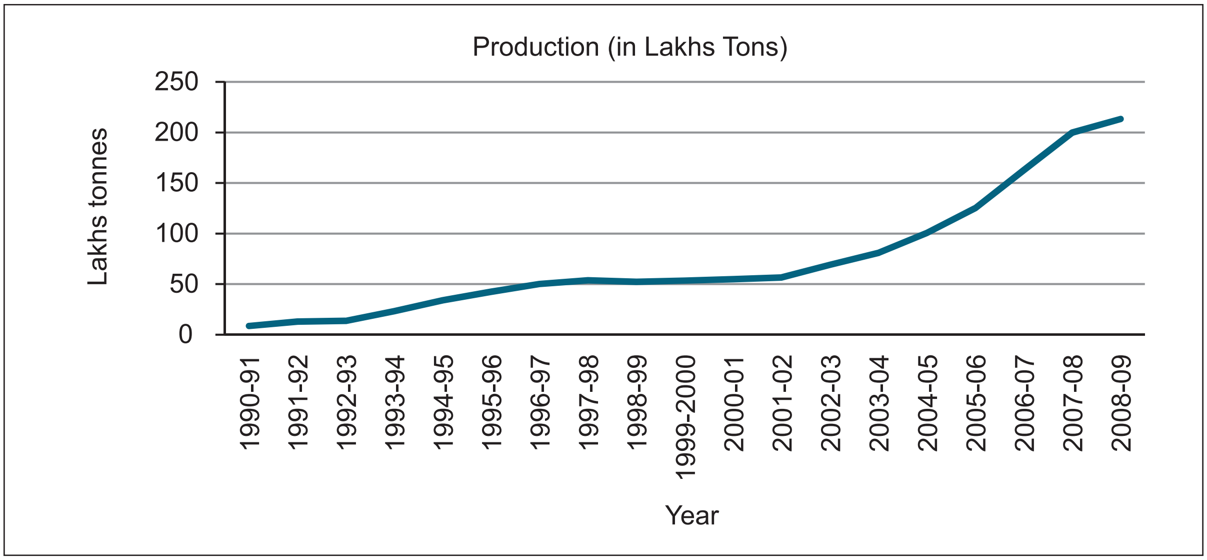

Figure 2.1: Growth trend in production of sponge iron in India

(1 lakh=0.1 million)

Source: SIMA

2.1.3 The DRI production in India in 1990–91 was 0.86 mn tonnes and increased to 5.37 mn tonnes in 1997–98. After rising till 1998, there was a marginal decline in production in 1999–2000 but increased thereafter at the rate of approximately 20–30 per cent. In 2008–09 it reached 21.33 mn tonnes. This sector provides employment to about 0.520 mn[21] people.

2.1.4 While sponge iron is used as a raw material in the steel industry, in some countries iron ore pellets are being used for making steel. In the first quarter of 2008, the sponge iron sub-sector experienced a shortage of pellets and caused disequilibrium in demand and supply. As a result, high demand existed during the first half of the year. Thereafter, as the financial crisis set in, demand levels came down, supplies increased and the prices of many types of raw materials declined. As a result, profit margins in the sponge iron industry declined in the second half of 2008. By the end of year 2008, both demand and prices had dropped and approximately one-third of all DRI capacity became idle, awaiting an economic rebound. This imbalance at the international level impacted the Indian sponge iron industry to a great extent.[22]

2.1.5 The production of sponge iron constitutes two processes: coal based and gas based. In 1992–03 the total production of Indian sponge iron was 1.36 mn tonnes of which production by gas-based units was 0.89 mn tonnes and that of coal-based units was 0.468 mn tonnes. With time the production of gas-based plants declined and that of coal-based units increased.

21 SIMA

22 World Diret Reduction Statistics, 2008, Pg 3

Figure 2.2 shows the comparison of percentage share of gas and coal based units from 1992–93 to 2008–09.

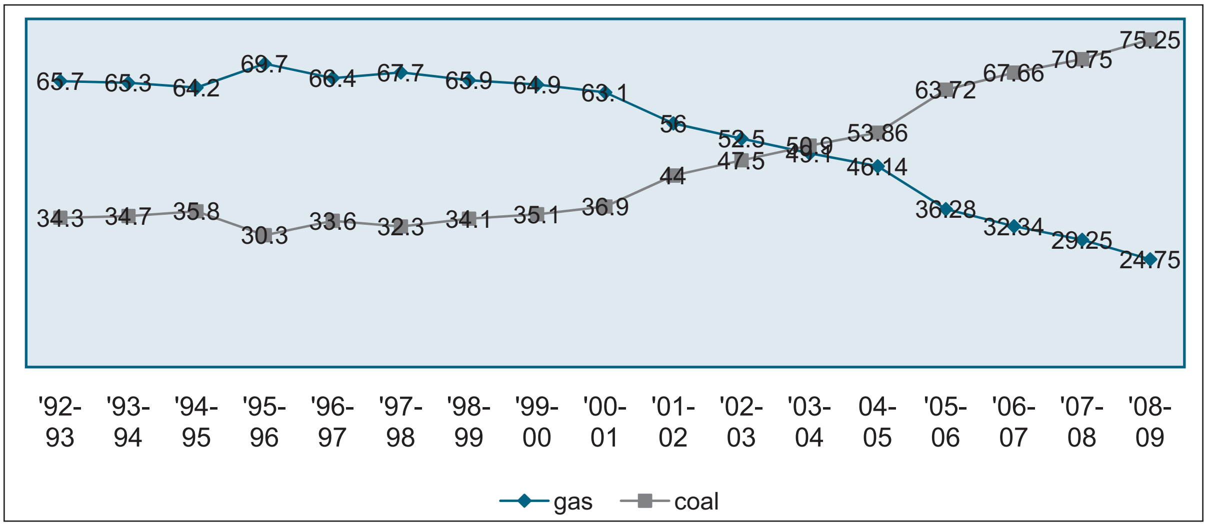

Figure 2.2: Percentage share of gas- and coal-based units, 1992–93

Source: Sponge Iron Manufacturers Association

2.1.6 From the above graph it can be seen that the while the share of gas-based units has been declining since 2000–01 that of coal-based units has been increasing since then. In 2003–04, some parity can be seen where the share of coal-based units was 50.9 per cent while that of gas-based units was 49.1 per cent. There has been a gradual shift from the gas-based process to the coal-based process can be seen from the fact that 49.1 per cent of DRI production in India in year 2003–04 was through the gas-based process as compared to 64.9 per cent in 1999–2000. Table 2.2 shows the increase in DRI production using gas- and coal-based processes. It can be seen that the share of coal-based process has increased at a greater rate (13.49 per cent) as compared to gas based-process, which has actually gone down. The main reason for shifting to the coal-based process from gas-based process is the unavailability of natural gas and coal is largely available at competitive prices. Hence coal-based DRI plants are being set up in large numbers.

Table 2.2: Growth analysis of Indian DRI production

	2007–08	2008–09	Growth (%)
A. Gas Based Production (in mn tonnes)	58.4528	52.802	(-9.66)
B. Coal Based Production (in mn tonnes)	141.424	160.50	13.49
Total (A+B)	199.88	213.302	6.72

Source: Sponge Iron Manufacturers Association (SIMA)

2.1.7 Coal-based units are also facing difficulties in growing further because of lack of mining capability of coal in India, which is the main fuel for the production of sponge iron. As a result, India has to import coal on a regular basis. In 2008, 60 mn tonnes of coal was imported and this is likely to increase every year by 20–25 per cent.

Of the total number of sponge iron units in India, approximately 75 per cent constitute large units while the remaining 25 per cent are medium and small units. However, the share of the top 10 large units in total production is 70 per cent.*[23]

2.1.8 The biggest sponge iron unit in India is M/s. Jindal Sponge Iron Ltd at Raipur. According to the National Steel Policy issued by the Ministry of Steel, India will produce 110 mn tonnes of steel by 2020 so the requirement of sponge iron will be 30 mn tonnes.

2.2 Geographical concentration of sponge iron clusters

2.2.1 There are approximately 355 units[24] all over India which constitutes big as well as small units. The SME units of sponge iron are often clustered at locations where raw material and fuel is available. The clusters are mainly located in Chhattisgarh, Gujarat, Orissa, West Bengal, Karnataka, Goa and Jharkhand, as shown in Table 2.3.

Table 2.3: Spread of sponge iron sub-sector in India

State	Area of Concentration	No. of units	Production Capacity in (mn tonnes /annum)
Chhattisgarh	Raipur	40	52
Chhattisgarh	Bilaspur	7	
Chhattisgarh	Raigarh	20	
Maharashtra	Raigad	2	1.9
Maharashtra	Nagpur	10	0.91
Maharashtra	Kolhapur, Pune, Thane	3	0.05
Orissa	Jharsuguda,	22	7.64
Orissa	Bhubaneswar	16	
Orissa	Keonjhar	23	
Orissa	Rourkela	42	

23 Discussion with Industry experts

24 Discussion with sponge iron experts

* Units with production capacity of minimum 30,000 tonnes per annum (plant and machinery cost ₹ 100 mn are considered as large-scale units). Assumption: Out of 355 units, data of units along with their production capacity is available for only 242 units. Of the remaining units, it is assumed that they are mostly small units, i.e., two-thirds of the balance 113 units.

State	Area of Concentration	No. of units	Production Capacity in (mn tonnes /annum)
West Bengal	West Mednipur	5	3.2
West Bengal	Bankura	11	
West Bengal	Purulia	12	
West Bengal	Burdwan	33	
Jharkhand	Saraia Kela Kharswa	15	1.8
Jharkhand	Giridih	5	
Jharkhand	Ramgarh	10	
Karnataka	Bellary	31	22.46
		10	(data not available)
Karnataka	Koppal	7	
Goa	Goa	7	2.62
Gujarat	Hazira	11	64
Gujarat	Kutch		
Gujarat	Gandhidham		
Gujarat	Surat		
Gujarat	Bhuj		
Gujarat	Vadodra, Gandhidham	2	(data not available)
Andhra Pradesh	Hyderabad	5	0.15
		3	(data not available)
Tamil Nadu	Chennai	4	0.24
	Total	355	301.9 ** (30.19 million tonnes)

** Complete list of all units and the production capacity of some of the known units is not available. Therefore the sum (301.9) is less than the actual total since some of the units are large units which are not considered.

2.2.2 From Table 2.3 it can be seen that there are seven clusters of sponge iron in India namely, Raipur, Raigarh, Jharsuguda, Rourkela, Keonjhar, Burdwan and Bellary with 20 or more units. According to the data on sponge iron production,[25] the total installed capacity in India is 156.97 mn tonnes in 2008–09. Since the total production of sponge iron in India is 21.2 mn tonnes, it is evident that these units are producing at a much lower rate than their production capacity. The total coal consumption by the sponge iron industry in India is 25.68 mn tonnes* and the total

25 SIMA

*As per SIMA estimates, 1.6 tonnes of sponge iron grade non-cooking coal is required to produce 1 tonne of sponge iron.

gas consumption is 1,848,103,600 normal cubic metres (ncm). *(According to SIMA, 350 ncm per tonne of gas is required to produce 1 tonne of sponge iron.)*

The average capacity utilisation of all sponge iron units is 70.72 per cent in 2008.

Table: 2.4 Calculation of total sponge iron production

	Available Data (mn tonnes)	Unavailable Data	Total (mn tonnes)	Calculation	Total Production[26] in mn tonnes
Total Production capacity of all sponge iron units in India	156.97 mn tonnes				
Total production capacity of known units	26.025				
Production capacity of large units	24.09	1.388 mn tonnes	25.478	(1/3*** of 4.165) + 24.09	18.45 (181.5 lakh tonnes)
Production capacity of small units	1.935	2.77 mn tonnes	4.711	(2/3 of 4.165) + 1.935	3.412 (34.12 lakh tonnes)
A-B	130.95				

** Data available for only 242 units out of 355. For the remaining 113 units, information is not available. Of these 113 units, one-third are assumed to be large and two-thirds are small units.
***As per the assumptions taken above

2.3 Production process

2.3.1 The reduction of iron ore can be achieved by using either carbon-bearing material such as non-coking coal or a suitable reducing gas in the form of reformed natural gas. The processes employing coal are known as solid-reluctant of coal-based processes while those using reducing gases are known as gas-based processes.

2.3.2 The reduction is carried out in an inclined horizontal rotary kiln which rotates at a predetermined speed. Coal-based direct reduction technologies involve reduction of iron oxides in the rotary kiln by using non-coking coal as redundant. Limestone or dolomite is used as a de-sulphurising agent. The normal operating practice is to feed the kiln with the desired proportion of iron oxide, non-coking coal and limestone or dolomite.

2.3.3 The charge is preheated in the preheat zone and the reduction of iron ore is effected by reducing gases derived from coal gasification. The heat for the process is provided by burning

26 72.43% is the actual capacity utilisation

coal volatiles and excess carbon monoxide emerging from the charge. This is done by introducing controlled quantity of air in the kiln along the preheating and reduction zones. Part of coal is introduced from the kiln discharge end to supply energy at discharge end, maintaining a reducing atmosphere at the discharge end to prevent re-oxidation of DRI and for controlling degree of metallisation and carbon content of DRI. A temperature profile ranging from 800–1050 degree centigrade is maintained along the length of the kiln at different zones and as the material flows down due to gravity, the ore is reduced.

2.3.4 The reduction process occurs in solid state. The crucial factor in this is the controlled combustion of the coal and its conversion to carbon monoxide to remove oxygen from the iron ore. The chemical reaction of the entire process is shown below:

$$C + O_2 = CO_2$$
$$CO_2 + C = 2CO$$
$$Fe_2O_3 + CO = Fe_3O_4 + CO_2$$
$$Fe_3O_4 + CO = FeO + CO_2$$
$$FeO + CO = Fe + CO_2$$

2.3.5 The overall process requires approximately ten to twelve hours inside the kiln during which the iron ore is optimally reduced and discharged to a rotary cooler for cooling. The hot, reduced sponge iron, along with semi-burnt coal, discharged from kiln is cooled in a water-cooled cylindrical rotary cooler to a temperature of 100–200 degree centigrade. The discharge from the cooler, consisting of sponge iron, char and other contaminations are passed through magnetic separators so that the sponge iron can be separated from other impurities. Subsequently the sponge iron is stored into bins by conveyor belts.

2.4 Energy intensity of sponge iron sub-sector

2.4.1 The main fuels used in the production process of sponge iron are coal and gas. As mentioned earlier, 16.05 mn tonnes of sponge iron are produced using the coal-based process and 5.28 mn tonnes using the gas-based process (2008–09). The maximum energy is consumed in the process of reduction of iron ore in the kiln. The estimated total value of energy consumption in the sponge iron sub-sector is ₹ 290.97 bn. All the small units use indigenous technology. There are several ways of improving energy efficiency in the sponge iron production process. Some of the potential ways of improving energy efficiency are:

- *Use of higher grade coal:* Sponge iron requires specific characteristics in the coal used — the Initial Deformation Temperature (IDT) of coal ash should have 13,000 degree C temperature, reactivity of coal should be 2 cc of CO / gm of c/sec., fixed carbon (FC) at the level of 42–44 per cent Other features like volatile matter between 26–32 per cent, ash 25 per cent, coking index and swelling index less than 1, etc., are required for maximising good quality sponge iron production. However, a cause of concern for the sponge iron industry as well as the environment is the fact that the sponge iron industry is forced to use coal with ash content over 40 per cent and FC less than 33 per cent.

- *Waste Heat Recovery:* For the reduction process to take place in the kiln, temperature is maintained in the range of 950–1050°C. The hot gas (CO_2) also has a temperature in the same range. In the existing practice of the hot gas treatment, the heat contained in the gas is lost to the environment. Hence there exists a great potential for waste heat recovery in the process. Energy efficiency measures can be implemented by utilising the waste heat in productive ways as explained below:

  a) Preheating Kiln: Iron ore enters the kiln at the room temperature. For the reduction process to take place it is necessary that the iron ore is heated to the desired temperature. For this purpose the kiln is divided into different zones (in existing practices). A few zones (two or three) are dedicated for preheating the iron ore. These zones are called 'preheating zones'. In the preheating zones, the coal charged with iron ore acts as the fuel to generate the heat for preheating. This preheating can be done in a preheating kiln by utilising the heat of the hot exhaust gas generated in the reduction process. Hence charging of iron ore at an elevated temperature will require a lesser number (or none at all) of preheating zones. This will reduce the consumption of coal for the purpose of preheating in the main kiln.

     Installing the preheating kiln can be viable for all the units (with any range of production capacity). The Financial Analysis and the technicalities involved in this venture are to be looked upon.

  b) Installing Waste Heat Recovery Boiler (WHRB): Waste heat can also be recovered by installing a Waste Heat Recovery Boiler. If a 100 MTD capacity kiln is operated at maximum capacity, it can generate approximately 10 tonnes of steam which has the potential of generating approximately 2 MW of electricity. Operation of WHRBs has been successful in sponge iron units with a minimum capacity of producing 200 TPD. Hence a 200 TPD sponge iron unit can generate approximately 4 MW electricity. The maximum electricity requirement of a 200 TPD SI unit is 0.7 MW. Hence the surplus electricity available through captive power generation can be utilised by forward integration of the production operations (like induction furnace or re-rolling) or it can be traded.

2.5 Environmental issues in sponge iron sub-sector

2.5.1 The sponge iron industry is one of the most pollution causing industry having enormous demand of its product in the country with low capital investment, resulting in the mushrooming growth of plants causing huge pollution and loss of natural resources. Coal-based sponge iron units are prone to pollution because it is a dry thermal reduction process. It is prone mainly to air pollution and also water and noise pollution. The sector has been listed under "Red Category" as per the standards specified by the Central Pollution Control Board (CPCB) on the basis of its generation and discharge of hazardous wastes. CPCB has set up emission standards for sponge iron sector. The minimum national standard is given in Table 2.5.

Table: 2.5 Minimum national standard of sponge iron

Parameter	Standard
Stack Emission	100 mg/Nm^3 (coal based)
Standards for Kilns (Particulate Matter)	50 mg/Nm^3 (gas based) 12 & CO_2 correction if monitored CO_2 level is less than 12%
Carbon Monoxide	Not to exceed 1% (max.), volume/volume

Source: CPCB

The environmental issues associated with this sector primarily include the following:

- Air emissions
- Solid waste
- Water waste

1. Air Emission

Table: 2.6 Air emission in sponge iron sub-sector

S No.	Pollutants
1	During raw material handling (unloading, stacking, reclaiming operations), large amount of fugitive dust is released into the environment. This includes coal, iron ore and dolomite dust.
2	In the process of crushing and screening of raw material, coal dust and iron ore dust are released into the environment. This also leads to noise pollution.
3	Heavy metals like cadmium, lead, zinc, mercury, manganese, nickel and chromium are released as particulate matter from the stacks of a steel-making plant. The problem is compounded if the rotary kiln does not have adequate air pollution control equipment.
4	Inside the rotary kiln, the hot DRI gases contain huge amounts of fine dust comprising oxides and unburnt carbon and toxic carbon monoxide which requires treatment before being discharging into the atmosphere.
5	Iron ore, coal and dolomite/lime stone are fed into the rotary kiln for converting it to sponge iron during which fumes are generated due to the tumbling action. Part of the fumes come out of the cooler through the double pendulum valve which leads to the generation of dust.
6	During product handling and separation, a large amount of dust is generated which causes air pollution.

2.5.2 According to industry norms 2 tonnes of carbon dioxide is emitted during the production of 1 tonne of sponge iron. Since the total production using coal is 16.05 mn tonnes, the total carbon dioxide emission is 32.1 mn tonnes.

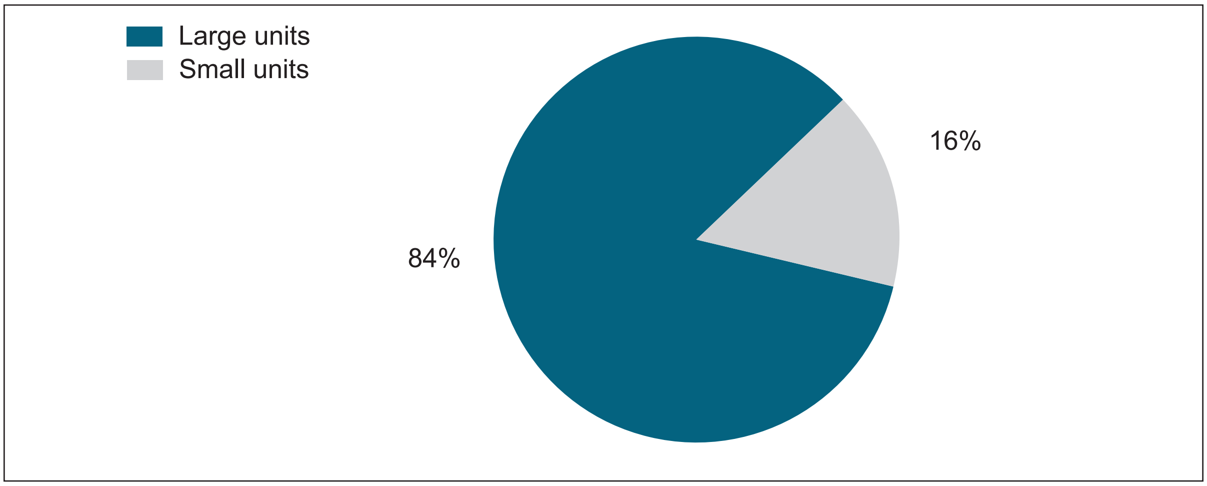

Figure 2.3: Carbon emission by sponge iron units (mn tonnes)

Figure 2.3 shows that the carbon dioxide emission by large units is about 84 per cent and remaining 16 per cent is by small units.

2. Water Pollution

Table 2.7: Water pollution in sponge iron sub-sector

S No.	Pollutants
	In sponge iron plants, water is used mainly for :
1.	Cooling the discharge feed from 950–1050^{0}C to below 100^{0}C. Water is continuously sprinkled over the rotary cooler shell and falls on a settling tank. This water is re-circulated for sprinkling and after that effluents are discharged into rivers. These effluents are in the form of iron particles, oil and grease.

3. Solid Waste

Table 2.8: Solid waste in sponge iron sub-sector

S N0.	Pollutants
	The solid wastes generated in the sponge iron plants are:
1.	*Char:* Char comprises of unburnt carbon, oxides and gangue and is segregated from the product during magnetic separation.
2.	*Flue dust:* Flue dust is generated from pollution control equipment like DSC, ESP and bag filter in the product handling area
3.	Kiln accretion waste
4.	*De-dusting:* Dust from pollution control equipment of the cooler discharge area.
5.	*Scrubber sludge:* Sludge is generated from the GCP when the plant uses wet scrubber for dust treatment.
6.	Process dust from pollution control equipment of kiln.

2.6 Social issues

- The social issues associated with the sponge iron sector are:
- Heavy metals released in air from sponge iron plants are highly toxic. Some of them, like chromium, cadmium, nickel, are human carcinogens. Iron acts along with other carcinogenic heavy metals and increases the risk of cancer.
- Sponge iron plants also emit oxides of sulphur and nitrogen and hydrocarbons. These air pollutants are likely to increase the incidence of respiratory tract ailments like cough, phlegm, chronic bronchitis and also exacerbate asthmatic conditions.
- Air pollution has a great impact on plant and vegetation as well, particularly pollutants like sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and particulate matter, which are the primary pollutants
- Noise is generated in gas-based plants from briquetting machines, compressors, etc. In coal-based plants, noise is generated from the moving parts of kilns, coolers and associated equipment like gear boxes, fans, etc., that generate up to 90 dB noise. These may impair the hearing capacity of the workers.
- Industrial dangers are present during the mining, transportation and preparation of the ores. Inhalation of iron dust or fumes occurs in iron ore mining, arc welding, metal grinding, polishing and working and boiling scaling.
- A number of zinc salts may enter the body by inhalation, through the skin or by ingestion and produce intoxication. Zinc chloride causes skin cancers.

2.6.1 Industry initiatives

SIMA, the apex body for sponge iron plants has set up a membership criterion that only those units registered under State Pollution control boards and have installed pollution control devices will be registered under them. For non-SIMA members, no information is available.

- In many sponge iron units, pollution control equipment have been installed to control the pollution levels, with maximum such units in Orissa.
- Many big sponge iron units have built schools and ensured medical checkups for the health of its workers. Temples have been built in the nearby industrial areas.
- Some units have supported the formation of SHGs to provide employment to the local workforce, especially women.

2.7 Institutions/associations

Table 2.9 shows the list of institutions and associations of the sponge iron industry.

Table 2.9: Institutions/Associations related to sponge iron industry

Knowledge Institutions	Financial Institutions	Associations
Ministry of Coal	State Bank of India	Sponge Iron Manufactures Association
Ministry of Steel	Allahabad Bank	Orissa Sponge Iron Manufactures Association
National Institute of Technology, Rourkela	Canara Bank	West Bengal Sponge Iron Manufactures Association
Indian Institute of Production Management (IIPM), Rourkela	Andhra Bank	Rourkela Chambers of Commerce and Industry
Steel Authority of India Limited (SAIL)	Orissa State Financial Corporation	District Small Scale Industries Association

Source: SIMA and other experts

2.7.1 Action areas for the growth of industry as suggested by SIMA

- Unavailability of gas and shortage of coal is a major factor for decline in the growth of sponge iron industry.
- Pollution measures need to be extended to all sponge iron units in India.
- Business Responsibility (BR) initiatives need to be expanded in this industry to ensure the safety of workers and people living in close proximity of the industrial region.

2.8 Cluster interventions

Table 2.10: Cluster initiatives in the past in sponge iron sub-sector

Agency	Cluster	Intervention	Scheme
NSIC	Rourkela	Helped the cast iron cluster in tender marketing for marketing grinding media balls to Hindustan Copper Limited.	Cluster Development Programme

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CHAPTER B3

Leather tanning

3.1 Economic significance

3.1.1 Leather manufacturing is one of the oldest industries that occupies a place of prominence in the Indian economy in view of its substantial export earnings, employment generation and growth. There has been increasing emphasis on its planned development, aimed at optimum utilisation of available raw materials for maximising the returns, particularly from export.

The major products of the leather sector are:

- Leather garments
- Footwear and footwear components
- Leather goods (bags, wallets, belts, gloves, accessories)
- Saddlery and harness articles

3.1.2 The leather industry ranks eighth in terms of foreign exchange earnings of the country and has 3 per cent share in global trade. The annual production of leather and leather products in India is about ₹ 270,000 mn. The composition of leather products exports from India has undergone a structural change during the last three decades, from merely being an exporter of raw materials in the 1960s to value added products in the 1990s. Exports are growing at the rate of 11.91 per cent (5 years),[27] Despite the slowdown in the US and EU, the major importers of leather goods, leather exports grew 20 per cent in the first half of financial year 2009, registering a 20 per cent rise over the previous year. A large proportion of India's export of leather and leather products is mainly to four countries — USA, Germany, UK and Italy. This sector employs about 2.5 mn[28] people with 30 per cent being women.

27 Council of Leather Exports
28 Council of Leather Exports

Table 3.1: India's export of leather and leather products for five years (2003–08)

	(Value in mn ₹)				
	2003–04	2004–05	2005–06	2006–07	2007–08
Finished Leather	12003.34	13126.97	13743.43	15638.4	16565.69
Footwear	16582.97	19672.63	22577.18	26717.26	31877.93
Leather Garments	6503.328	7115.904	7199.28	6694.056	7430.184
Leather Goods	11646.94	12651.55	14259.67	15255.65	16954.92
Saddlery & Harness	1138.536	1332.936	1674.432	1778.328	2285.496

Source: (DGCI&S)

3.1.3 The growth of the leather sector is directly related with the growth of the livestock sector. India is the largest livestock holding country with 21 per cent large animals and 11 per cent small animals. The Indian leather sector meets 10 per cent of global leather requirements with an annual production value of ₹ 216,000 mn. The estimated production capacity of hides and skins is 65 mn and 170 mn pieces[29], respectively.

3.2 Geographical concentration of tanneries

There are about 1,381 tanneries spread across India. About 96 per cent of these tanneries are in the small and medium sector, and approximately 4 per cent in the large sector.[30]

3.2.1 Since the tanning process requires large quantities of water, most of these units are located near river banks and they draw surface water. Many tanneries also use groundwater from own open wells/tube wells located within their premises. In places where overhead water tanks are not available, the water is pumped directly to the process and in some places water is stored in open cement-lined pits and ground-level tanks. Tanning industry clusters are located mainly in Tamil Nadu, West Bengal, Uttar Pradesh, Karnataka, Punjab and Maharashtra. The highest concentration of tanneries in India is on the banks of the Ganga river system in north India and the Palar river system in Tamil Nadu. Each location produces a particular end use leather product. Isolated medium- and large-scale tanneries are located in other states like Rajasthan, Bihar, Andhra Pradesh, Haryana, Orissa, Madhya Pradesh, Gujarat, etc.

Table 3.2 provides the list of leather tanning clusters in India along with their number of units.

29 CLRI
30 Discussion with the expert

Table 3.2: Spread of leather tanning sub-sector in India

State	Area of Concentration	No. of Tanneries	Production capacity (tonnes/day)	Process
Tamil Nadu	Melvisharam	27	22	
	Ambur	43	126	Raw to final product
		36		Raw to finishing
		24		Raw to wet blue
		15		Dry finishing
	Ranipet	179	129	Raw to finish
			125	Semi-finished to finished
	Vanniyambadi	110	100	Raw to finished leather
	Chennai	140	135	Semi-finished to finished
	Trichy	18	77	
	Erode	40	115	Raw hides to semi-finished leather
	Dindigal	62	51	Raw hides to semi-finished leather
	Pernambut	34	42	
West Bengal	Bantala	224	400	Raw to finished
Uttar Pradesh	Kanpur (Jajmau)	300	200	30 units — raw hides to finished leather 50 units — raw hides to wet blue 50 units — wet blue to finished 70 units — finishing operation
	Unnao	25	89	
	Banthar	12	56	
Punjab	Jalandhar	70	135	Raw hides to wet blue
Karnataka	Bangalore	8	15	
Puducherry	Pondicherry	1	1	
Andhra Pradesh	Vijaynagram,	1	15	Raw hides to finished leather
	Hyderabad,	5		
	Warangal	2		
Bihar	Muzzafarpur	5	7	Processing raw material
Total		1,381	1,840	

Source: Discussion with experts, Council for Leather Exports

3.2.2 Table 3.2 shows that there are 12 clusters of leather tanneries with more than 20 units each and of these there are five big clusters with more than 100 tanneries each. There are a total of 1,381 tanneries across India with a production capacity of 1,840 tonnes per day. The top five clusters with more than 100 tanneries, constitute approximately 70 per cent of the total number of tanneries and their production capacity is 962 tonnes per day (tpd), which is 52 per cent of total production capacity of 1,840 tpd of all tanneries in India. This clearly shows that in these five clusters, there are more medium and small units than large units. The total number of large tanning units* in India is approximately 60 and the remaining 1,321 are small and medium sized tanneries.[31] The production capacity of all tanneries is 552,000 tonnes per annum. Of the total production in India, 50 per cent is contributed by the large units and remaining 50 per cent by the medium- and small-scale units. Therefore, the total production capacity of the SME tanneries is around 270,000 tonnes per annum

3.3 Production process

3.3.1 The tanning industry consumes large quantities of water. The quantity of water usage and nature of wastewater discharge is dependent on the tannery as well as the typology of the tanning process. Generally, water consumption is highest during the pre-tanning process, but a significant amount of water is also consumed in the post-tanning processes. Raw animal skins go through several steps during the tanning process. Depending upon the type of hide used and the desired end product, the steps taken during tanning can vary greatly. The different tanning processes are:

- Vegetable tanning
- Chrome tanning

Table 3.3: Average water usage and wastewater discharge per kg of hide/skin for different processes

Process	Water Usage
Raw material to E.I.*	25-30 l/kg of raw weight
Raw material to Wet Blue**	25-30 l/kg of raw weight
Raw to Finish	30-40 l/kg of raw weight
E.I. to Finish	40-50 l/kg of E.I. weight
Wet blue to Finish	20-25 l/kg of wet blue weight

* E.I. is vegetable tanning, popularly known as East India tanning
** Wet blue tanning is also known as chrome tanning processing
Source: CPCB

31 Discussion with expert
*Units producing more than 20 lakh sq ft of leather per day is considered large unit

3.3.2 The composite wastewater from the raw to finishing process is alkaline with an average contribution of about 575 kg of total solids, 465 kg of dissolved solids, 240 kg of chlorides, 135 kg of chemical oxygen demand (COD), 100 kg of sulphates, 65 kg of biochemical oxygen demand (BOD), 7.5 kg of chromium and 4 kg sulphides per ton of raw hides/skins for processing finished leather.

3.3.3 Common steps taken in different types of processes: First, the animal skins or hides are cured, which involves salting or drying the skin. These are then soaked in water for several hours to several days. After soaking, the flesh and hair are removed and then *de-liming*[32] is done, i.e., the hides are de-limed in a vat of acid. Hides and skins are often treated several times during the process of tanning. The type of tanning procedure largely depends on the hide itself. Vegetable tanning uses tanning which occurs naturally in bark. The primary barks used are chestnut, oak, tanoak, hemlock, quebracho, mangrove, wattle and myrobalan. Hides are stretched on frames and immersed for several weeks in vats of increasing concentrations of tannin. Vegetable tanned hide is flexible and is used for luggage and furniture.

3.3.4 Mineral tanning usually uses chromium in the form of basic chromium sulphate and is employed after picking. Once the desired level of penetration of chrome into the substance is achieved, the pH of the material is raised again to facilitate the process. In the raw state, chrome tanned skins are blue in colour and therefore referred to as "wet blue".

Table 3.4 provides the details of the tanning operations, water and other chemicals used and general constituents of wastewater.

Table 3.4: Details of tanning operations, water and other chemicals used and general constituents of wastewater

Important operations in tanning process	Mode of operation	Approx. Qty of water used/ Waste-water Discharge in m^3/ tonne of skin/ hide processed	Important Chemicals used	General constituents of waste-water
Soaking	Pits/ paddles	9.0–12.0	Wetting, emulsifying agents and bactericidal agent	Olive green in colour, obnoxious smell, contains soluble proteins, suspended matter and high amount of chlorides
Liming	Pits/ paddles	2.5–4.0	Lime and sodium sulphide	Highly alkaline, contains high amount of sulphides, ammoniacal nitrogen, suspended solids, hair, pulp and dissolved solids

32 De-liming involves the removal of residual lime from the pelts and preparing the pelts for bating.

Important operations in tanning process	Mode of operation	Approx. Qty of water used/ Waste-water Discharge in m^3/ tonne of skin/ hide processed	Important Chemicals used	General constituents of waste-water
Deliming	Paddles/ pits/ drums	2.5–4.0	Ammonium salts, enzymatic bates	Alkaline, contains high amount of organic matter and ammoniacal nitrogen.
Vegetable Tanning	Pits/drums	1.0–2.0	Vegetable tanning material	Highly coloured, acidic and has a characteristic offensive colour
Pickling and chrome tanning	Drums	2.0–3.0	Common salt, acid, basic chrome salt	Coloured, acidic, contain high amount of trivalent chromium, TDS and chlorides
Dyeing and fat liquoring	Drums	1.0–1.5	Dyes and fatty oils	Coloured, acidic, dyes and oil emulsions
Composite waste-water including washing (raw to finish process)	–	30.0–40.0	–	Alkaline, coloured contains soluble proteins, chromium, high TDS, chlorides, sulphides, suspended solids etc.

Source: CPCB

3.3.5 As inferred from the tanning process, the most vital concern related to the leather tanning sector is water pollution. The volume of water consumed in the process and also the pollutants that are present in the discharged water is alarming and needs attention not only from those who are directly affected but also from policy makers and civil society.

3.3.6 The clusters in India have mostly shifted from vegetable tanning to chrome tanning. Table 3.5 provides the typology of tanning and the estimated state-wise range of wastewater discharged.

Table 3.5: Typology of tanning and wastewater discharged

State	Area of Concentration	Type of Tanning	Estimated range of wastewater discharge in m^3 per day
Tamil Nadu	Melvisharam	Chrome tanning	27,800
	Ambur,	Chrome tanning	
	Ranipet,	Chrome tanning	
	Vanniyambadi,		
	Chennai	Chrome tanning	
	Trichy,	Vegetable tanning	
	Erode	Chrome tanning	
	Dindigal	Majority units do vegetable tanning and a few units (10) do chrome tanning	
	Pernambut	-	
West Bengal	Bantala	Chrome tanning	18,000
Uttar Pradesh	Agra	Chrome tanning	15,000
	Kanpur (Jajmau)	Only 50 units do chrome tanning and remaining do vegetable tanning	
	Unnao	Chrome tanning	
	Banthar	-	
Punjab	Jalandhar	-	6,000
Karnataka	Bangalore	-	600
Andhra Pradesh	Vijaynagram,	Chrome and vegetable tanning	600
	Hyderabad,		
	Warangal		
Bihar	Muzzafarpur		300
	Total		68,300

Source: discussion with experts

The total quantity of water discharged by tanneries is estimated to be about 68,300 m^3 per day. According to discussions with experts, the volume of water discharged by both large and small units is approximately 34,150 m^3 each as both segments' share is 50 per cent of the total production.

It is estimated that approx. 45 m^3 *of water is required to process 1 tonne of finished leather.*

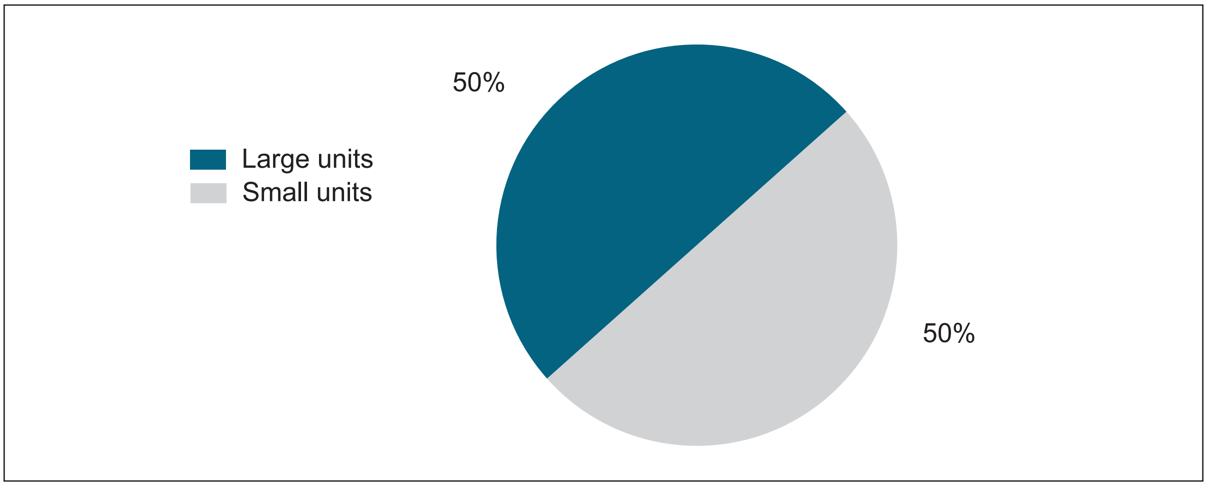

Figure 3.1: Percentage of wastewater discharged by large and small tanneries

Source: on the basis of above calculations

3.4 Environmental issues in leather tanning sub-sector

3.4.1 The leather tanning sector has been listed under "Red Category" as per the standards specified by the Central Pollution Control Board (CPCB) on the basis of its generation and discharge of hazardous wastes. Also, environmental effluent standards have been set for waste discharges in the leather sector. The minimum national standard for tanneries is given in Table 3.6.

Table: 3.6 Minimum national standard for tanneries

Parameter	Limits not to exceed
pH	6.5–9.0
BOD5, 20°C, mg/l	100*
Total suspended solids mg/l	100
Sulphides, mg/l	2.0
Total chromium, mg/l	2.0
Oil & grease	10

*Note: For effluent discharge into inland surface waters, the BOD limit may be made stricter to 30 mg/l by the concerned State Pollution Control Boards
Source: Central Pollution Control Board

The environmental issues associated with this sector primarily include the following:

- Wastewater
- Air emissions
- Solid waste
- Hazardous materials

1. Wastewater

3.4.2 The tanning process consumes large quantities of water. Most of this water is finally discharged as wastewater carrying high amounts of suspended solids, salts and dissolved solids, biochemical oxygen demand (BOD) and chemical oxygen demand (COD). The wastewater dark in colour and has a bad smell. This depends on the type of chemical used during the tanning process. The total wastewater discharge from tanneries in India is estimated to be about 50 mn litres per day.[33] The biggest polluting material in the tanning industry, which is also difficult to get rid of, is common salt. For every 10 tonnes of salted hide and skin processed, 2–3 tonnes of salt are removed and in addition another one ton of salt is removed while pickling.[34] It has been established that a single tannery can pollute groundwater within a radius of 7–8 km.

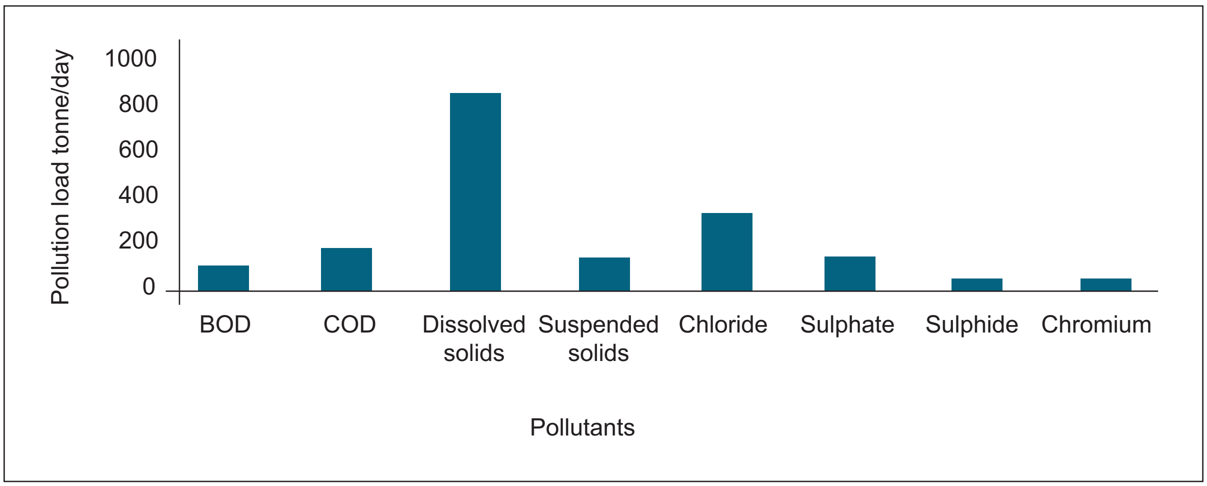

Figure 3.2: Pollution contribution from Indian tanning sub-sector

Source: CPCB

33 CPCB
34 Mondal, Saxena and Singh, 2005. 'Impact of pollution due to tanneries on ground water regime', Groundwater Group, National Geophysical Research Institute, Hyderabad.

Table 3.7: Wastewater pollutants in leather tanning process

SNo.	Pollutants
1.	*COD/BOD and Suspended Solids:* Approximately 75 per cent of the organic load (measured as biochemical oxygen demand [BOD] and chemical oxygen demand [COD]) is produced in the beamhouse, with the main contribution coming from the liming/dehairing processes. Dehairing is also the main generator of total suspended solids. An additional source of COD / BOD is the degreasing process. Total COD/BOD concentrations can reach 200,000 mg/l.
2.	*Salts and Total Dissolved Solids:* Salting and other tannery processes contribute to the presence of salts / electrolytes in wastewater streams, measured as Total Dissolved Solids (TDS). Approximately 60 per cent of the total chloride is produced from salt used for curing, which is subsequently released in the soaking effluent. The rest is generated mainly from the pickling, tanning and dyeing processes. Additional contributors to TDS include the use of ammonium chloride and sodium sulphate. The high amount of salt contained in the effluent increases soil salinity, reduces fertility and damages farming in large areas.
3.	*Sulphides:* Inorganic sulphides (NaHS or Na_2S) and lime treatment are used in the dehairing process, which may result in sulphide-containing liquors in the wastewater effluent.
4.	*Nitrogen Compounds:* Significant nitrogen loads and resulting discharge of ammonia nitrogen are typically associated with tanning processes. The use of ammonium salts in the process is a main source of ammonia nitrogen in tannery effluents (up to 40 per cent). Other sources of ammonia nitrogen are dyeing and animal proteins generated from beamhouse operations. The majority of total nitrogen matter (measured as Total Kjeldahl Nitrogen, TKN) is discharged from the liming process in beamhouse operations which, as a whole, accounts for approximately 85 per cent of the TKN load from a tanning facility.
5.	*Chromium and Other Tanning Agents:* Trivalent chromium salts (Cr III) are among the most commonly used tanning agents, accounting for a majority (approximately 75 per cent) of the chromium in wastewater streams. The remainder is typically generated from post-tanning wet processes, from stock drainage and wringing.
6.	*Post-Tanning Chemicals:* Post-tanning operations involve the use of several classes of chemicals including fat liquoring agents, chlorinated organic compounds, impregnating agents, sequestering agents, masking agents and dyes. Impregnating agents are used to improve wearing qualities, achieve oil-repelling or anti-electrostatic properties, reduce permeability to gas, reduce abrasion, and to act as a flame retardant. Other complexing agents (e.g., carboxylic acids, di-carboxylic acids and their respective salts) are used as masking agents in chrome tanning (certain phthalates, such as di-sodium phthalates (DSP), are also used as masking agents).
7.	*Biocides:* Biocides are usually included in most liquid chemical formulations such as dyes, fat liquors, and casein finishes. Biocides are potentially toxic and include bactericides and fungicides. Bactericides are used mainly at the beginning of the leather-making process, during the curing and soaking phases. Fungicides are typically used from the pickling stage to the drying stage, because the pH conditions in these processes are ideal for mould growth

Source: IFC Health and Safety Guidelines

3.4.3 However, in 1995 the Supreme Court of India ordered the closure of hundreds of tanneries in Tamil Nadu for failing to treat their effluents. With their survival at stake, local producers opted overwhelmingly for a collective solution and took immediate steps to form central treatment plants. A Supreme Court order forced the tanneries in Tangra (in Kolkata) to relocate to a self-contained leather-processing complex in the Bantala area. This was in response to a public interest litigation filed by environmentalists alleging that pollution from the industry exceeded the state pollution standards. Similar attempts were also made in other states to combat water pollution.

2. Air emission

Table 3.8: Air emission pollutants in leather tanning process

Air Emissions	
1.	*Organic Solvents:* Organic solvents are used in the degreasing and finishing processes. Untreated organic solvent emissions from the finishing process may vary between 800 and 3,500 mg/m^3 in conventional processes. Approximately 50 per cent of VOC emissions arise from spray-finishing machines, and the remaining 50 per cent from dryers. Chlorinated organic compounds may be used and emissions released from the soaking, degreasing, dyeing, fat liquoring, and finishing processes.
2.	*Sulphides:* Sulphides are used in the dehairing process. Hydrogen sulphide (H_2S) may be released when sulphide-containing liquors are acidified and during normal operational activities (e.g., opening of drums during the deliming process, cleaning operations / sludge removal in gullies and pits, and bulk deliveries of acid or chrome liquors pumped into containers with solutions of sodium sulphide). H_2S is an irritant and asphyxiant.
3.	*Ammonia:* Ammonia emissions occur during some of the wet processing steps like deliming and dehairing, or during drying if it is used to aid dye penetration in the colouring process.
4.	*Dust:* Dust / total particulate may be generated from various operations (e.g., storage and handling of powdery chemicals, dry shaving, buffing, dust removal machines, milling drums, and staking).
5.	*Odours:* Odours may result from raw hides and skins, putrefaction, and from substances including sulphides, mercaptans, and organic solvents.

Source: IFC Health and Safety Guidelines

3. Solid waste

Table 3.9: Solid wastes in leather tanning process

	Solid Waste
1.	The problem of solid wastes arises in tanneries both in the tanning process and also during effluent treatment. Solid wastes include salt from raw skin/hide dusting; raw skin/hide trimmings; hair from the liming/dehairing process which may contain lime and sulphides; and fleshing from raw skins / hides. Other solid waste includes wet blue shavings, which contain chromium oxide (Cr_2O_3); wet blue trimming, which is generated from the finishing processes and contains chromium oxide, syntans, and dye; and buffing dust, which also contains chromium oxide, syntans, and dye.

Source: IFC Health and Safety Guidelines

4. Hazardous materials

The tanning and leather finishing processes involve the use of a variety of hazardous chemicals, most importantly chrome, which needs to be recovered from wastewater. However, a significant proportion of chrome is left in the drain water to mix with potable and groundwater.

3.5 Social issues in leather tanning sub-sector

3.5.1 The social issues pertaining to the leather tanning sector are mainly related to occupational health and safety issues associated with the construction and decommissioning of tanning and leather finishing facilities. Specific occupational health and safety issues for this industry include the following:

- Tannery workers are exposed to chemical hazards during loading, unloading, handling, and mixing of chemicals; during the washing and disposing of chemical containers; and also during the disposal of chemical waste and effluents. This may cause dizziness and breathing problems.
- Workers are exposed to disease agents such as bacteria, fungi, mites, and parasites which may be present in the hides or as part of the manufacturing process. Some allergic reactions also develop due to these diseases agents.
- An obnoxious smell comes from hides and skins which makes breathing difficult for workers.
- Since workers use acids like benzene and chromic acid, they suffer many skin problems.
- In Kamatchipuram village located five kilometres from Dindigul town, only 16 of the 56 wells in the village are uncontaminated forcing people to walk 2–3 km every day to fetch water.

- Most tanneries have unhygienic working conditions, and inadequate ventilation and lighting.

3.6 Institutions/associations

The major technical and knowledge institutions for the leather industry are:

- National Institute of Fashion Technology (NIFT)
- Central Leather Research Institute (CLRI)
- Council of Leather Exports (CLE)
- Punjab State Leather Development Corporation, Jalandhar
- Central Footwear Training Institute (CFTI)
- All India Hides and Leather Tanner Merchant Association (AISHTMA)

3.7 Cluster interventions

Table 3.10 shows the interventions undertaken in different clusters so far by different national and international agencies and institutions over the years.

Table 3.10: Cluster interventions in the past

Agency	State/ Concentration	Programme/ Scheme	Type of Intervention	Time Duration
UNIDO	Uttar Pradesh (Kanpur), Calcutta, Tamil Nadu	Pollution control in the tanning sector in South East Asia	Pollution control	1996–2002
UNDP, GOI	All India	National Leather Development Programme	Overall development of leather sector	1992–98
UNDP, GOI	All India	National Leather Development Programme	Overall development of leather sector	1992–98
UNIDO	Tamil Nadu (Chennai), West Bengal (Santiniketan)		Consolidated project for SME development in India	2007–10
Punjab State Leather Development Corporation	Punjab (Jalandhar)		Setting up a Common Effluent Treatment Plan (CETP)	

Agency	State/ Concentration	Programme/ Scheme	Type of Intervention	Time Duration
Government of India and Industry	Punjab (Jalandhar)		Upgrading of CETP of 5 MLD with the help of the SPV Punjab Effluent Treatment Society to resolve the environmental concerns of the leather complex	
State Industries Promotion Corporation of Tamil Nadu (SIPCOT)	Tamil Nadu (Ranipet)		Setting up an industrial complex which also houses many tanneries	
BIPCC* as per the advice of corporation under a tripartite agreement with UPSIDC, Banther Industrial Pollution Control Company and CLRI, Chennai	Uttar Pradesh (Unnao)	ASIDE scheme of GOI	Setting up CETP under this scheme	

*A public limited company formed jointly in public interest by all tanneries to assist small-scale units in matters of prevention and control of pollution.
Source: Discussion with experts

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CHAPTER B4

Textiles

4.1 Economic significance

4.1.1 The Indian textile industry is the second largest in the world. It contributes about 14 per cent to the national industrial production, 4 per cent to GDP and about 17 per cent to the total national export earnings.[35] The textile industry in India is a key sector in terms of employment as it is the second largest employment provider after agriculture with direct employment of about 35 mn people, which constitutes 21 per cent of the total workforce.[36]

The products of the textiles sector include:

- Bed sheets
- Quilt covers
- Tent materials
- Pullovers
- Shirts
- Dress materials

India's textile industry is divided into the organised and the unorganised sectors.

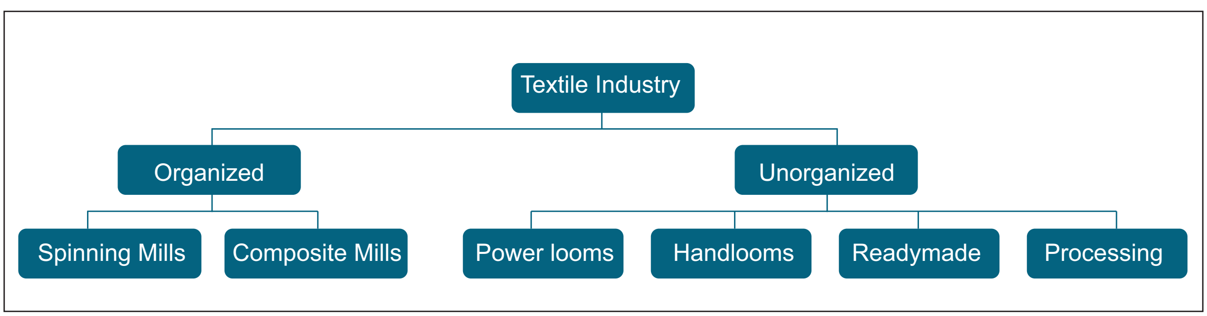

Figure 4.1: Distribution of textiles industry

35 Ministry of Textiles Annual Report, 2008–09, Government of India
36 Official Indian Textiles Statistics, 2005–06

4.1.2 Currently, India has about 1,726 spinning mills and 176 composite units with about 39.07 mn spindles and 0.6 mn rotors in the organised and unorganised sectors. The total number of composite mills in the organised sector has decreased from 223 units in 2003–04 to 176 units 2007–08.[37] There are about 12,400 processing factories of which around 10,000 are engaged in manual processing. There are 2.15 mn power looms in the country as on 31 December 2008 distributed over approximately 0.482 mn units. The power loom sector contributes about 62 per cent of the total cloth production in the country and provides employment to about 5.4 mn persons.[38]

4.1.3 The power loom sector occupies a pivotal position in the Indian textiles industry. However, the sector has been plagued by technological obsolescence, fragmented structure, low productivity and low-end quality products. Most of the looms in the power loom sector are more than 20 years old and 75 per cent of these are of the conventional type and not capable of producing fault-free fabrics and high efficiency.

4.1.4 India is the second largest producer of textile and garments; garment exports totalled ₹ 439,200 mn during the year 2008–09, giving it an enviable market share of 2.99 per cent.[39] These account for 42 per cent[40] of the total textiles exports.

Of the total fabric-producing units in the country, 5 per cent are in the organised sector, 62 per cent in unorganised, 28 per cent in the handloom segment and the remaining 5 per cent in the knitting and hosiery segments.

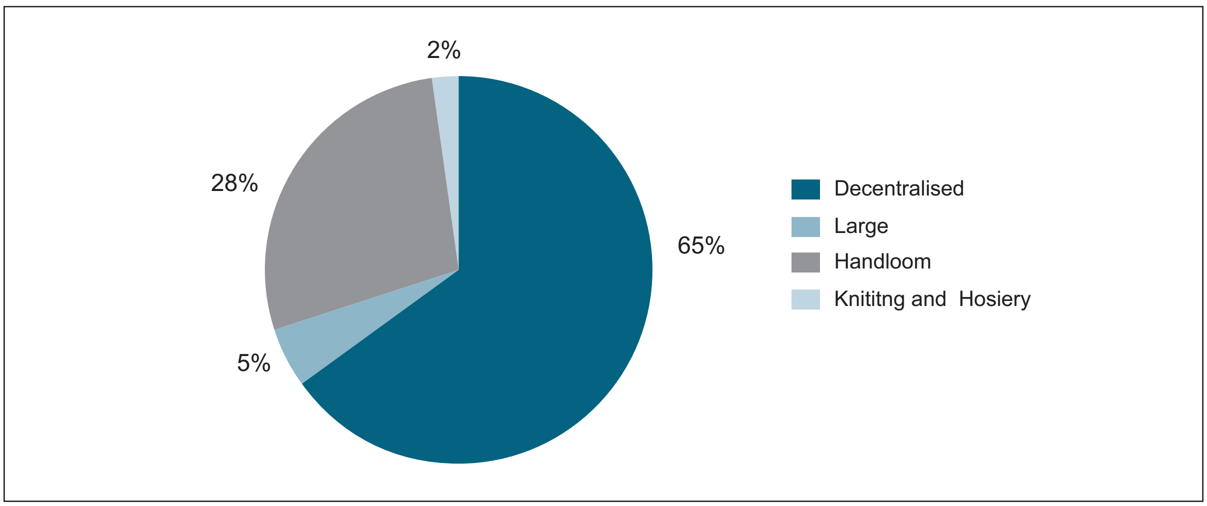

Figure 4.2: Classification of Indian textiles sub-sector

Source: Based on the above-mentioned calculations

37 www.txcindia.org
38 Ministry of Textiles Annual Report 2008–09, Government of India
39 Apparel Export Promotion Council
40 Ministry of Textiles Annual Report 2008–09, Government of India

Table 4.1: Production of cloth in textiles sub-sector (in bn sq metres)

Sector	2007–08	2008–09 (P)
Mill	1.781	1.796
Decentralised power loom	34.725	33.648
Decentralised hosiery	11.804	12.077
Khadi, wool and silk	0.768	0.768
Total	56.025	54.966

(P) Provisional, Government of India
Source: Ministry of Textiles Annual Report 2008–09

4.1.4 The total production of cotton yarn and cotton fabrics in the year 2007–08 was 2.948 bn kg and 27.196bn square metres, respectively. But its percentage share in the global trade of textiles and clothing continues to be low, at about 3 per cent. The major reason for such a small share in world trade has been technological obsolescence in the weaving, processing and clothing segments.

4.2 Geographical concentration of textiles clusters

Table 4.2 shows the textiles clusters in India along with the number of units, employment and total production.

Table 4.2: Spread of textiles sub-sector in India

Sector	No of Clusters	Number of units	Number of looms/ spindle	Employ-ment	Total Production	Locations with Maximum concentration
Spinning mills	20	1,726	39 mn	-	4.00 bn kg	Tamil Nadu (Coimbatore), Maharashtra, Punjab
Composite mills	14	176	-	176,000* (approx.)		Maharashtra, Gujarat, Punjab
Power loom	45	0.482 mn	2.15 mn power looms	5.4 mn	54.96 bn sq. metres (2008–09)	Maharashtra, Gujarat (Surat), Uttar Pradesh
Readymade garments	18	40,000 (approx.)	-	7.0 mn		Karnataka (Bangalore), Madhya Pradesh (Indore)
Wet processing	16	8,183	-		7.38 bn kg	Maharashtra, Gujarat, Tamil Nadu (Tirupur), Punjab

*Assuming 1000 persons are working per unit.
Source: Discussions with experts

4.3 Production process

The production process in the textiles industry comprises three main stages, as shown in Figure 4.3.

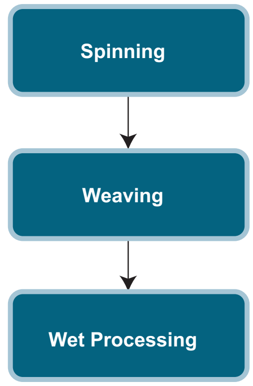

Figure 4.3: Production process of textile sub-sector

4.3.1 Spinning: The spinning process involves opening/blending, carding, combing, drawing, drafting and spinning. It uses four types of technologies: ring spinning, rotor spinning, air jet spinning and friction spinning. Ring spinning is used the most in India with its main advantage being its wide adaptability for spinning different types of yarn. Rotor spinning technology is also widely used.

4.3.2 Weaving: It uses two main technologies: shuttle and shuttle-less. Shuttle-less weaving has higher productivity levels and produces better quality of cloth. Less than 1 per cent of all power looms are shuttle-less and, in the organised mills sector, less than 6 per cent are shuttle-less looms

4.3.3 Wet processing: It covers all processes in a textile unit that involve some form of wet or chemical treatment. The wet processing process can be divided into three phases: preparation, colouration and finishing. It uses different types of technologies depending on the type of yarn or fabric to be dyed. Jigger, winch, padding, mangle and jet-dyeing are some important dyeing machines. Similarly, there are different types of printing processes: direct printing, warp printing, discharge printing, resist printing, jet printing, and so on.

4.4 Energy intensity in textiles sub-sector

4.4.1 Energy consumption in the textiles sub-sector has augmented with increased mechanisation. Energy costs vary from 5 to 17 per cent of the total manufacturing costs according to the type of process involved. The Indian textile sub-sector consumes nearly 10.4 per cent[41] of the total power produced in India.

41 IREDA Report

4.4.2 The energy consumption in spinning mills is approximately 40 watts per spindle. Weaving includes the use of power looms and handlooms. Power looms consume approximately 4 kilowatts per loom whereas in the case of handlooms energy consumption is negligible. Consumption of steam in a fabric dyeing unit may vary from 4 to 9 kg of steam per kg of fabric.

Table 4.3: Energy consumption in textiles sub-sector

Sector	Calculation	Small units	Large units	Electricity consumption (in ₹ mn)		
				Small units	Large units	Total
Spinning mills	Total number of spindles = 40 mn Energy consumption per spindle = 40 watts No. of working hours = 24 hours No. of working days = 350 days Energy cost per unit = ₹ 4.5 {40 mn*(40/1000)*24*350*4.5} = ₹ 60,480 mn	10%	90%	6,048	54,432	60,480
Weaving	Power looms and handlooms					
Powerlooms	Total number of power looms = 2.15 mn Energy consumption per loom = 4 kilowatts No. of working hours = 16 hours No. of working days = 350 days Energy cost per unit = ₹ 4.5 2.15 mn (*4*16*350*4.5) = ₹ 216,720	95%	5%	206,343	10,861.2	217,224
Handlooms	Negligible electricity consumption	95%	5%			

Sector	Calculation	Small units	Large units	Electricity consumption (in ₹ mn)		
				Small units	Large units	Total
Processing	Total number of processing units = 8,183 Energy consumption per kg of fabric produced = 0.15 KWh/kg Number of working hours = 16 Number of working days = 350 days Energy cost per unit = ₹ 4.5 8183*0.15*16*350*4.5 = ₹ 30.6 mn			30.87		30.87
Composite mills	Total number of composite mills = 176 No. of spindles = 25,000 No. of power looms = 400 No. of working hours = 24 hours No. of working days = 350 days Energy cost per unit = ₹ 4.5 [176{25000*(40/1000)*24*350*4.5}+{400*4*24*350*4.5}] = ₹ 17,293.5 mn		100%		17,297.1	17,297.1
Total				212,440.5	82,575	295,020

Source: Discussion with experts

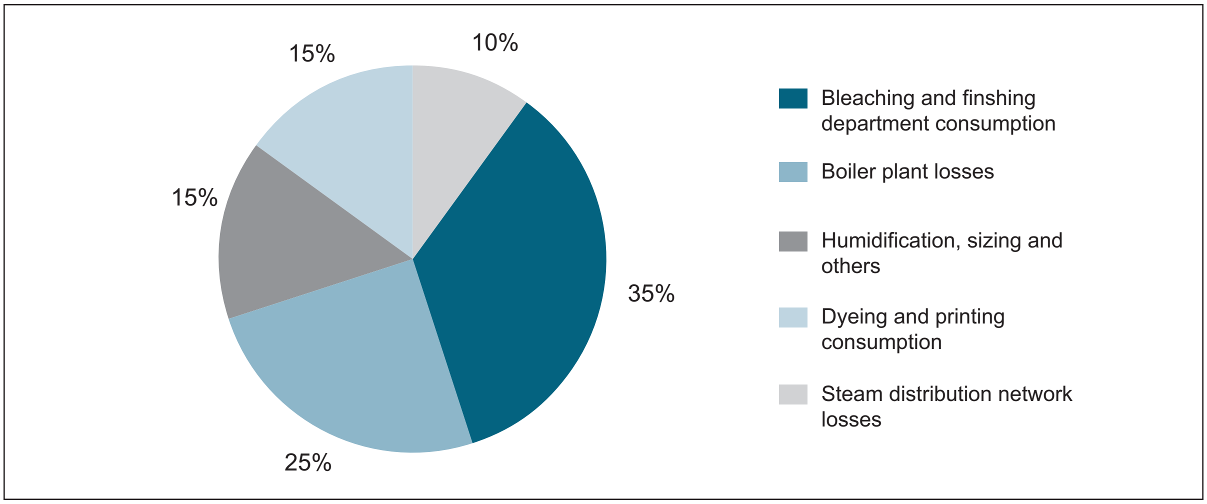

Figure 4.4: Consumption of heat

Source: UNEP DTIE

4.4.3 The textile industry requires both thermal and electrical energy for its operation. About 80 per cent of the energy requirement is in the form of heat. Thermal energy used in the textiles sector is in the form of coal and gas. Wet processing in the production of textiles includes bleaching and finishing, dyeing and printing, humidification and boiler plant losses. Figure 4.4 shows that in the process of wet processing maximum thermal energy is used i.e., 82 per cent of the total energy consumed. In the stage of weaving and spinning 15 per cent and 18 per cent energy is used respectively.

Since the maximum amount of thermal energy is used in wet processing, it can be interpreted that maximum pollution is caused in this stage of textile production because of the consumption of large quantities of coal.

The three major steps that can help bring about energy conservation in the textile industry are high capacity utilisation, fine tuning of equipment and technology up-gradation.

4.5 Environmental issues in textiles sub-sector

4.5.1 The textiles sector has been listed under "Red Category" as per the standards specified by the Central Pollution Control Board (CPCB) on the basis of its generation and discharges of hazardous wastes. The wastewater general standard for textiles sector is given in Table 4.4.

Table 4.4: General standards for wastewater in textiles sub-sector

Textile Industry	Quantum
Man-made fibre	1.1.19
Nylon and polyester	120 m^3/tonne of fibre produced
Viscose staple fibre	150 m^3/tonne of product
Viscose filament yarn	500 m^3/tonne of product

Source: Central Pollution Control Board

Environmental issues during the operational phase of textile manufacturing primarily include the following:

- Hazardous materials management
- Wastewater
- Emissions to air
- Solid and liquid waste
- Hazardous materials management

Table 4.5: Management of hazardous materials

1.	Textile manufacturing activities includes the use of hazardous chemicals in pre treatment, dyeing, and other processes to provide the final product with desired visual and functional properties.

Source: IFC Health and Safety Guidelines

a) Wastewater

4.5.2 Water is highly polluted by textiles processing. In Tirupur, textiles manufacturing activities alone utilise around 28.80 bn litres of groundwater, which is approximately 1 per cent of the present demand of water in Tamil Nadu.[42] This has led to the depletion of groundwater. Around 30 litres of water is used for processing 1 kg of textile product. This amounts to a daily requirement of about 0.1 to 0.15 mn cubic metre of fresh water which, after processing, is discharged into drainage systems, surface water bodies and on the land. It is estimated that around 0.080 mn to 0.1 mn cubic metre of water is discharged every day.

42 Ministry of Textiles

Table 4.6: Wastewater pollutants in textiles sub-sector

S No	Pollutants
1.	*Industrial Process Wastewater:* Industry-specific wastewater effluents are related to wet operations during different stages of the textile manufacturing process. Process wastewater from textile manufacturing is typically alkaline and has high BOD (700–2,000 mg/l) and COD loads. Pollutants in textile effluents include: • Suspended solids, • Mineral oils (e.g., antifoaming agents, grease, spinning lubricants, non-biodegradable or low biodegradable surfactants) • Other organic compounds, including phenols from wet finishing processes (e.g., dyeing), and halogenated organics from solvent use in bleaching. *Effluent streams from dyeing processes* are typically hot and coloured and have high concentrations of heavy metals (e.g., chromium, copper, zinc, lead or nickel). *Industrial process wastewater from natural fibre processing* contain pesticides used in pre-finishing processes (e.g., cotton growing and animal fibre production), potential microbiological pollutants (e.g., bacteria, fungi and other pathogens), and other contaminants (e.g., sheep marking dye, tar).

Source: IFC Health and Safety Guidelines

b) Air pollution

Table 4.7: Air pollutants in textiles sub-sector

S NO	Pollutants
1.	Air pollution in the textiles sector is in the form of chemicals like carbon disulphide, hydrogen sulphide, hexamethylene diamine and nitric acid, which are released during the process of regenerated fibres (viscose) and synthetic polymers (nylon and acrylic fibres) *Volatile organic compound (VOCs) and Oil Mists:* Emissions of VOCs are related to the use of organic solvents in processes such as printing, fabric cleaning, wool scouring and heat treatment. Another source of emissions is the evaporation or thermal degradation of chemicals used in textile materials. The main sources are often the stenter frames which are used for drying. Other substances with significant air emission potential that are used in printing processes include ammonia, formaldehyde, methanols and other alcohols, esters, aliphatic hydrocarbons and several monomers. *Exhaust Gases:* The release of polluting gases during process heating is common in this sector. *Odours:* Odours are generated during dyeing and other finishing processes and also during use of oils, solvent vapours, formaldehyde, sulphur compounds, and ammonia.

Source: IFC Health and Safety Guidelines

c) Wastes

Table 4.8: Waste pollutants in textiles sub-sector

Wastes	
S No	Pollutants
1.	Wastes specific to the textile industry include trials, selvedge, trimmings, cuttings of fabrics and yarns, spent dyes, pigments and printing pastes; and sludge from process wastewater treatment containing mainly fibres and grease.

Source: IFC Health and Safety Guidelines

4.6 Social issues in textiles sub-sector

The social issues pertaining to the textile industry include occupational health and safety hazards during the operational phase of textile manufacturing projects. These are:

- *Chemical Hazards:* Workers are mostly exposed to chemical and microbiological contaminants like bacteria, fungi, pesticides and herbicides. These generate respiratory hazards like byssinosis in cotton manufacturing, chronic bronchitis, asthma and emphysema. Workplace exposure to asbestos dust during fibre production leads to lung cancer (mesothelioma) and injury to the bronchial tubes.
- *Exposure to Dusts and Fibres:* Exposure of workers to dusts from materials such as silk, cotton, wool, flax, hemp, sisal and jute can occur during weaving, spinning, cutting, ginning and packaging. Exposure to fibres and yarns may cause nasal or bladder cancer.
- *Musculoskeletal Disorders:* Manual handling, lifting, holding, putting down, pushing, pulling, carrying or movement of a load is the primary cause of injury in the textiles industry. Manual handling causes either cumulative disorder from the gradual deterioration of the musculoskeletal system such as lower back pain, or acute trauma such as cuts or fractures due to accidents.
- *Volatile Organic Compounds (VOC):* Workers' exposure to VOC emissions due to the use of solvents in textile printing processes, fabric cleaning and heat treatments can cause skin and respiratory impacts. Exposure to certain compounds like carbon disulfide in rayon manufacturing has significant toxic effects, including nervous system and heart diseases.
- *Explosion:* Explosions in the workplace during the combustion of organic dusts, including cotton dust, are hazardous for the workers.
- *Physical Hazards:* Activities related to the maintenance operations of industry-specific equipment like spinning machinery, looms and stenters expose workers to physical impacts, particularly to hot surfaces and moving equipment.

- *Heat:* The workers are exposed to heat during the wet processing and dry finishing operations which is caused by the use of steam and hot fluids in these processes.
- *Noise:* The main sources of noise in textile plants are associated with yarn processing, i.e., texturising, twisting and doubling; and during the production of woven fabrics. These may affect the hearing capacity of the workers.
- *Colour in Effluents:* The human eye can readily detect less than 1 ppm of most dyes. Hence, colour from textile wastes causes significant aesthetic problems.
- *Accidents in the Textiles Industry:* The textiles industry is prone to many hazards that cause injury to the workers. The causes range from transport in the workplace (lift truck), dangerous large work equipment and plant, to the risk of slipping in wet working environment. Workers being struck by objects such as moving machine parts and vehicles are a significant cause of injury in the sector. There also exist the risks of fire and explosions.

4.7 Institutions/associations

The various institutions and associations of the textiles sub-sector are shown in Table 4.9.

Table 4.9: Institution/associations associated with textiles sub-sector

Knowledge Institutions	Financial Institutions	Govt. Support Institutions	BDS Providers	Associations
Sardar Vallabhbhai Patel Institute of Textile Management, Coimbatore	Small Industry Development Bank of India (SIDBI),	The Office of the Development Commissioner for Handlooms	National Textile Corporation Limited	Power Loom Owners Association, Rajasthan
National Institute of Fashion Technology (NIFT)	Rajasthan Financial Corporation (RFC)	Office of the Development Commissioner for Handicrafts, New Delhi	Central Cottage Industries Corporation of India Ltd, New Delhi (CCIC)	Cotton Textiles Export Promotion Council (TEXPROCIL)
Ahmedabad Textiles Industry Research Association (ATIRA)	Union Bank of India	All India Handicrafts Board	National Handlooms Development Corporation Ltd. (NHDC)	Carpet Export Promotion Council, New Delhi (CEPC)

Knowledge Institutions	Financial Institutions	Govt. Support Institutions	BDS Providers	Associations
Bombay Textiles Research Association (BTRA)	State Bank of India	All India Power looms Board	The Cotton Corporation of India Ltd (CCI)	Apparel Export Promotion Council, New Delhi (AEPC)
Coordination Council for Textiles Research Associations	Central Bank of India	The Cotton Advisory Board		Handloom Export Promotion Council (HEPC)
Man-made Textiles Research Association, Surat (MANTRA)	Bank of India	Development Council for the Textiles Industry		Power loom Development & Export Promotion Council (PEDEXCIL)
Northern India Textiles Research Association, Ghaziabad (NITRA)	Indian Bank	All India Handlooms Board		Export Promotion Council for Handicrafts (EPCH)
South Indian Textiles Research Association (SITRA)	Indian Overseas Bank	The Handicrafts and Handlooms Export Corporation of India, New Delhi (HHEC)		Kishangarh Yarn Merchants Association
Indian Institutes of Handloom Technology (IIHTs)	Punjab National Bank			Sizers Association, Kishangarh
Weavers Service Institution				Broker's Traders Association, Kishangarh
Punjab Institute of Textile Technology				
Indian National Institution of Fashion Designing (INIFD)				

Source: Discussion with experts and various diagnostic studies

4.8 Cluster interventions

The major cluster intervention done so far by different agencies are:

Table 4.10: Cluster initiatives in past in textiles sub-sector

Sector	Agency	Type of Intervention	Clusters	Scheme
Spinning	Ministry of Textiles	To provide interim relief to textile workers rendered unemployed as a consequence of permanent closure of any particular portion or entire textile unit	43 units in Gujarat, 5 units in Tamil Nadu, 4 units in Maharashtra, 4 units in Madhya Pradesh, 7 units in Karnataka, 2 units in West Bengal, 3 units in Punjab and 1 unit each in Delhi and Kerala	Textile Workers' Rehabilitation Scheme (TWRFS)
Powerloom	Ministry of Agriculture and Textiles	To increase productivity, improvement of quality and reduction in the cost of production and thus provide the much-needed competitive advantage to the textile industry, along with ensuring attractive returns to the farmers		Technology Mission on Cotton
	Ministry of Textiles	Setting up of power loom parks with modern weaving machinery to enhance their competitiveness in the global market		Group Workshed Scheme
	Ministry of Textiles	Marketing Development programme for Power loom sector Exposure visit of power loom weavers to other clusters Survey of the power loom sector Power loom cluster development Development and upgrading of skills (HRD)		Integrated Scheme for Power loom Cluster Development

Sector	Agency	Type of Intervention	Clusters	Scheme
Readymade Garments	Ministry of Textiles	Setting up of 40 textile parks	Andhra Pradesh (6), Gujarat (7), Karnataka (1), Madhya Pradesh (1), Maharashtra (9), Punjab (3), Rajasthan (5), Tamil Nadu (6), and West Bengal (1)	Scheme of integrated textile parks
	Ministry of Textiles	To set up apparel units of international standard	Tronica City & Kanpur (Uttar Pradesh), Surat (Gujarat), Thiruvananthapuram (Kerala), Visakhapatnam (Andhra Pradesh), Ludhiana (Punjab), Bangalore (Karnataka), Tirupur & Kanchipuram (Tamil Nadu), SEZ, Indore (Madhya Pradesh), Mahal (Jaipur, Rajasthan) and Butibori-Nagpur (Maharashtra)	Apparel Park for Export Scheme
	Central and state governments	Setting up of CETP for small units where grants up to 50% of the cost of the CETP is provided by state and Central governments	Pali (Rajashtan), Jetpur (Gujarat), Mathura (Uttar Pradesh)	Common effluent treatment plant

Sector	Agency	Type of Intervention	Clusters	Scheme
	Ministry of Textiles	To upgrade infrastructure facilities at important textile centres	Pashmylarlam-distt Medak, and Sircilla-distt Karimnagar (Andhra Pradesh) Panipat (Haryana), Indore (Madhya Pradesh) Jassol, Balotra-Bithuja belt Barmer distt and Paali (Rajasthan) Narol-Shahwadi-Ahmedabad (Gujarat) SEWA Trade Facilitation Centre, Ahmedabad (Gujarat) Pandesara-Surat (Gujarat) Tirupur, Kancheepuram and Cauvery Hi-tech Weaving Park, Komarapalayam (Tamil Nadu) Solapur, Bhiwandi and Malegaon (Maharashtra) Kannur (Kerala) Zakura (Jammu & Kashmir) Pilkhuva (Uttar Pradesh)	Textiles Centres Infrastructure Development Scheme

Source: Various diagnostic studies

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CHAPTER B5

Dyes and chemicals

5.1 Economic significance

5.1.1 The Indian dyestuff industry is only about 40 years old. The dyestuff sector is an important segment of the chemicals industry in India, having forward and backward linkages with a variety of other sectors such as textiles, leather, paper, plastics, printing inks and foodstuffs. Dyes are colouring pigments that find application in a variety of industries. The textile industry is the largest consumer of dyestuffs. This sector has now emerged as a very strong industry and a major foreign exchange earner. India is a global supplier of dyestuffs and dye intermediates, particularly for reactive, acid, vat and direct dyes. The total export of dye products has increased from ₹ 21,924 mn in 2001–02 to ₹ 41,058 mn in 2006–07.[43] Currently, all varieties of synthetic dyestuffs and intermediates are produced in India but has only a small presence in the natural dyestuff segment.

5.1.2 The main competitor China's share in the world market is estimated to be around 25 per cent. The global market share of the Indian dyes industry is between 5–7 per cent, and it is expected to increase to almost 10 per cent by 2010.

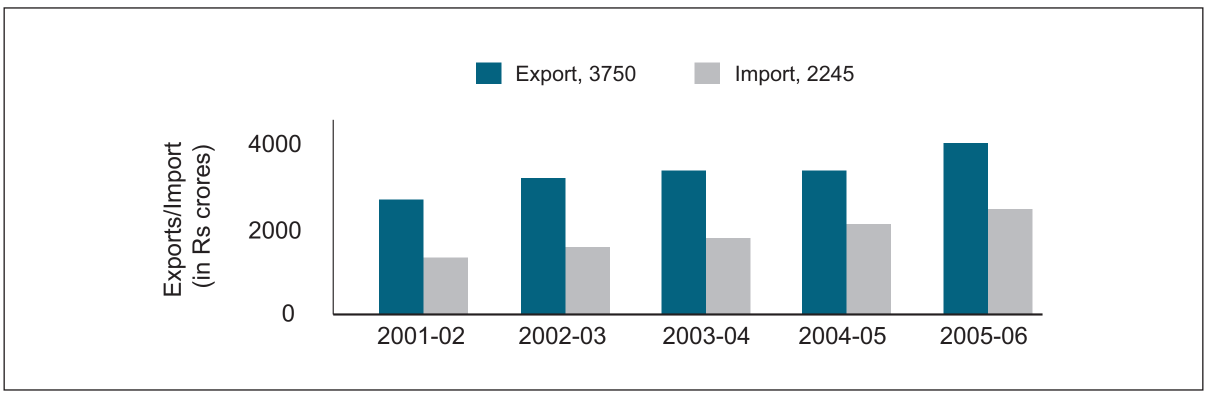

Figure 5.1: Exports and imports of dyes

Source: Ministry of Chemicals and Petrochemicals (1 crore = 10 mn)

43 Department of Chemicals and Petrochemicals

Figure 5.1 shows the growth trend of exports and imports from 2001 to 2006. This clearly indicates an increasing market for dyes and chemicals.

5.1.3 The industry is characterised by the co-existence of a small number of players in the organised sector and a large number of small manufacturers in the unorganised sector. This industry constitutes about 50 large-scale manufacturers and the remaining are small and medium scale units.[44] The small-scale units account for the majority of dyestuff production while the large units dominate the manufacturing of dyestuff intermediates.

Table: 5.1 Installed capacity of the dyestuff and intermediates sub-sector

	2003–2004		2004–2005	
	Actual (in MT)		Actual Anticipated (in MT)	
Product	Installed Capacity	Production	Installed Capacity	Production
Azo Dyes	8.7	3.9	8.7	4.5
Acid Direct Dyes (other than Azo)	0.2	0.0	0.2	0.0
Basic Dyes	0.5	0.1	0.5	0.0
Disperse Dyes	6.3	1.2	6.5	1.1
Fast Colour Bases	0.6	0.0	0.6	0.0
Ingrain Dyes	0.3	0.2	0.3	0.3
Oil Soluble Dyes (Solvent Dyes)	1.6	0.0	1.6	0.0
Optical Whitening Agents	1.1	0.3	1.1	0.3
Organic Pigment Colours	12.3	11.3	12.3	13.3
Pigment Emulsion	6.4	2.4	6.4	2.5
Reactive Dyes	6.2	2.3	6.2	2.7
Sulphur Dyes (Sulphur Black)	3.3	2.9	3.3	2.4
Vat Dyes	2.9	1.0	2.9	1.1
Solubilised Vat Dyes	0.1	0.0	0.1	0.0
Food Colours	0.1	0.0	0.1	0.0
Nepthols	3.5	0.5	3.6	0.5
Total	54.1	26.1	54.4	28.7

Source: www.gujexim.com

44 http://www.gujexim.com/tradeleads_chem_dyes.htm

The dye industry is also classified based on its application, as shown in Table 5.2.

Table 5.2: Classification of the dye industry based on application of dyes

Type of dye	Main Use
Acid	Wool, silk, nylon, leather
Azoic	Cotton
Basic	Acrylic, jute, paper
Direct	Cotton, synthetics, paper, leather
Disperse	Polyester, synthetics
Food Colours	Colouring food, candies, confections and cosmetics
Ingrain	–
Metal Complex	Cotton fabrics
Mordant	Wool
Optical Brightening, whitening agents	Whitening textiles, plastics, paper, soap
Pigment	Paint industry, plastics, leather, paper
Reactive	Cotton, wool
Solvent dyes	Colour oils, waxes, varnishes, shoe, dressings and gasoline.
Sulphur	Cotton, synthetics
Vat	Cotton, synthetics
Total	

Source: Central Pollution Control Board

5.1.4 Direct and reactive dyes constitute the largest product segments in the country, constituting nearly 35 per cent of dyestuff consumption due to a greater use of polyester and cotton-based fabrics. These two segments have the largest share on account of dominance of textile and synthetic fibres in dyestuff consumption.

5.2 Geographical concentration of dyes and chemicals sub-sector

5.2.1 There are a few geographical concentrations of small and micro units of dye manufacturers into clusters. Table 5.3 provides the list of dyes clusters in India. The dyes clusters are located mainly in Gujarat.

Table 5.3: Spread of dyes and chemical sub-sector in India

State	Location	No. of units	Type of Dye
Gujarat	Ahmedabad	600	Reactive, direct, vat, sulphur, azo, acid
Gujarat	Ankhleshwar	150	
Gujarat	Vadodra	32	
Gujarat	Himatnagar	4	
Gujarat	Jetpur	20	
Gujarat	Keda	7	
Gujarat	Rajkot	10	
Gujarat	Surat	150	
Gujarat	Vapi	600	
Maharashtra	Tarapur	500	Not available
Maharashtra	Konkan	300	
Maharashtra	Thane/ Belapur	30	
Maharashtra	Dombivali	75	
Maharashtra	Aurangabad	42	
Others		80	
Total		2,600	

Source: Discussions with experts

5.2.2 From Table 5.3 it can be seen that the distribution of these units is skewed towards the western region (Maharashtra and Gujarat), which accounts for more than 90 per cent of the total number of units. In fact, almost 70 per cent of the total capacity is in the state of Gujarat alone.

Out of the total production, 60 per cent is contributed by large and medium units and the remaining 40 per cent by small units (see Figure 5.2).

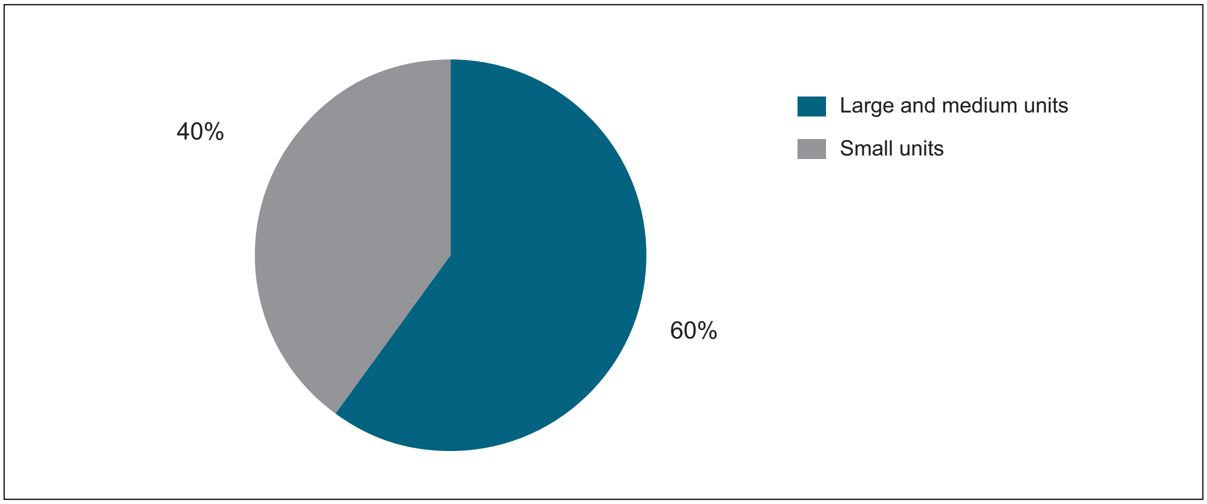

Figure 5.2: Production share of small and large & medium-sized units

The manufacturing process of dyes is provided in the following section.

5.3 Production process

5.3.1 Dyes are synthesised in a reactor, filtered, dried and blended with other additives to produce the final product. The synthesis step involves reactions such as sulfonation, halogenation, amination, diazotisation, and coupling,[45] followed by separation processes that may include distillation, precipitation and crystallisation. Temperature is controlled in the process by adding ice to the reaction tank. Then a dye mixture is prepared which is filtered and purified. After this the mixture is dried, ground and standardised to make the final product. The dyes industry consumes large quantities of water.

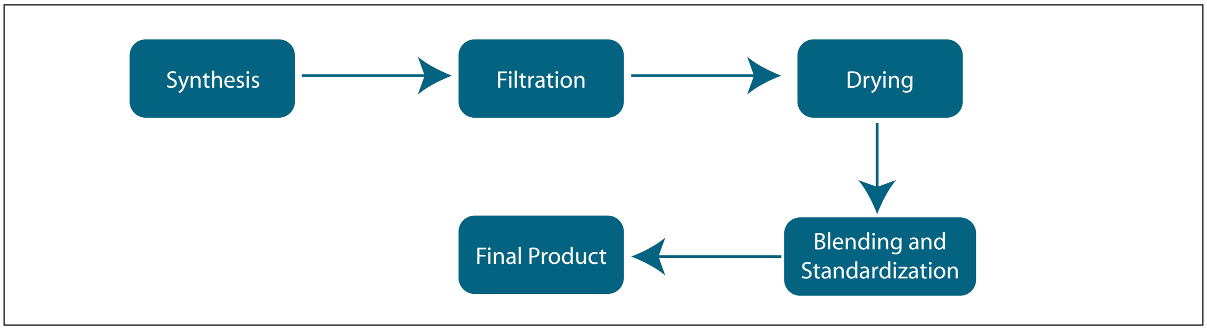

Figure 5.3: Production process of dyes sub-sector

45 Sulfonation – The introduction into an organic molecule of the sulfonic acid group (or its salts), – SO3H, where the sulphur atom is joined to a carbon atom of the parent molecule.
Halogenation – It is a chemical reaction that incorporates a halogen atom into a molecule.
Amination – It is the process by which an amine group is introduced into an organic molecule.
Diazotization – It is the reaction between a primary aromatic amine and nitrous acid to give a diazo compound; also known as the diazo process.

5.4 Energy intensity in dyes and chemicals sub-sector

5.4.1 The major energy-consuming equipment used in the dye manufacturing are the pressure vessel, dryer, boiler and mixer. Energy costs constitute 5–8 per cent of the total production cost. The major cost is of raw materials, which is as high as 65 to 70 per cent.

Detailed information on energy consumption for two clusters, Ahmedabad and Vapi, is given below in Table 5.4.

Table 5.4: Fuel usage[46] in two dyes and chemicals clusters

	Vapi		Ahmedabad	
	Qty consumed per annum	No. of units using the fuel	Qty consumed per annum	No. of units using the fuel
Electricity	30,857,544 units	203	6,142,878	149
Light Diesel Oil	2,207,160 litres	134	299,760 litres	22
Firewood / Husk	4,086 tonnes	47	45,534 tonnes	142
FO	1,108,944 litres	29	–	
High Speed Diesel (HSD)	181,200	8	–	
Pressurised Natural Gas (PNG)	–	–	784,200 kg	25
Coal/Hard Coke	–	–	3,300 tonnes	2

Source: Energy efficiency study by Bureau of Energy Efficiency

Table 5.4 shows that most units in both clusters use electricity as a fuel for preparing dyes and chemicals. In Vapi, the next major fuel used is light diesel oil while in case of Ahmedabad, firewood/husk is used as this is easily available from the local traders at the rate of ₹ 3 per kg. PNG is used by only 25 units as the cost of gas consumption is high at the rate of ₹ 15.50 and 15 per cent VAT is additional. Also, gas service is offered if the minimum consumption is 100 units per month.

Using the formula: coal (MT) * 0.52*44/12, the total carbon dioxide emitted by 2 units is 6,292 tonnes per annum. Assuming 48 per cent impurity in coal, the carbon content is 52 per cent (atomic wt of C is 12 and O is 16).

46 Situation Analysis Report by BEE — Vapi and Ahmedabad Clusters

Table 5.5: Cumulative raw material usage in dyes and chemicals sub-sector

	Raw Material	Quantity
Ahmedabad	Sulphuric Acid, Hydrochloric Acid, Acetylic Acid, Chlorine gas, Benzene, Sodium Nitrate, Pigments, Soda, Methylene, Ethylene, Ammonia, Disulphonic Acid, etc.	Due to the variety of products being manufactured, the raw materials are different for each set of units.
Vapi	Hydrochloric Acid, Lead Oxide, Butyl, Methylene, Caustic Soda, Sulphuric Acid, Soda Ash, Sodium Sulphate, Lithium Carbonate, Various Solvents, etc.	

Source: Situation analysis report on Vapi and Ahmedabad dyes and chemicals cluster by the Bureau of Energy Efficiency

5.5 Environmental issues in dyes and chemicals sub-sector

The dyes sector has been listed under "Red Category" as per the standards specified by the Central Pollution Control Board on the basis of its generation and discharge of hazardous wastes. It is one of the 17 industries identified by CPCB to be among the most polluting. For the leather sector, environmental effluent standards have been set for waste discharges. The minimum national standard for the dyes and dye intermediaries industry is given in Table 5.6.

Table 5.6: Minimum national standard for dyes and dye intermediary industry

Parameter	Concentration not to exceed mg/l*
pH	6.0–9.0
Colour, hazen unit	400
Suspended Solids	100
BOD (Biological Oxygen Demand)	100
Oil and grease	10
Phenolics	1.0
Cadmium	0.2
Copper	2.0
Manganese	2.0
Lead	0.1
Mercury	0.01

Parameter	Concentration not to exceed mg/l*
Nickel	2.0
Zinc	5.0
Chromium	Hexavalent – 0.1 Total – 2.0
Bio assay test	90% survival in 96 hours

*Except pH, colour and bio assay test
Source: CPCB

The environmental issues associated with this sector primarily include the following:

- Wastewater
- Air emissions
- Solid waste
- Hazardous materials

5.5.2a Dyes clusters mainly lead to water pollution. The usage of water is also very high in this sector.

Wastewater: The sources of wastewater generation are:

Process water: This is mainly the mother liquor left over after the product is isolated and separated by the filter press. This wastewater, although smaller in volume, has a high concentration of pollutants.

- Washing and rinsing wastes, i.e., washing of reaction kettles, filter press, floors, etc.
- Cooling water bleed and boiler blow-down: This happens during synthesising when ice is added to control the temperature.
- Sanitary and other miscellaneous wastewater.

Table 5.7: Wastewater pollutants in dyes and chemicals sub-sector

S No	Pollutants
1	High levels of biochemical oxygen demand (BOD) and chemical oxygen demand (COD): The wastewater generation rate for vat dyes is of the order of 8,000 l/kg of product. The BOD and COD levels of reactive and azo dyes are of the order of 25 kg/kg of product and 80 kg/kg of product, respectively.
2	High acidity
3	High total dissolved solids (TDS)
4	Deep colour of different shades: This contains many chemicals left after dye synthesis
5	High levels of chlorides and sulphates
6	Presence of phenolic compounds
7	Presence of heavy metals such as copper, cadmium, lead, manganese, mercury, nickel and zinc
8	Presence of oil and grease present in the wastewater streams

Since wastewater is a major concern in this sub-sector, a high-tech internal collection system and an advanced treatment plant has been developed by The Green Environment Co-operative service in the Ahmedabad dyes and chemicals cluster wherein it collects the primarily treated liquid effluent and gives it secondary treatment and proper disposal.

The water usage in the dyes industry is mainly for:

- Synthesis of dyes and dye intermediaries
- Steam generation and cooling system
- Washing and rinsing of reaction kettles, filter press, floors, etc.
- Domestic and other miscellaneous activities

The rate of water consumption depends on the feed material, synthesis reaction and the desired product. The change of product pattern requires cleaning and washing, which consumes substantial quantities of water. In general, process water consumption is highest, next is the cooling and boiler make-up water requirement, and water needs for domestic purposes is the lowest.

Thus water consumption in this sector largely depends on:

- Type of dye produced
- Number of products
- Gross production

- Pattern of working of the factory (continuous or on shift only)
- Frequency of change of product pattern

Table 5.8: Water consumption and wastewater generation during production of various types of dye products

Type of Product	Range litres/kg. of Product	
	Water Consumption	Wastewater Generation
Direct Dyes	2.5–667	1.0–644
Reactive Dyes	2.0–186	2.0–157
Basic Dyes	60–4,200	50–200
Azo Dyes	90–400	8.0–213
Vat Dyes	1,528–10,345	1,389–7,980
Dye Intermediaries	36–230	9.0–74
Naphthol Dye	6.0–17	5.0–8.0
Pigments	93–923	7.0–785
Indigosol Colours	529	429
Disperse Dyes	70	12–42.5
All Varieties of dyes/ intermediates	13–2,300	11–1,146

Source: Central Pollution Control Board

The generation of wastewater follows the trend of consumption of water. Table 5.8 shows that 1 kg of vat dye consumes 1,528–10,345 litres of water, which is the highest among all dyes whereas naphthol dye consumes the least quantity of water, i.e., 6–17 litres. The maximum quantity of water is wasted in vat dyes, which is about 90 per cent of the water consumed. The quantity of water consumed depends on:

- Number of batches of products manufactured in a day, week or month
- The duration of synthesis of the dye in the reactor vessel
- Duration of the washing and rinsing operations

5.5.2b *Air emission*

Table 5.9: Air emission in dyes and chemicals sub-sector

S No.	Pollutants
	The principal air pollutants from dye manufacturing are volatile organic compounds (VOCs), nitrogen oxides (NO_X), hydrogen chloride (HCl) and sulphur oxides. Reaction vessels: In the dye industry, emissions are generated from reaction vessels. These emissions are scrubbed with water *Steam Generation plant:* The other emissions are generated from the steam generation plant and captive power plants.

5.5.2c *Solid Waste*

Table 5.10: Solid waste pollutants in dyes and chemicals sub-sector

SNo.	Pollutants
1.	Filter press from the process house and container residues
2.	Physico-chemical wastewater treatment plant
3.	Biological wastewater treatment plant, spent acids and process residues from the manufacture of chrome yellow and orange pigments, molybdate orange pigments, iron blue pigments, azo dyes, etc.

5.6 Social issues in dyes and chemicals sub-sector

- In Gujarat, many big dyes and chemicals units did not have proper CETPs and thus discharged wastewater into the drainage system or underground water. As a result, the underground water in the inner and outer regions of Gujarat was totally damaged and coloured water starting coming into bore wells. This led to the closure of some of the most polluting units by order of the High Court.
- Many acids like sodium hydroxide/hypochlorite, acetic acid and sulphuric acid caused the problem of skin burns and scalds among workers.
- Many different groups of chemical substances are used, which leads to respiratory problems like bronchitis, cancer, etc.
- Since the workers work with different dye colours, it is has been found that their skin colour often changes to the colour of the dye.
- Women are also employed especially in the packaging processes.
- The workforce is not trained in machine handling and other systems.
- The working conditions and the infrastructure are not proper.

- According to a study conducted by the non-profit Blacksmith Institute, Vapi is among the top ten most polluted regions in the world. Vapi's distance from sources of clean water has forced residents to consume the town's contaminated water. As a result, incidences of respiratory diseases, carcinoma, skin and throat cancers, birth defects, and infertility are high in Vapi.

5.7 Institutions/associations

The major knowledge institutions and associations for dyes and chemicals are shown in Table 5.11.

Table 5.11: Knowledge institutions and associations for dyes and chemicals sub-sector

Institutions	Associations
ITI Kubernagar	Gujarat Dyestuff Manufacturers' Association (GDMA),
Ahmedabad Textiles Industry Research Association (ATIRA)	Gujarat Industrial and Technical Consultancy Organisation Ltd (GITCO)
Bombay Textiles Research Association (BTRA)	Gujarat Chemical Association, GCA
University Institute of Chemical Technology (UICT)	Gujarat State Plastic Manufacturers' Association (GSPMA)
Department of Chemicals and Petrochemicals	Vatva Industries Association (VIA)
MSME – DI, Ahmedabad	The Green Environment Service Co op. Soc Ltd., Vatva Green
MSME – DI, Maharashtra	Naroda Industries Association (NIA)
Gujarat Chambers of Commerce and Industry	Association of Chemical Technologists India (ACTI)
Gujarat State Small Industries Federation	Odhav Industries Association (OIA)
	Chemical Association of India (CAI)
	Ahmedabad Management Association
	Federation of Industries and Associations

Source: Various diagnostic studies

5.8 Cluster interventions

Table 5.12: Cluster interventions in the past in dyes and chemicals sub-sector

Implementing Agency	Type of intervention	Clusters	Duration of intervention
Bureau of Energy Efficiency (BEE)	Conducted a study to evaluate energy consumption and potential for energy management by SME units in Ahmedabad and Vapi dyes clusters	Ahmedabad	
GITCO	Setting up of Common Facility Centre. It is estimated at about 10% dyes is lost during washing as spray dryers are used during mechanical filtration of water.	Vatva, Odhav, Baroda, Ankaleshwar	2009–10

Source: Discussions with experts

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http://220.156.189.23/schemes/documents/smes/Vapi.pdf

http://chemicals.nic.in/chem1.htm

http://www.cpcb.nic.in/Industry-Specific-Standards/Effluent/425.pdf

http://www.gujexim.com/tradeleads_chem_dyes.htm

www.gujexim.com

CHAPTER B6

Electroplating

6.1 Economic significance

6.1.1 In India, the electroplating sector got firmly established in the 1930s when job shops were set up in Mumbai and Delhi especially to cater to the automobile and two-wheeler sectors. Initially most chemicals required by the industry were imported. In the second half of 1950s, indigenous manufacture of plating chemicals and accessories had begun and since the 1960s, the industry has seen phenomenal growth. Today the industry is worth over ₹ 4,500 mn and is witnessing an average growth of around 15 per cent per annum. The total direct employment generated by this sector is 50,000.1

6.1.2 It is difficult to determine the distribution of production between the organised and small-scale/tiny/unorganised sectors. However, judging by the consumption of chemicals and additives, it is estimated that about 18,000 tonnes are consumed by the organised sector, while the tiny and unorganised sectors consume about 10,000 tonnes. Therefore, approximately 36 per cent of the industry is contributed by the unorganised sector.[47]

6.2 Geographical concentration of electroplating clusters sub-sector

Table 6.1: Spread of electroplating sub-sector in India

State	Geographical Concentration
Punjab	Govindgarh, Ludhiana
Punjab	Chandigarh
Himachal Pradesh	Parwanoo
Tamil Nadu	Chennai
Tamil Nadu	Madurai
Tamil Nadu	Coimbatore
Karnataka	Bangalore
Haryana	Faridabad, Sector-58

47 COINDS 2008, CPCB

State	Geographical Concentration
Maharashtra	Mumbai
Maharashtra	Nasik
Maharashtra	Pune
Gujarat	Surat
Gujarat	Ahmedabad
Gujarat	Rajkot
Delhi	Wazirpur, Delhi
Delhi	Anand parbat
Delhi	Okhla Industrial Estate
Delhi	Mayapuri
Andhra Pradesh	Secunderabad
Uttar Pradesh	Noida, Gautam Budh Nagar

Source: Discussions with experts

The major clusters are located in Ludhiana, Delhi (4 clusters), Chennai, Mumbai and Ahmedabad.

6.3 Production process

6.3.1 In electroplating clusters, work is now done using semi-automatic processes which was earlier done manually. The main reason for technology up-gradation is vendors' demand and to stay ahead of competition but government policy and lack of capital are the two hindrances in technology up-gradation. These clusters face the problem of increasing costs of raw materials and inadequate power supply. The details of two medium-size clusters are discussed in the following sub-sections.

6.3.1.1 In the Pune cluster, there are over 250 electroplating/surface coating units with a gross turnover of ₹ 225–270 mn per annum and providing employment to around 3,500 skilled/unskilled workmen. These are located in industrial estates in Bhosari, Pimpri and Chinchwad.

6.3.1.2 In the Faridabad cluster, there are 292 electroplating units with a gross turnover of around ₹ 198 mn per annum and providing employment to around 2,100 skilled/unskilled workmen. This cluster is located in Sector 58 of Faridabad, Haryana. The details given by the Metal Finishers Association of Faridabad is provided in Table 6.2.

Table 6.2: Enterprises in Faridabad

Plot Size (sqm)	No. of Plots	Employees per Firm	Total No. of Employees	Total Turnover (₹ mn/month)
115	157	6	942	2.7
225	95	7	665	3.24
450	40	12	480	10.8
Total	292		2087	16.74

Source: Discussions with experts

6.3.2 *Definition of Electroplating:* Electroplating is a plating process that uses electrical current to reduce cations[48] of a desired material from a solution and coat a conductive object with a thin layer of the material, such as a metal. It is one of a variety of techniques of metal finishing. Various types of plating methods are used to make precious metal solutions and ancillary items.

6.3.3 Electroplating is primarily used for depositing a layer of material (generally metal like chromium to a combustion ampere of at least 563 volts) to bestow a desired property (e.g., abrasion and wear resistance, corrosion protection, lubricity, aesthetic qualities, etc.) to a surface that otherwise lacks that property. Another application of electroplating is to build up thickness on undersized parts.

The process involves pre treatment (buffing, cleaning, degreasing and other surface preparation steps), plating and post treatment (rinsing, passivating and drying). In the plating process, the object to be plated is usually used as the cathode in an electrolytic bath containing metal salts. Plating solutions are acid or alkaline and may contain complexing agents such as cyanides. After plating, the plated items are rinsed with water. After rinsing, the items are dried by either normal air drying or hot air drying or in an oven. The rinsing can either be manual or mechanised (automatic).

The estimated total electricity consumption in this sub-sector is 288 mn units. The estimated value is ₹ 1296 mn [{(28.8*5)/5000}*45*1000]. The main sources of energy are electricity and diesel.

6.4 Environmental issues in electroplating sub-sector

6.4.1 The electroplating industry causes air and water pollution and also generates solid wastes. Environmental pollution is caused in the following ways:

48 A cation (+) (/□kaet.a□.ən/KAT-eye-ən), from the Greek word KATÁ (katá), meaning "down", is an ion with fewer electrons than protons, giving it a positive charge.

- By directly reacting with air, water and soil, resulting in degeneration or disintegration;
- By accumulating as persistent chemicals (geo-accumulation);
- By entering environmental pathways and transcending from non-living to living beings, causing toxicity to living organisms; and
- By entering into the food chain, finally affecting humans and cattle.

6.4.2 The major pollutants are:

Air emissions (particulates, gases and vapours): It contains toxic organics such as trichloroethylene and trichloroethane. The solvents and vapours from hot plating baths result in elevated levels of volatile organic compounds (VOCs) and, in some cases, volatile metal compounds which may contain chromates.

Water pollution (both in soluble and suspended form): Any or all of the substances used in electroplating (such as acidic solutions, toxic metals, solvents and cyanides) is found in wastewater, either through rinsing of the product or from spillage and dumping of process baths. The overall wastewater stream is typically high in heavy metals, including cadmium, chrome, lead, copper, zinc, nickel, cyanides, fluorides and oil and grease.

Solid and Hazardous Wastes: Solid wastes include sludge generated from wastewater treatment, cleaning and bath tanks and various residues like, cleaning powder, buffing compounds, spent anodes and various scraps. Unused chemicals, spent resins from ion exchange/metal recovery systems also contribute to solid wastes. Much of the solid wastes contain hazardous and toxic substances.

6.4.3 Exhaust fans that are installed in the electroplating units have a capacity of 14.2 cu m/min (500cfm) to 28.5 cu m/min (1000 cfm). Therefore 8,523 cu m/day (0.3mn cfm) of contaminated air is generated by each unit even if we estimate it on the lower side, i.e., 14.2 cu m/min (500 cfm) as exhaust and 10 hours per day of operation. Assuming 250 units per cluster, the total volume of contaminated air produced by 20 clusters is 15.30 bn m^3 per year.[49]

6.4.4 Every unit releases a minimum of 200 litres (based on an estimate by one unit owner in Faridabad) of waste water per day. On an average, 50 kilolitres of waste water (common ETP capacity is 100 Kl per day in Faridabad) is being discharged in every cluster every day, assuming there are 250 units per cluster. For all the 20 clusters, the total discharge is at least 0.36 mn kilo litres per year. The industry consumes about 36,000 litres of chemicals of which approximately 50–70 per cent finds it way into the wastewater discharged.

6.4.5 Each cluster generates at least 50 kg of solid waste (assuming 1 kg sludge from 2,000 litres of waste water and 100 gm of other wastes like grease, oil, etc., per day from factory) every day. Therefore, the total waste generated by every cluster is 18.25 tonnes per year. All the clusters together contribute 365 tonnes in a year.

49 35.2cfm=1cum/min

6.4.6 The state of Common ETP is generally non-functional. According to industry opinion, there is a lot of scope for minimising the waste and reusing the recovered metal. Since the waste is highly toxic, interventions should be initiated as soon as possible in order to avoid any harmful impact of such wastes. This is an urgent need of the industry.

Table 6.3: Effluents from the electroplating industry as per standards of CPCB (mg/litre, except for pH)

Parameter	Maximum value
pH	6.0 to 9.0
Temperature	Shall not exceed 5°C above the ambient temperature of the receiving body
Oil & Grease	10
Suspended Solids	100
Cyanides (as CN)	
Ammoniacal Nitrogen	50
Total Residual Chlorine (as Cl)	1.0
Cadmium (as Cd)	2.0
Nickel (as Ni)	3.0
Zinc (as Zn)	5.0
Hexavalent Chromium (as Cr)	0.1
Total Chromium (as Cr)	2.0
Copper (as Cu)	3.0
Lead	0.1
Iron	3.0
Total Metal	10

Source: EPA Notification {S.O. No.393 (E) dated 16 April 1987}

These standards have generally been adopted by the State Pollution Control Boards and used to issue consent orders and for monitoring of quality of wastewater discharge.

6.4.7 Current practices of Effluent treatment

a) Wastewater Treatment: The main treatment processes are equalisation, pH adjustment for precipitation, flocculation and sedimentation/ filtration. The optimum pH for metal precipitation is usually in the range of 8.5–11, but this depends on the mixture of metals present. The presence of significant levels of oil and grease affect the effectiveness of the metal precipitation process; hence, the level of oil and grease affects the choice of treatment options and the treatment sequence. It is preferred that the degreasing baths be treated separately. Flocculating agents are sometimes used to facilitate the filtration of suspended solids. Pilot testing and treatability studies are necessary, and final adjustment of pH and further polishing of the effluent is required.

b) Air Emissions Treatment: Exhaust hoods and good ventilation systems protect the working environment, but the exhaust streams should be treated to reduce VOCs and heavy metals to acceptable levels before venting to the atmosphere. Acid mists and vapours should be scrubbed with water before venting. In some cases, VOC levels of the vapours are reduced by use of carbon filters which allow the reuse of solvents, or by combustion (and energy recovery) after scrubbing, adsorption or other treatment methods. 90 per cent recovery of the quantity of VOCs released from the process is required.

6.5 Social issues in electroplating sub-sector

6.5.1 The workers are exposed routinely and persistently to the pollutants in the environment of the electroplating unit and suffer from various health problems. Over a period of time, such exposures, even at a low level, have been known to cause diseases and various infirmities. The employed labours are mostly illiterate and are not aware of the safety procedures or the impact of pollutants on their health. Masks and Safety gloves are generally not used.

6.6 Institutions/associations

a) *WMC in Pune electroplating units by NPC:* With the introduction of the WMC concept by M/s EMCON consultants as WMC facilitator with NPC's support, eight entrepreneurs teamed up as WMC member units. The WMC member units are partnership firms, proprietary or limited companies. They have been set up during the period 1979–1994 and have a current annual turnover in the range of ₹ 1.08–3.6 mn, while producing a gross volume ranging between 300–800 tonnes per annum of electroplated components. They employ between 10–20 workmen, including supervisors, and undertake electroplating work for a wide range of components.[50]

b) *Electroplating Industrial Park, Karaisalkulam, Madurai:* Eighty electroplating units came together to form an association called 'Electroplating and Metal Finishers Association of Tamil Nadu' (EPMFAT) in the year 2000. For the purpose of building and operating the park, a Special Purpose Vehicle (SPV) 'Madurai Eco Electroplating Industrial Park Private Ltd', has been formulated that has equity participation of all the 80 industrial units. The project encompasses both management and technological treatment of hazardous effluents with the aim of avoiding the generation of metallic sludge. The objective is to set up an Eco-Electroplating Park using environmentally clean technology with zero liquid discharges and to introduce enterprises with

50 'Waste Minimisation Circle News' National Productivity Council, Vol 3, No.2, June 2002.

tools and techniques of cleaner production. The park is being developed on 10 hectares of land and will house 80 industrial sheds with supporting infrastructure, pollution control and resource recovery infrastructure, including environmental enhancement measures such as rainwater harvesting and landscaping and development of a green belt. The total capital investment for the park is estimated to be ₹ 306 mn. The entire cost is being borne by CPCB and the state government.

The partners in this project are:

- German Technical Cooperation Agency (GIZ) under the 'Advisory Services for Environmental Management' (ASEM) — to provide the technical guidance.
- IL&FS Ecosmart Ltd. is assisting the SPV in raising financial support for the project.
- European Union is providing the technology demonstration grants for a wastewater treatment plant.
- Central Pollution Control Board (CPCB) is providing 50 per cent of the grant for the common effluent treatment plant (CETP).
- The state government is providing the balance 50 per cent of the grant for the CETP.
- Electroplating and Metal Finishers Association of Tamil Nadu (EPMFAT).

c) *Metal Finishers Association of India (MFAI)* is the apex body of industry associations for the metal plating industry in India and is based in Mumbai. There are local Metal Finishers Associations at the cluster level under the umbrella of MFAI. The programmes of these associations are partly successful but not very effective. Common ETPs have been installed in some clusters like Ludhiana and Faridabad but these are not being maintained properly. Firms in these clusters complain that they are not functional and are bypassed.

d. *Centre for Electro Chemical Research Institute (CECRI), Karaikudi, Tamil Nadu,* is a premier institute which is working in the R&D for electroplating and metal finishing and has a special cell.

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CHAPTER B7

Brick kilns

7.1 Economic significance

7.1.1 In India, brick making is a traditional, unorganised industry, generally confined to rural and semi-urban areas. According to the All India Brick manufacturer's Association, it is one of the largest employment-generating industries, employing around 10 mn workers), since hard work is needed to transform clay from the soil into green bricks and transporting them to the kiln for firing. The status of their technology has remained virtually stagnant over the last 100 years, with very few improvements in brick-making procedures. This leads to inefficient utilisation of energy and thereby resultant increase in the production cost of bricks. The rich, clayey soil of river banks is the raw material for a whopping 140 billion bricks a year.[51] Produced in over 100,000 brick kilns in India, these are part of a large but unorganised, brick-making industry in the country. This industry is the third largest consuming industry of coal in India after steel and power industry.

7.2 Geographical spread of clusters

7.2.1 These brick-making units often exist in clusters spread across the country. The highest number of brick-making units is in Uttar Pradesh (33 per cent of national production) followed by Bihar, West Bengal, Tamil Nadu, Punjab and Gujarat. Some of the brick-making clusters in India are shown in Table 7.1.

51 TERI, VSBK Technology, Brick by Brick, FAO study

Table 7.1: Spread of brick-making sub-sector in India

S.No.	State	Geographical Concentration	S. No	State	Geographical Concentration
1	Madhya Pradesh	Indore	2	Haryana	Rohtak
3	Madhya Pradesh	Sangam Nagar	4	Haryana	Jhajhar
5	Madhya Pradesh	Gwalior	6	Haryana	Hissar
7	Madhya Pradesh	Bhind	8	Punjab	Amritsar
9	Madhya Pradesh	Sehore	10	Punjab	Gurdaspur
11	Madhya Pradesh	Datia	12	Punjab	Ludhiana
13	Tamil Nadu	Tirunelveli	14	Punjab	Jallandhar
15	Karnataka	Kolar and Malur	16	Jammu and Kashmir	Jammu
17	UP	Aligarh	18	Gujarat	Ahmedabad
19	UP	Kanpur	20	Maharashtra	Pune
21	UP	Varanasi	22	Tripura	Agartala
23	UP	Bareili	24	Assam	Gauhati
25	UP	Gorakhpur	26	West Bengal	24-Parganas
27	UP	Jaunpur	28	West Bengal	Asansol
29	UP	Moradabad	30	Chattisgarh	Raipur
31	UP	Ghaziabad	32	Chattisgarh	Janjgir
33	UP	Meerut	34	Chattisgarh	Raigarh
35	UP	Muzaffarnagar	36	Rajasthan	Kota
37	Haryana	Bhiwani	38	Orissa	Rayagada
39	Haryana	Faridabad	40	Orissa	Puri
41	TN	Coimbatore	42	Kerala	Calicut
43	TN	Madurai	44	Maharashtra	Nagpur
45	TN	Chennai	46	Jammu and Kashmir	Srinagar
47	Rajasthan	Jaipur	48	Bihar	Arah
49	Bihar	Patna			

Source: In consultation with brick sector and cluster experts.

7.3 Production process

7.3.1 To understand the energy and environmental implications of the sector, it is vital to explore the brick manufacturing process. The manufacturing process of brick involves transformation of clay from soil into green brick. The clay is pugged by feet and then moulded into bricks by hand and sun dried. These moulded bricks, called green brick, are then fired in kilns at high temperature followed by cooling to the ambient temperature. During the heating and cooling process several changes take place, which include "... removal of moisture or drying of bricks; combustion of inherent carbonaceous matter; decomposition of the clay molecules and evaporating of chemically combined water; and finally vitrification, a process of forming new mineral phases include liquid phases, which on cooling set as glass phases and provide strength to the fired brick...." (Sameer Maithel and Urs Heierli). Thus, energy is consumed in the process of firing and is dependent on the typology of kiln used in the process.

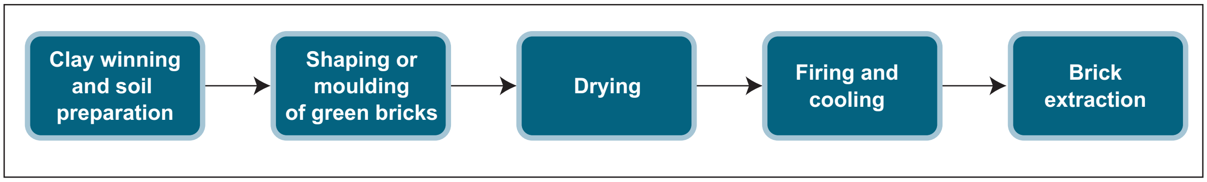

Figure 7.1: Brick-making process

7.4 Energy intensity of the brick kiln sector

7.4.1 Brick manufacturing is a highly energy intensive sector and the share of energy in the total cost of brick production amounts to 35–50 per cent.[52] Coal consumption in the sector is approximately 8 per cent of the total coal consumption in the country. The quantity of coal consumed in the production process of brick depends on the typology of kiln used.

7.4.2 Brick kilns are classified as intermittent kilns and continuous kilns. The production capacity of intermittent kilns is low in comparison to continuous kilns, and generally ranges from 5,000–500,000 bricks per firing. The energy efficiency and quality of brick is also low in intermittent kilns as compared to continuous kilns.

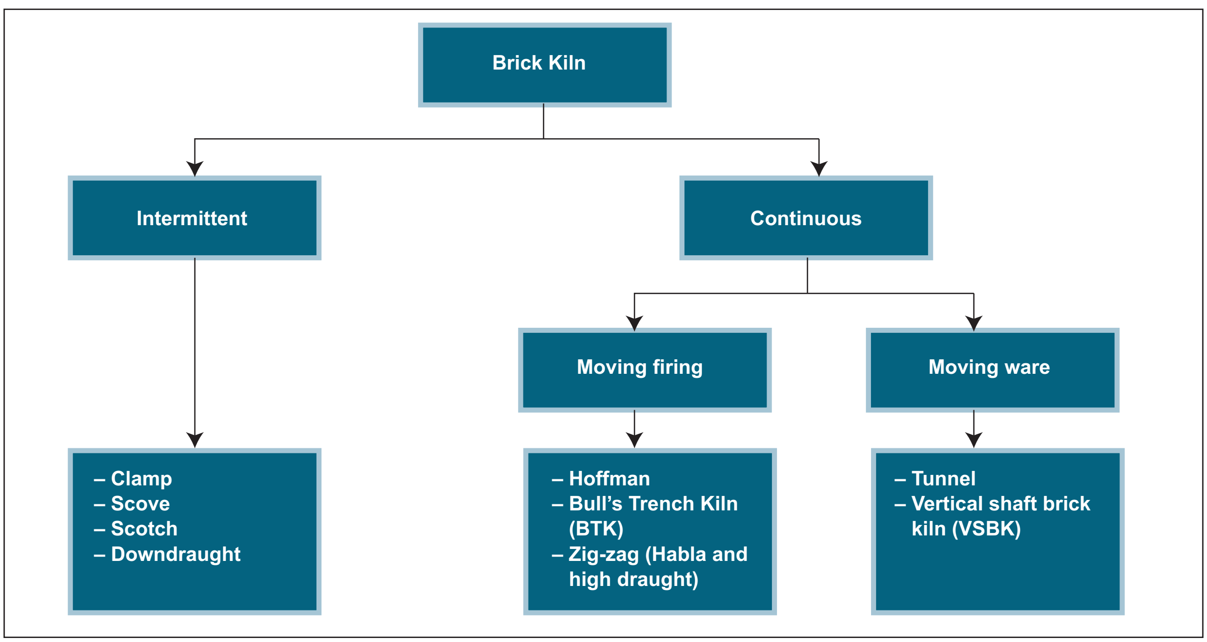

Figure 7.2: Different types of kilns

52 The Brick Industry, Central Pollution Control Board.

7.4.3 Coal is the main source of energy used for firing bricks in India. The next choice of fuel is biomass, including fuel wood. In one of the studies undertaken by the FAO (2000) the use of fuel wood in the entire brick industry in the country is reported to be 300,000 tonnes/year, while the use of coal is reported to be about 14,000,000 tonnes/year. Thus, use of fuel wood represents a very small fraction (less than 2 per cent in terms of energy inputs) of the total energy requirement of the brick industry in India. The energy consumption of the different types of kilns is provided in Table 7.2.

Table 7.2: Comparison of kilns: Energy use

Type of kiln	Specific Energy Consumption (MJ/ kg of fired brick)	Specific coal consumption (tons/ 100,000 bricks)
Continuous kiln		
VSBK	0.7–1.0	11–14
Zig-zag kiln	0.9–1.1	13–16
Fixed Chimney BTK	1.4	16–20
Moveable Chimney BTK	1.2–1.75	18–24
Tunnel kiln	1.4–1.7	20–24
Intermittent kiln		
Clamp and other batch kiln	2.0–4.5	28–50

Source: Sameer Maithel and Urs Heierli, 2008.
Note: Assuming GCV (Gross Calorific Value) of coal as 5000 kcal/kg and fired brick weight of 3 kg/brick

7.4.4 As inferred from Table 7.2, VSBK is the most efficient kiln with lesser energy consumption in comparison to other kilns used for firing bricks. Thus there exist a huge potential to save coal by upgrading BTKs to VSBKs. However, the choice of kiln is also dependent on the typology of soil used for brick making. To calculate the total amount of coal that can be saved by moving from BTK to VSBK, let us first look into the production of brick by typology of kilns used. The estimated annual production of brick by different typology of kiln in India is provided in Table 7.3.

Table 7.3: Brick kilns in India

Type of Kiln	Annual Production capacity (100,000 bricks/ year)		Approximate number of kilns	Total Annual production capacity (100,000 bricks/ year) [53]	Main fuel
	Range	Average			
Clamp	0.5–10	5	>60,000	300,000	Biomass, fire wood, rice husk, dung, coal and lignite.
Moving chimney BTKs	20–80	30	8,000	240,000	Coal
Fixed Chimney	30–100	50	25,000	1,250,000	Coal
VSBK	5–40	15	30	4,500	Coal
High Draft Kiln / zig-zag (HDK)	30–50	40	200	8,000	Coal
Total				1,802,500	

Source: In consultations with experts from Development Alternatives and Greentech Knowledge Solutions Pvt. Ltd.

7.4.5 As can be observed from Table 7.3, the estimated annual production capacity of the brick sector is around 180 billion bricks per year. However, the actual production of the brick sector is estimated to be around 140 billion bricks per year. This reveals a below capacity production of bricks in India. Therefore to calculate the actual production of brick based on the typology of kiln used in brick making, let us first calculate the percentage of bricks produced given the typology of kilns.

Table 7.4: Production of bricks

Type of Kiln	Share of brick produced (%)	Total Annual production (100,000 bricks/year) (based on current production 140 bn/yr)
Clamp	12.86	1,80,072 (18 billion)
Moving chimney BTKs	17.15	2,40,096 (24 billion)
Fixed Chimney BTKs	69.67	9,75,390 (97.5 billion)
VSBK	0.28	3,962 (0.4 billion)
High Draft Kiln (HDK)	0.03	480 (0.05 billion)
Total	100	14,00,000 (140 billion)

Source: Development Alternatives

53 Estimate based on annual production capacity and approximate number of kilns.

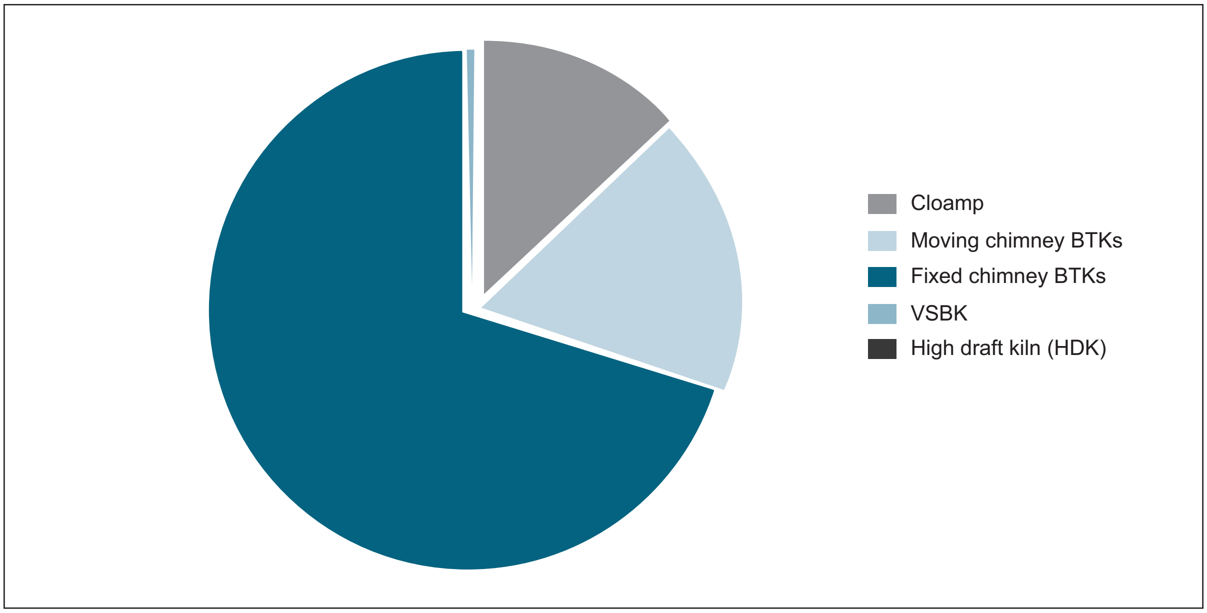

Figure 7.3: Production of bricks from different types of kilns

7.4.6 As can be inferred from Table 7.4 and Figure 7.3, till date the maximum number of bricks are manufactured using BTKs, both moving and fixed. Therefore the coal consumption for brick making employing these two types of kilns are:

a) Annual coal consumption for moving chimney BTKs: To produce 100,000 bricks total coal requirement is 24 tonnes. Therefore to produce around 24 billion bricks using moving chimney BTKs, the total coal consumption is 5.7 million tonnes. Now if the kilns are upgraded to VSBK, total coal consumption to produce 24 billion bricks will be 3.36 million tonnes. Therefore, around 2.4 million tonnes of coke will be saved annually if the type of kiln used in brick making is upgraded to VSBK from moving chimney BTKs.

b) *Annual coal consumption for fixed chimney BTKs:* To produce 100,000 bricks total coal requirement is 20 tonnes. Therefore to produce 97.5 billion bricks using fixed chimney BTKs, the total coal consumption is 19.5 million tonnes. Now if the kiln is upgraded to VSBK, total coal consumption to produce 97.5 billion bricks will be 13.5 million tonnes. Therefore, around 6 million tonnes of coal will be saved annually if the type of kiln used in brick making is upgraded to VSBK from fixed chimney BTKs.

7.4.7 Therefore by upgrading the existing BTKs, both fixed and moving chimney, to VSBKs in India, the total annual coal saving will amount to 8.4 mn tonnes per annum.

7.4.8 The Clamp type kilns, which has 5 per cent share in the total installed capacity of India contributes to 12.86 per cent of total brick production in India. The average specific energy consumption of clamp type is almost 3 times more than VSBK. A change of clamp type kiln to VSBK type will save a huge amount of biomass/coal which is being used in clamp type kilns.

Since these units are based in remote areas, exact details are not available on the quantity of coal, cow dung or biomass used to produce bricks.

7.4.9 The estimated total coal consumption in this sub-sector is 26 mn tons per annum as estimated from Tables 7.2 and 7.4. The estimated value is ₹ 260 billion (@ ₹ 10,000 per tonne).

7.5 Environmental issues in brick kiln sub-sector

7.5.1 In brick production, the main type of pollution is air pollution. The Central Pollution Control Board (CPCB) has set a standard for industry-specific emission both for effluents and emission. In case of the brick industry, the standard is set for emissions. The emission standards is given in Table 7.5.

Table 7.5: Brick kilns: Emission standards

Size	Kiln Capacity	Maximum limit for the concentration of particulate matter (mg/Nm^3)
Small	Less than 15,000 bricks per day (less than 15 ft trench width)	1000
Medium	15,000–30,000 bricks per day (15–22 ft trench width)	750
Large	More than 30,000 bricks per day (more than 22 ft trench width)	750

Source: CPCB

Table 7.6: Stack height regulation: The following stack heights are recommended for optimal dispersion of sulphur dioxide.

Kiln Capacity	Stack Height
Less than 15,000 bricks per day (less than 15 ft trench width)	Minimum stack height of 22 m, or, induced draught fan operating with minimum draught of 50 mm water gauge with 12 m stack height.
15,000–30,000 bricks per day (15–22 ft trench width)	Minimum stack height of 27 m with gravitational settling chamber or Induced draught fan operating with minimum draught of 50 mm water gauge with 15 m stack height.
More than 30,000 bricks per day (more than 22 ft trench width)	Minimum stack height of 30 m with gravitational settling chamber or Induced draught fan operating with minimum draught of 50 mm water gauge with 17 m stack height.

Source: Discussion with experts

7.5.2 Notifications to use fly ash and stop production by moving BTK kiln

Existing moving chimney Bull's trench kilns shall be dispensed with by 31 December 1987 and no new moving chimney kilns shall be allowed to come up. Considering the immediate need to protect the top soil and to find ways for safe disposal/utilisation of fly ash, it is provided that from the 1 January 1997, all brick manufacturing units within a radius of 50 kms from any thermal power plant, shall utilise fly ash in optimal proportion for making bricks. (Source: EPA Notification [GSR No. 176(E), 3 April 1996]).

7.5.3 Amendments: (i) Existing moving Bull's trench kilns shall be dispensed by 30 June 1999 and no new moving chimney kilns shall be allowed to come up. (Source: EPA Notification [GSR No. 7, 22 December 1998])

(ii) Existing moving chimney Bull's trench kilns shall be dispensed with by 30 June 2000 and no new moving kilns shall be allowed to come up. (Source: EPA Notification [GSR 682(E), 5 October 1999]).

7.5.4 The environmental issues associated with brick manufacturing primarily includes the following:

i) Emissions to air

The sources of air pollution are stack emissions and fugitive emission from unloading and material handling. The magnitude of the atmospheric pollution being caused by these brick kilns can be gauged from the fact that burning of one kg of coal releases at least 4 kg of harmful and toxic gases. Therefore the total emission will be around 104 mn tons of such gases per annum assuming 26 mn tonnes of coal consumption per annum. These gases primarily include sulphur dioxide, carbon monoxide, carbon dioxide, oxides of nitrogen and suspended particulate matter (SPM).[54] The CO_2 emitted is 49.4 mn tons. (Assuming 48 per cent as impurities and 52 per cent carbon content in coal used in brick kilns. 1 ton carbon will emit 3.666 tons of CO_2).

- Sulphur oxides concentration is mainly dependent of the amount of sulphur present in the coal. The sulphur dioxide gas released from these kilns leads to itching in the eyes.
- Hydrocarbon and carbon monoxide emissions are caused due to incomplete combustion of fuel.
- Presence of oxides of nitrogen in the air leads to lung and skin infections.
- SPM in flue gas is mainly generated due to incomplete combustion of fuel (black smoke) or comes from fine coal dust, ash present in coal and burnt clay particles.

The workers engaged as firemen, unloaders and ash handlers have the maximum exposure to the pollutants.

54 The Times of India, 1 February 2009

(ii) Top Soil Erosion: Another environmental issue pertaining to the brick making sector is depletion of good quality agricultural soil leading to reduction in productivity of land. The indiscriminate usage of top soil in brick making remains a serious issue. Approximately, 22,000 bn cubic metre of clay/silt is used every year for brick making. Taking 2 metre average depth of sand use, this accounts for 0.11 mn hectares every year.

7.6 Social issues in brick kiln sub-sector

7.6.1 The brick manufacturing sector mainly uses the service of migrant labourers. "Millions of people from the poverty pockets of India and Bangladesh migrate every year during the dry season — when there is no work as farm labourers — to more than 50,000 brick kilns in northern India, desperately seeking jobs as firemen or as brick moulders" (Sameer Maithel and Urs Heierli, 2008). But for the thousands of migrant families who throng the kilns, basic amenities are a far cry in these kilns. Children are denied education, a healthy environment or any future as parents toil hard to make ends meet in hot, dusty kilns.

7.6.2 The workers in the brick industry are contracted through middlemen and belong to the poor districts of UP, Bihar, Chhattisgarh and Orissa. Tight margins in the brick market coupled with rising costs of energy result in poor remuneration for the majority of brick workers and deterioration in the quality of their life.[55]

7.7 Perspective of industry

7.7.1 The industry is represented by All India Brick Manufacturer's Federation based at IHC, Lodhi Road, New Delhi. However, a majority of firm owners are not members but are associated with the Federation and are aware of its programmes. The rising cost of coal is a big problem and open market prices eat away the profit margins. The earlier technological demonstrations of VSBK kilns based on Chinese technology have not yielded the desired results. Hence the industry has lost faith in new technology initiatives of VSBK (as per the AIBMF president). The working condition of workers is very bad. There is a huge scope of interventions both in the field of technology and organisational health and safety.

7.8 Institutions/associations

- Central Brick Research Institute, Roorki, is a leading institute which is working on research work in the field of brick making.
- The Punjab State Council for Science and Technology (PSCST) has developed an efficient kiln design and dissemination work in Punjab.
- TERI and Development Alternatives have also done projects in the field of technology demonstration and up-gradation in the brick industry.

55 Development Alternatives, Newsletter, September 2006.

- Development Alternatives (an NGO) is actively working with the brick industry.
- Some NGOs have come forward to intervene to handle social issues in a few areas which have improved the lives of a few hundred labourers, but this is a tiny fraction of the nearly 10 mn labourers. Some examples are listed below.

IFA (Indian Friends Association) and Manavi (both are NGOs) joined in an effort against the problem of child labour in brick kilns in Bihar. The work was initiated in five brick kilns each with about 250–300 workers. The main vehicle for intervention is non-formal education classes for children that run for over 9 months. Ten teachers, four female and six male, were teaching a total of about 200 children.

The Indian Sponsorship Committee, an NGO, started its project in 1994 to take care of the overall development of children of brick kiln workers in the Vithalvadi brick kiln area in Maharashtra. In a span of 10 years, they were through with their high school and were pursuing higher studies. Corporations like L&T, Infotech, the Tech Mahindra Foundation and the Volkart Foundation provided financial support to this project.

7.9 Bibliography

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CHAPTER B8

Ceramics

8.1 Economic significance

8.1.1 The ceramic industry is an age-old industry and has evolved over the centuries, from the potter's wheel to a modern industry with sophisticated controls. It comprises ceramic tiles, sanitary ware and crockery items. Ceramic products are manufactured both in the large and small-scale sectors with wide variations in type, size, quality and standard. State-of-the-art ceramic goods are being manufactured in the country and the technology adopted by the Indian ceramic industry is of international standard. The main product segments are wall tiles, floor tiles, vitrified tiles and porcelain tiles.

The four different types of products are identified as:

- Unglazed ceramic tiles
- Glazed ceramic tiles
- Ceramic household articles
- Ornamental ceramic products

8.1.2 India ranks fifth in the world in terms of production of ceramic tiles and is growing at a healthy 15 per cent per annum.[56] It produced 340 mn sq. metres of ceramic tiles, out of a global production of 6.9 bn sq. metres during 2003–04 and increased to 0.34 bn sq. meters in 2006–07.[57]

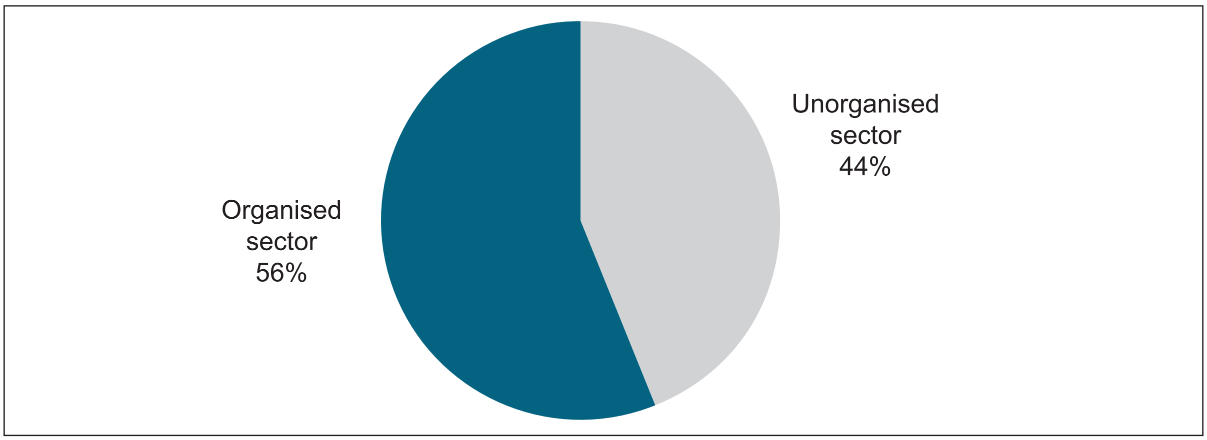

Figure 8.1: Share in total production

Source: Compiled from Figures 8.2(a) and 8.2(b)

56 IREDA Report Investors Manual on Energy and Efficiency, Indian Council of Ceramic Tiles and Sanitary ware (ICCTAS)

57 ICCTAS

8.1.3 Ceramic tiles are produced both in the organised and unorganised sectors. The current size of the organised sector is about ₹ 270,000 mn with approximately 16 players having an installed capacity of 1.2 mn MT.[58] The current size of the unorganised sector is ₹ 315,000 mn which constitutes 44 per cent of the total industry and accounts for about 2.5 per cent of the world's ceramic tiles production.

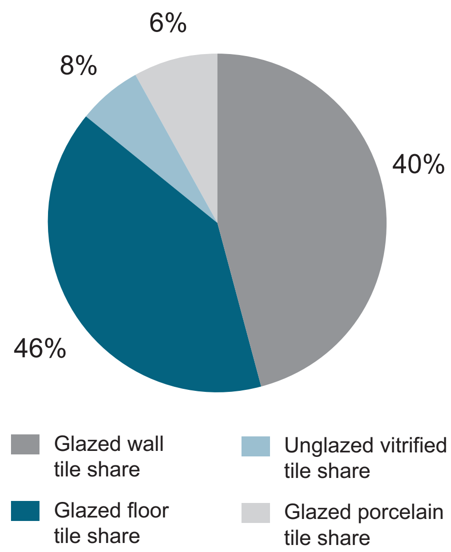

Figure 8.2(a): Organised sector

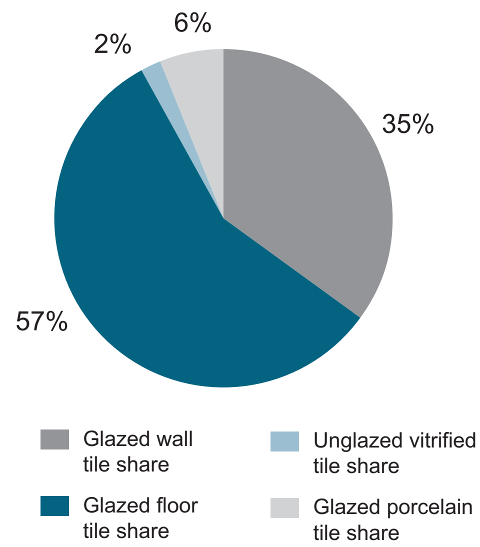

Figure 8.2(b): Unorganised sector

Source: Indian Council of Ceramic Tiles and Sanitary Ware

8.1.4 Figures 8.2(a) and 8.2(b) show the percentage share of the organised and unorganised sectors' turnover in glazed wall, glazed floor, unglazed vitrified, glazed porcelain tiles. While in the organised sector, the maximum turnover is from glazed floor tiles, in the unorganised sector it is from glazed wall tiles. The minimum turnover in both the sectors is in glazed porcelain.

8.1.5 A total of 550,000 people are estimated to be employed in this sector. Of this, 50,000 people are employed directly and 500,000 are associated indirectly. The demand for ceramics is dependent on the growth of the housing, retail, IT and BPO sectors. In India, the per capita consumption of ceramic tiles is 0.30 sq. mtr. per annum as compared with 2 sq. mtr. per annum in China and 5–6 sq. mtr. per annum in European countries. Indian tiles are competitive in the international market and are being exported to East and West Asian countries.

8.1.6 Sanitary ware is manufactured both in the large and small sectors. At present there are seven units with installed capacity of 86,500 tonnes per annum and more than 500[59] plants with a capacity of 50,000[60] tonnes per annum in the small-scale sector. The industry has a turnover

58 IREDA Report Investors Manual on Energy and Efficiency
59 As can be seen from Table 8.1
60 (http://dipp.nic.in/industry/content_industries/CERAMIC%20INDUSTRY.htm#ceramic)

of ₹ 360–4,500 mn. There is significant export potential for sanitary ware. These are presently being exported to East and West Asia, Africa, Europe and Canada.

8.1.7 Pottery ware, signifying crockery and tableware, are produced both in the large-scale and small-scale sectors. There are 16 units in the organised sector with a total installed capacity of 43,000 tonnes per annum. Most of the ceramic tableware produced is of bone china and stoneware. This industry in India is highly labour intensive while in USA, UK, Japan and other countries, it is fully automatic. The quality of finished products, designs and shapes in India are still below international standards.

8.2 Geographical concentration of ceramics sub-sector

8.2.1 Most of the small-scale ceramic units are located in clusters. These clusters are spread across the country in the states of Gujarat, Andhra Pradesh, Maharashtra, Uttar Pradesh and West Bengal, and produce a range of products varying from sanitary ware to crockery. Gujarat is the most important ceramic manufacturing cluster in South Asia. Overall, the state accounts for about 50 per cent of India's ceramics production and the Morbi/Thangadh centres alone are responsible for the manufacture of nearly 60 per cent of the country's ceramic wall and floor tiles and sanitary ware. Table 8.1 provides the list of significant ceramic clusters in India.

Table 8.1: Spread of ceramics sub-sector in India

State	District	Location	Units	Product Specification	Type of fuel used	Type of kiln
Gujarat	Sabarkantha	Himatnagar	25	Wall tiles	Gas	Tunnel kiln
	Ahmedabad	Ahmedabad	32	Cup, saucer, fine porcelain, sanitary ware, firebricks, insulators	Gas	Tunnel kiln
		Kadi	6	Sanitary ware and tiles		
		Kadi Chatral	6	Sanitary ware and tiles		
	Surendranagar	Thangarh	200	Sanitary ware, electric porcelain, pottery, refractory	LDO, Gas	Tunnel kiln
	Rajkot	Morbi	300	Floor tiles, wall tiles, vitrified tiles, porcelain, bone china, refractory, sanitary ware	Gas	Roller kiln
			30	roofing tiles		

State	District	Location	Units	Product Specification	Type of fuel used	Type of kiln
Gujarat	Surendranagar	Surendranagar	25	Electrical porcelain, high tension insulators, filter candle	LDO	Tunnel Kiln
	Rajkot	Wankaner	20	Refractory	LDO	Tunnel Kiln
Andhra Pradesh	Guntur	Piduguralla	275	Calcined lime	Coal	Updraught kiln
		West Godavari	45	Fire clay, refractory, sanitary ware	Coal	Down-draught kiln
		Vizianagaram	35	Ordinary roofing tiles		Down-draught kiln
	East Godavari	Rajmandry	80	Graphite crucibles	Fire-wood	Updraught kilin
	Prasham	Chimakurthy	65	Granite slabs and tiles		
	East Godavari	Jaggampeta	70	-	Fire-wood	Chamber kiln and down-draught kiln
Tamil Nadu		Madras	15	Sanitary ware, refractory		Tunnel and shuttle kiln
Maharashtra	Gujroli	Chandrapur*		-		
Rajasthan		Bikaner	40	Low / high tension insulators	Low sulphur diesel oil	
Uttar Pradesh	Bulandshahar	Khurja	100	Crockery, low and high tension insulators		Down draft shuttle, tunnel type
Total			1,369**			

Notes: * Data not available
** As per discussions with experts

8.3 Energy intensity in ceramics sub-sector

8.3.1 The ceramics sector is highly energy intensive, accounting for about ₹ 2,115 mn[61] worth of energy consumption per year and amounts to 35 per cent of the manufacturing cost.[62] The energy used in the ceramic industry is of two types — electric energy and thermal energy. The electric energy is converted to mechanical energy when used in the motors and fans of machines and as thermal energy when used to heat kilns and furnaces. Fuel is converted into thermal energy by combustion. The main fuel used by the ceramic industry is liquefied petroleum gas (LPG) and natural gas. The other types of fuels used are kerosene, low diesel oil (LDO), propane and high speed diesel (HSD).

8.3.2 The manufacturing process of ceramics differs according to the type of product. However, the basic production process consists of a series of successive stages, which can be summarised as follows:

- Raw material preparation
- Pressing and drying of the green body
- Firing, with or without glazing
- Additional treatments
- Sorting and packing

8.3.3 Of these processes, the firing process is the greatest energy consumer, and includes usage of kilns and dryers. Around 80–90 per cent of the total energy is used by kilns and dryers. In the case of tile manufacturing, the temperature required for firing ranges between 1080 between 1100 °C. In the case of sanitary ware, the temperature required is around 1200 °C. The amount of energy consumed is also dependent on the typology of kilns used. The types of kilns mostly used are either continuous or intermittent. The continuous kilns include tunnel and roller hearth kilns. The tunnel kilns are refractory tunnels served by rail tracks carrying kiln cars. Most tunnel kilns are gas fired. In the roller hearth kiln, firing is provided by natural gas air burners located at the sides of the kilns. The intermittent kilns include shuttle-and-hood type kilns based on single chambers that are charged with dried ceramic products, sealed and then exposed to a defined firing cycle. These kilns are usually provided with gas burners and generally used for small-scale manufacture of special sanitary ware.

8.3.4 Before 2002, shuttle kilns were mostly used. But now with change in technology, the units have shifted to tunnel and roller kilns which are natural gas based and consume less energy. These are continuous kilns. The production process is fast and the quality of the product is better than those produced in intermittent kilns. Since gas is used, pollution is less as compared to shuttle kilns which use oil.

61 IREDA and CII Report, 2002; IREDA Report Investors Manual on Energy and Efficiency
62 Discussion with experts

8.3.5 In terms of energy consumption, Table 8.2 below shows the amount of energy required by refractories using different types of kilns — periodic, tunnel and roller. The periodic kilns are intermittent (small batches) and tunnel kilns and roller kilns are continuous. So the productivity of tunnel and roller kilns is higher than that of periodic kilns. Maximum production and usage is of fire bricks. High alumina and basic refractories consume more energy. In small units, fire bricks are generally used which are fired at a temperature of 1200–1400 °C. 2500–3500 kJ/kg of energy is required for fire bricks if tunnel kilns are used, 6000–8000 kJ/kg of energy is required when periodic kilns are used and, in case of roller kilns, 2000–2800 kJ/kg of energy is required. This shows that roller kilns are better than periodic or tunnel kilns in terms of energy consumption.

Table 8.2: Energy consumption by different types of kilns

Type of refractory	In Periodic Kilns (kJ/kg)	In Tunnel Kilns (kJ/kg)	In Roller Kilns (kJ/kg)*
Fire bricks (fired at 1200–1400 °C)	6000–8000	2500–3500	2000–2800
High alumina refractories (fired at 1400–1600 °C)	12000	3500	2800
Basic refractories (fired at 1600–1750 °C)	12000–16000	6000–7000	4800–5600

*As per discussions with experts, approximately 20 per cent less energy is consumed in roller kilns as compared to tunnel kilns.
Source: IREDA Investor Manual for Energy Efficiency (2002), p 171

Energy consumption depends on the factors as listed below:

- Type of kiln and dryer
- Capacity utilisation of kilns and driers
- Combustion control systems
- Type of heat recovery system
- Type of insulation used in kilns and driers
- Type of press
- Type of spray drier

8.3.6 The energy efficiency measures in any industrial sector starts with behavioural changes. The energy efficiency efforts in the ceramic sector can be classified into the following three steps.

Step 1 Good Housekeeping: This includes elimination of minor wastes, review of operations standards in the production line, more effective management, improvement of employees' cost consciousness and operations techniques.

Step 2 Equipment improvement: Improvement of energy efficiency of equipment by making minor modifications in the existing production line.

Step 3 Process improvement: This is intended to reduce energy consumption by substantial modification of the production process itself through technological development; such as conversion from tunnel kiln to roller hearth kiln (better technology).

8.3.7 As Gujarat accounts for almost 50 per cent of India's ceramic production, it is vital to explore the energy consumption pattern of the state. The type of furnace predominantly used in the production process in Gujarat (as shown in Table 8.2 above) is the tunnel kiln, except in Morbi, the fuel used is mainly natural gas. Therefore, the energy consumption is much less as compared to other ceramic clusters. The Khurja ceramics cluster is also well known for its ceramic products and there are around 100 small units. The production process involves the use of downdraft, shuttle and a few tunnel type kilns. Thus, there exists a scope of upgrading the downdraft and shuttle type kilns to tunnel type kiln for efficient energy utilisation.

8.4 Environmental issues in ceramics sub-sector

8.4.1 The ceramics sector has been listed under "Red Category" industries on the basis of its emission/discharge of high/significant polluting potential or generating of hazardous wastes. The Central Pollution Control Board (CPCB) has set a standard for industry specific emission both for effluents and emissions. In the case of the ceramics industry, the standard has been set for emissions, which is given in Table 8.3.

Table 8.3: Ceramics: Emission standards

Section		Pollutants	Concentration (mg/Nm^3)
A.	Kilns		
	Tunnel, Top Hat, Chamber	Particulate Matter	150
		Fluoride	10
		Chloride	100
		Sulphur dioxide	**
	Down Draft	Particulate Matter	1200
		Fluoride	10
		Chloride	1000
		Sulphur dioxide	**
	Shuttle	Particulate Matter	150
		Fluoride	10
		Chloride	100
		Sulphur dioxide	**

Section		Pollutants	Concentration (mg/Nm^3)
	Vertical Shaft Kiln	Particulate Matter Fluoride Sulphur dioxide	250 20 **
	Tank Furnace	Particulate Matter Fluoride Sulphur dioxide	150 10 **
B.	**Raw Material Handling, Processing and Operations**		
	Dry raw material handling and processing operations	Particulate Matter	150
	Basic raw material and processing operations	Particulate Matter	*
	Other sources of air pollution	Particulate Matter	*
C.	**Automatic Spray Unit**		
	Dryers Fuel fired dryers For heat recovery dryers	 Particulate Matter Particulate Matter	 150 *
	Mechanical finishing operation	Particulate Matter	*
	Lime / plaster of paris manufacture		

*All possible preventive measures should be taken to control pollution as far as is practicable
Source: Central Pollution Control Board

The environmental issues associated with ceramic tile and sanitary ware manufacturing primarily includes the following:

- Emissions to air
- Wastewater
- Solid waste

Table 8.4: Environmental issues in ceramics sub-sector

Air Emission	
(i)	*Particulate Matter:* These are generated during the handling of raw materials during processes like screening, mixing, weighing, and transporting / conveying, dry grinding / milling, drying (spray drying), glaze-spraying, decorating and firing, and fired ware finishing operations.
(ii)	*Sulphur Oxides:* Emission of ceramic kiln exhaust gases depends on the sulphur content of the fuel and certain other raw materials (e.g., gypsum, pyrite, and other sulphur compounds). The presence of carbonates in raw materials prevents sulphur emissions because of their reaction with SO_2.
(iii)	*Nitrogen Oxides:* These are generated by the high firing temperature in kilns, the nitrogen content in raw materials and the oxidation of nitrogen in the fuel used in the process.
(iv)	*Greenhouse Gases:* These are associated with the use of energy in kilns and spray dryers.
(v)	*Chlorides and Fluorides:* These are generated from impurities in clay materials. During the preparation of raw materials, the use of additives and water containing chlorides leads to hydrochloric acid (HCl) emissions. The decomposition of clay flurosilicates forms hydrofluoric acid.
Waste Water	
	Industrial Process Wastewater: It is generated from cleaning water in preparation and casting units and in various process activities like glazing, decorating, polishing, and wet grinding. The pollutants include suspended solids (e.g., clays and insoluble silicates), suspended and dissolved heavy metals (e.g., lead and zinc), sulphates, boron and traces of organic matter. Fine suspended particles of glaze and clay minerals lead to turbidity and colouring of the process wastewater.
Solid Waste	
	Solid wastes mainly consist of different types of sludge, including sludge from process wastewater treatment, and process sludge resulting from glazing, plaster, and grinding activities. Other process wastes include broken ware from process activities (e.g., shaping, drying and firing); broken refractory material; solids from dust treatments (e.g., flue-gas cleaning and de-dusting); spent plaster moulds; spent sorption agents (e.g., granular limestone and limestone dust); and packaging waste (e.g., plastic, wood, metal, paper).

Source: IFC Environmental, Health and Safety Guidelines (30 April 2007) and CPCB

8.5 Social issues in ceramics sub-sector

8.5.1 The social issues pertaining to the ceramics sector are mainly related to occupational health and safety issues arising during the construction and decommissioning of ceramic tiles and sanitary wares. Some of them are explained below.

The main occupational hazard is the exposure to fine airborne particulates in the form of silica dust (SiO_2) deriving from silica sands and feldspar in the workplace. Other hazards result from glaze application and combustion by-products.

- Exposure to heat during operation and maintenance of furnaces or other hot equipment results in severe burns.
- Raw material preparation like crushing, grinding, milling, dry and wet mixing, screening, clarification, pressing and granulation processes, cutting, grinding and polishing, fan burners in kilns and packaging activities generate a lot of noise, which effects the hearing of the workers.
- The starting and shutting down of equipment requires a lot of physical work as does operation and maintenance of equipment like mills, mill separators and conveyor belts. Other hazards include handling sharp materials, lifting heavy objects, performing repetitive motions. These equipment need to be handled carefully to avoid physical impacts.
- Throughout ceramic tile and sanitary ware manufacturing facilities, workers are exposed to electrical hazards due to the presence of electrical equipment.

8.6 Institutes/associations

Table 8.5 shows the list of institutes and associations associated with the ceramics industry.

Table 8.5: Institutes and associations associated with the ceramics industry

Institutes	Associations
Central Glass and Ceramics Research Institute (CGCRI)	Gujarat Ceramics Floor Tiles Manufacturers Association
Indian Council of Ceramic Tiles and Sanitary ware (ICCTAS)	Federation of Ceramics Industry
MSME DI, Ahmedabad	Morbi-Dhruva Glaze Tiles Manufacturers Association
L.E. Engineering College, Morbi	Terra Tiles Consortium (P) Ltd, Trissur
Ceramic Centre for Rural Development (CCRD), Bankura District of West Bengal.	Murlu Potters Association
	Sanitary ware Manufacturers Association, Morbi
	Naroda Industry Association

Source: Discussion with experts and diagnostic studies

8.7 Cluster interventions

Table 8.6 shows the interventions done in ceramics clusters by certain agencies and organisations.

Table 8.6: Cluster interventions in the past in ceramics sub-sector

Implementing Agency	Funding Agency	Type of Intervention	Clusters	Programme/ Scheme	Time Duration
Department of Industrial Policy and Promotion (DIPP), UNIDO	Department of Industrial Policy and Promotion (DIPP), UNIDO, Ministry of Commerce and Industry	Technology upgrading of select units at ceramic clusters in India – at Khurja (Uttar Pradesh), Morbi (Gujarat) and Thangadh (Gujarat) by introducing energy-efficient technologies and processes, encouraging quality control and adopting international standards. Capacity building of enterprises, workers and managers, strengthening of institutional structures and policy frameworks, promotion of the Indian brand image through enhancing the quality of Indian ceramic products and improving market linkages.	Khurja (Uttar Pradesh), Morbi (Gujarat) and Thangadh (Gujarat)		5 years
CGCRI, Ahmedabad	Ministry of Commerce and Industry, Govt. of Gujarat	Capacity building of enterprises by way of technical assistance drawn from CGCRI and UNIDO through its cluster development initiative	Morbi	Cluster Development Programme	2002–05

Source: Discussions with experts

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CHAPTER B9

Glass and glassware

9.1 Economic significance

9.1.1 Glass has existed in India since ancient times. Archaeological surveys have unearthed glass pieces and crucibles that can be dated back 2,000 years in which the glass was found to have been made near Basti in Uttar Pradesh. The Mahabharata makes a mention of glass, as does another ancient text, Yuktic Kalpataru, which talks of the effect of drinking water out of a glass tumbler to be the same as drinking out of a crystal cup. Evidence shows that by 1,000 BC, glass beads were being made in north India. Small drawn glass beads were a speciality, and seem to have originated in India after which the craft spread to East Africa and South-East Asia by AD 1000. The main centres of production were Brahmapuri and Arikamedu in south India. With time, the craft died down but was revived, mostly at Firozabad, Purdilnagar (Hathras) and Varanasi, which continue to operate as important centres of glass bead making.

9.1.2 Glass is a vital component in day-to-day domestic use as well as in various industries. Around 90 per cent of the industry output is used in other industries like construction, motor vehicles and food and beverages industry. From the early 1950s, the glass industry started manufacturing using modern equipment, both for melting and production. Collaboration with multinational companies gave a boost to the industry. It was in the last decade of the twentieth century that the Indian glass industry started to seriously compete globally, installing improved furnaces to conserve energy and therefore reduce the cost of production.

9.1.3 The principal constituent of glass is silicon dioxide. However, silica melts at a very high temperature; so to reduce the fusion temperature catalysts like soda ash and potash are added to the charge as flux. Various types of glass items produced in India, such as glass bottles; containers of various kinds; sheet, figured and wired glass; safety glass and mirrors; syringes; vacuum flasks; etc. Glass products can be categorised into four groups: (i) sheet and float glass, (ii) fibre glass, (iii) bottles and glass ware, and (iv) laboratory glassware. The production figures of these four categories of glass products are shown in Figures 9.1 (a)–(d).

Figure 9.1(a): Production of sheet and float glass

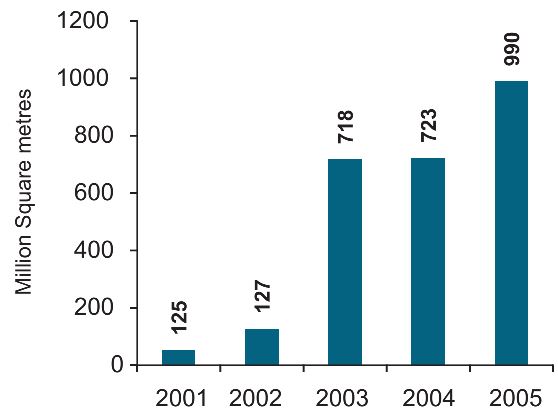
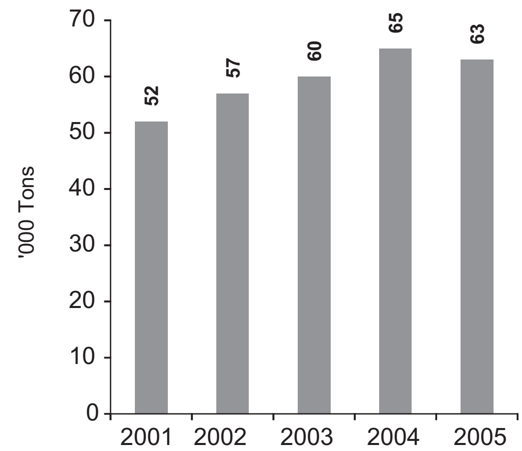


Figure 9.1(b): Production of fibre glass



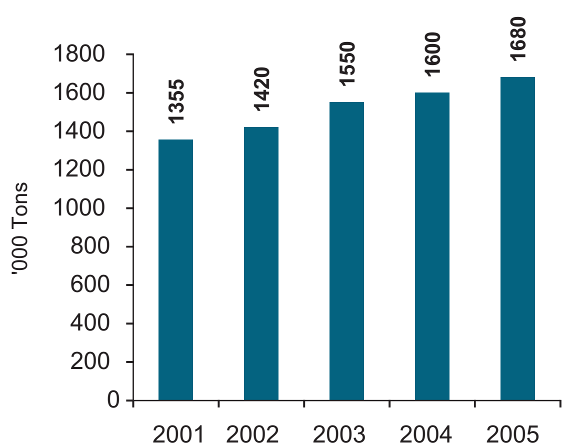


Figure 9.1(c): Production of bottles and glassware

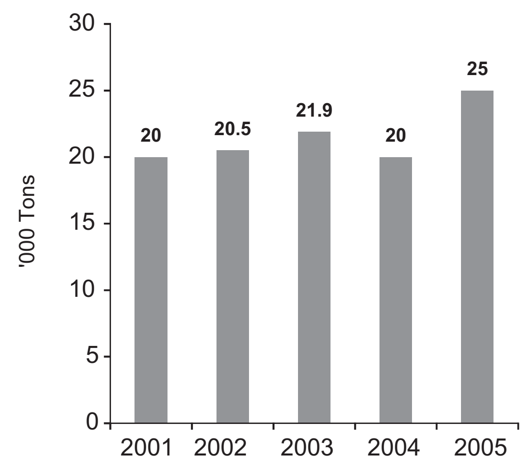


Figure 9.1(d): Production of laboratory glassware

Source: ibef.org

The value and product types of glass and glassware exports are shown in Table 9.1 and Figure 9.2, respectively.

Table 9.1: Export of glass and glassware sub-sector, 2004–09

Year	Exports (₹ mn)	Percentage Share
2004–05	8824.916	0.26
2005–06	9393.116	0.23
2006–07	12527.04	0.24
2007–08	13679.67	0.23
2008–09 (April–Dec)	13271.14	0.25

Source: ibef.org

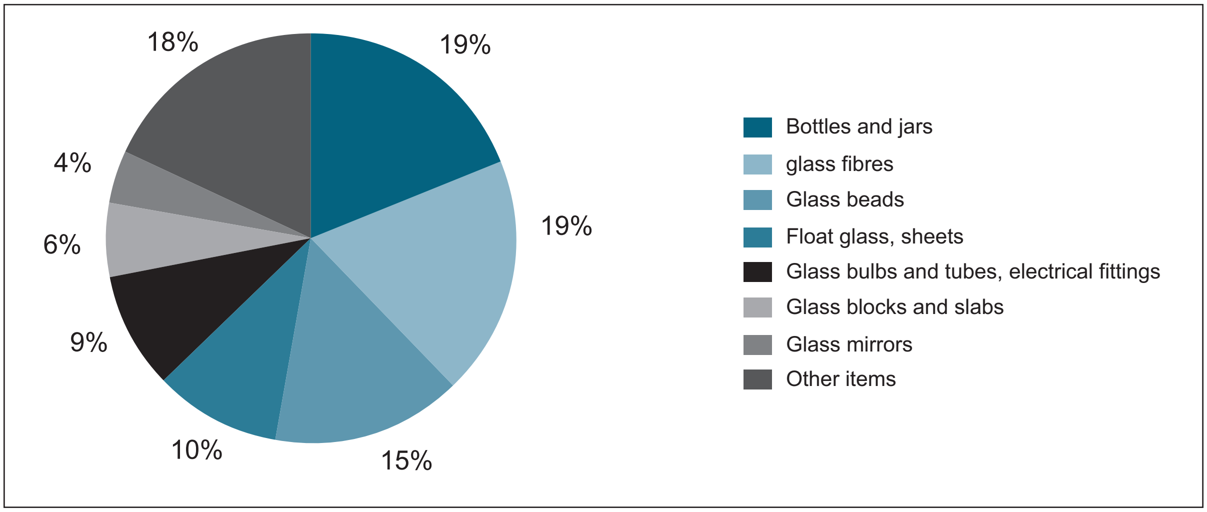


Figure 9.2: Contribution of product segments of glass industry in 2006–07

Source: ibef.org

9.1.4 The Firozabad cluster accounts for almost the entire glass bangle production and 70 per cent of glass tumbler production in the country. There are around 150 units for glass melting using tank and pot furnace and around 400 muffle furnace units, locally called pakai bhattis, for baking bangles. However, there are around 1,000 unregistered units in the cluster. The cluster provides livelihood to around 0.5 mn people.

9.1.5 The three glass bead clusters in India together have a turnover of ₹ 4.50 bn and export around ₹ 1.50 bn worth of beads. The total employment by these three clusters is around 0.4 mn people. The clusters use pot and tank furnaces for making beads. Some clusters that manufacture value added products depend on these three bead-making clusters for their inputs.

9.1.6 Glass is the most eco-friendly packaging medium. Each bit of broken glass can be re-cycled to manufacture new glass with much lower consumption of energy. The traditional fuel used for glass-making in the Firozabad cluster was coal, which changed due to a landmark judgement by the Supreme Court passed in December 1996, banning the use of coal in the Taj Trapezium Zone. The energy intensity of the glass sector and thereby the Firozabad cluster is discussed in Section 9.4.

9.2 Geographical concentration of glass and glassware sub-sector

The glass industry is fairly uniformly distributed throughout the country. It has been estimated that there are around 40 glass manufacturing facilities, producing different types of products, in the western region that are mainly located in the industrial areas, around 20 glass industries in the eastern region (a few of them have closed down due to labour unrest), about 15 in the southern region comprising Karnataka, Andhra Pradesh, Kerala and Tamil Nadu, and about 20 in the Northern region spread over Uttar Pradesh, Haryana and Delhi.[63] However, these units are not clustered in any particular location.

The largest conglomerate of small-scale glass manufacturing units is located 40 km from Agra (UP) in Firozabad. There are three clusters of glass bead manufacturing unts which are located in Purdilnagar, Hathras (UP), Banaras (UP) and Nathdwara (Rajasthan).

9.3 Production process

9.3.1 The manufacturing process of glass can be divided into four main phases, which are more or less similar irrespective of the type of product to be manufactured.

9.3.1(i) *Phase 1 Preparation of raw material:* The common raw materials used for the manufacture of glass are glass sand, recycled glass (cullets), feldspar and flux materials like soda ash, dolomite, etc., which are crushed to 20–120 mesh and mixed with other additives to form a batch.

9.3.1(ii) *Phase 2 Melting in a furnace:* The batch is introduced into the furnace for melting at about 1500°C.

9.2.1(iii) *Phase 3 Forming:* The glass is drawn from the furnace and blown (formed) into different shapes. These products are then heated and cooled in a controlled manner, termed as annealing, to impart hardness to the glass.

9.2.1(iv) *Phase 4 Finishing:* The products are subjected to various cutting and finishing operations and then packed for despatch to the markets.

63 Glass Sector Study, CPCB

9.4 Energy intensity in glass and glassware sub-sector

9.4.1 Glass manufacturing is a highly energy-intensive activity. It has been estimated that 40 per cent[64] of the manufacturing cost is attributable to energy cost. According to estimates, the energy required to melt one tonne of glass is approximately 2.2 mn Btu but, in actual, twice the amount of energy (4.4 mn Btu) is required due to a variety of losses and inefficiencies in furnace design. Therefore, the total coal burnt is 7.7 mn tonnes (assuming specific energy 8360 kJ per kg for Indian coal).The estimated value of the total quantity of coal consumption is ₹ 27.7 bn {(0.77*4000)/5000}.

9.4.2 The principle variation in the glass industry is in the type of furnaces used for melting of the raw material. The melting process accounts for over 80 per cent of the total energy consumed by a glass factory. Other significant areas of energy use are fore hearth, the forming process, annealing, factory heating and general services. The various types of furnaces used for melting are:

- Regenerative furnace/tank furnace: These are large furnaces and the glass from these furnaces are used for making a wide range of items such as jars, tumblers, lamp shades, laboratory ware, etc. The fuels used in a tank furnace are coal, gas and oil.
- Recuperative furnace/ pot furnace: These are relatively small furnaces that are used to make small quantities of coloured glass. There are two kinds of pot furnaces — open pot and closed pot. The fuels used are coal, oil and gas.
- Electric furnace: These are commonly small and particularly used for special glass. Electric heating eliminates the formation of combustion by-product with the replacement of fossil fuels, thus reducing emissions.

9.4.3 Of the types of furnaces just mentioned, the coal-fired pot furnace and muffle furnace are very low in energy efficiency and are being used in MSME clusters in India. Apart from the melting process, energy is also required for baking or annealing, for which the traditional coal fired muffle furnace (pakai bhatti) is used. The fuel used for baking is mainly coal and causes very high levels of pollution in the form of CO_2, smoke and particulates.

9.4.4 In the case of the Firozabad cluster, banning the use of coal in the Taj Trapezium Zone and making natural gas available through Gas Authority of India Limited (GAIL), a public sector organisation, has resulted in a shift from use of coal-fired pot furnaces to gas-fired pot furnaces. This has led to a reduction in energy consumption and low emission of particulate matter. The Energy and Resources Institute (TERI), an implementing organisation working in the field of energy, environment and sustainable development, has been instrumental in providing the design of a gas-fired pot furnace that leads to energy savings of almost 50 per cent as compared to the traditional coal-fired pot furnace. Similar attempts have been made by TERI to upgrade the muffle furnace that has the energy saving potential of 30 per cent as compared to the traditional coal-based muffle furnace. Of the 70–80 open pot recuperative furnaces in the

64 Towards Cleaner Technologies, TERI

country, 50 have been upgraded using the furnace designed by TERI. Also, of the 400 muffle furnace units, around 100 have been installed using TERI's design. At present there are only about 10–12 gas-fired muffle furnaces in operation in Firozabad, mainly due to the availability of low-cost fuel like wood. Considering the unregistered units present in the Firozabad cluster, there is considerable scope for upgrading the furnaces and thereby saving energy consumption by almost 50 per cent.

9.5 Environmental issues in glass and glassware sub-sector

9.5.1 The glass sector has been listed under "Red Category" as per the standards specified by the Central Pollution Control Board on the basis of its generation and discharge of hazardous wastes. CPCB has set a standard for industry specific emissions for both effluents and emissions. In the case of the glass industry, the standard is set for emissions. The emission standard is given in Table 9.2.

Table 9.2: Standard for industry-specific emissions

Section of the Plant	Parameter	Emission Limit
Soda lime & borosilicate glass and other special glass (other than Lead Glass)		
Up to a product draw capacity of 60 tpd	Particulate matter	2.0 kg /hr
Product draw capacity of more than 60 tpd	Particulate matter tpd	0.8 kg per tonne of product drawn
All capacities	Sulphur dioxide	Minimum stack height (H in mt) = 14Q0.3 where Q is SO_2 emission rate in kg/hour.
	Total fluorides NO_X	5.0 mg/Nm^3 use of low NO_X burners in new plants
Lead Glass		
All capacities	Total particulate matter	50 mg/Nm^3
	Lead	20 mg/Nm^3
Pot Furnace		
	Particulate matter	1200 mg/Nm^3

Source: Central Pollution Control Board

9.5.2 Emission levels depend on the type of furnace. In regenerative furnaces, the emission level is quite low under normal conditions with little or no visible smoke. Emissions increase some time (usually a few minutes) during the reversal of regenerators.

9.5.3 In pot type furnaces, the emission levels are quite high when a fresh batch is charged and also few hours before the start of withdrawal of glass. During this period, the firing rate is quite high. For the remaining period, the emissions are considerably lower with only a little visible smoke.

9.5.4 In the case of open fire furnaces, the emissions rate is low due to low and slow firing rates. Similarly in pakai bhattis, the furnaces are small and the temperature required is also very low.

9.5.6 The environmental issues in glass manufacturing sector primarily include:

- Emissions to air
- Wastewater
- Solid waste

a) Emissions to air

Air Emissions: Glass manufacturing is a high temperature, energy intensive industry resulting in the emission of combustion by-products (sulphur dioxide, carbon dioxide and nitrogen oxides) and the high-temperature oxidation of atmospheric nitrogen. The main source of air pollution is emission of dust in the manufacture of special glasses like lead glass and borosilicate glass. In lead glass, the level of emission depends on the quantity of lead.

Particulate Matter: Particulates are pollutants emitted by glass manufacturing facilities. Dust emissions are the result of raw materials transportation, handling, storage and mixing. The dust generated by these processes is typically coarser than the particulates emitted from the hot processes which have sizes below 1 μm, but the small particulates readily agglomerate into larger particles. Whereas the dust emitted from handling processes is mostly an occupational health and safety (OHS) issue, MSMEs produce around 648 tonnes per annum of PM (assuming 2 kg per hour as per CPCB standard, 10 hours of operation, 54 tonne production in Firozabad, 54 tonnes in all bead clusters and 300 working days in a year).

Nitrogen Oxides: The main sources of emission of nitrogen oxides (NO_X) are the generation of thermal NO_X caused by high furnace temperatures, the decomposition of nitrogen compounds in batch materials and the oxidation of nitrogen in fuels. The presence of KNO_3 in raw materials also contributes to NO_X emissions.

Sulphur Oxides: SO_2 originates from the sulphur content in fuel oil as well as well as from the sulphite/sulphate/sulphide content in raw materials, particularly in the sodium or calcium sulphate added for glass oxidation.

Chlorides and Fluorides: These pollutants arise from raw material impurities in glass-melting furnaces. The volumes are usually limited. Fluorides are emitted when fluoride-containing compounds like sodium silicon fluoride or fluorspar are used in raw materials as fine chemicals.

The presence of chlorides in the flue gases is due to the use of chloride compounds like sodium chloride as refining chemicals.

Metals: Heavy metals are present as minor impurities in some raw materials, in cullet and in fuels. Lead and cadmium are used in fluxes and colouring agents in the frit industry. Particulates from lead crystal manufacturing can have a lead content of 20–60 per cent.

Greenhouse Gases: Glass manufacturing is a significant emitter of greenhouse gases (GHG), especially carbon dioxide (CO_2). According to the Petroleum Conservation Research Association (PCRA), the total amount of CO_2 released in the Firozabad cluster is 0.409 mn tonnes. Almost same amount is released by all the beads clusters put together. Therefore, 0.8 mn tonnes of CO_2 are released every year by MSME clusters. The emission by the entire glass industry was 14.7 mn tonnes in 2006.

b) Waste water

The main source of water pollution in the glass industry is:

- Cullet washing
- Cooling water at different areas in the furnace operation

Cullet washing: The cullet contains dust, metal caps, etc. To clean it, the material is introduced into a rotary drum washer. The thorough agitation of the dirty cullet with water cleans the cullet which is then sent for crushing. The mud and also the oil (used for cutting blade for cutting the glass) in this water is the source of water pollution.

Cooling water: Water for cooling purposes is used at different areas in the furnace operation. Some amount of bleed/blow down is necessary to keep the concentration of solids within limits, which appears as waste water. Some treatment chemicals like dissolved salts and water treatment chemicals used for the cooling-water system are also sources of pollution.

c) Solid waste

There are three sources of solid wastes in the glass industry:

- Coarse sand from sand screens
- Waste glass from furnaces
- Ash and unburnt coal

Sand Screening: The silica sand /quartz sand which is the main raw material for glass-making is screened through 30 to 80 meshes. The course sand is rejected as it cannot be used in glass making and becomes a solid waste.

Waste Glass from Furnace: While drawing the molten glass from the furnace, a certain amount of glass is wasted and solidifies.

Ash and Unburnt Coal: Ash and unburnt coal particles result from coal combustion. The ash generated is 3.7 mn tonnes for 48 per cent coal. These are sold to contractors and the ash is used for land filling purposes. This type of solid waste has reduced after use of natural gas has increased in Firozabad.

9.6 Social issues in glass and glassware sub-sector

9.6.1 The social issues pertaining to the glass sector are mainly related to occupational health and safety issues. Some of these are:

Heat: During the operation and maintenance of furnaces or other hot equipment, the workers are exposed to heat. Excessive heat must be prevented in the workplace, adequate ventilation and cooling air should be provided to disperse fumes and dust away from work stations.

Noise: Workers are exposed to noise during glass manufacturing. Hearing loss (hypoacusia) is a typical occupational illness in this industry, especially in glass container manufacturing. The noise level from glass-pressing machines can be as high as 100 decibels or more, causing hearing impairment.

Respiratory Hazards: The glass manufacturing process releases particulate matter (PM) in the workplace. This PM may contain silica dust (from silica sands and feldspar), and sometimes toxic compounds like lead oxide, boron, arsenic, tin, nickel and cobalt. This may cause respiratory problems for the workers.

Physical Hazards: Often, broken and flying glass particles can cause eye injuries. Severe injuries can be caused by broken flat glass during handling. There must be provision of cut-resisting gloves and long aprons to workers who handle flat glass.

The baking of bangles is mainly done in homes, where the sitting posture is not proper and may lead to health problems.

Labour Issues: Bangle makers are paid piece-rate wages which are very low. Contractors receive a certain amount from the glass factories for providing labourers but pay only a portion of this amount to the bangle makers.

Child labour and occupational health and safety are also a major issue for MSME clusters, besides pollution. MSMEs use outdated technology and face threats from modern technology. The survival of beads cluster is at present especially endangered and can lead to loss of livelihood for around 0.4 mn people.

9.7 Institutional linkages

- The Centre for Glass and Ceramic Research Institute (CGCRI) is the leading government institute for developing the glass and ceramics industry and has a special cell located in Firozabad.
- TERI has worked on technological upgradation work in the Firozabad cluster along with SDC as the funding agency.
- CGCRI has worked on introducing LPG-based community kilns in Purdilnagar, Hathras.
- Goonj, an NGO, has worked on social issues in the Firozabad clusters along with local NGOs.
- KVIC is a premier funding agency for MSME in such clusters.

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CHAPTER B10

Cement

10.1 Economic significance

Cement is one of the most polluting products in the world. It accounts for 5 per cent of global CO_2 emission, a greenhouse gas responsible for global warming.

10.1.1 India is the second largest producer of cement in the world after China. The sector provides direct employment to 0.14 mn people and has the capability to create huge indirect employment. This sector also accounts for 1.3 per cent of GDP. In the year 2006–07, 176 mn MT was the total production while export of cement amounted to 10 mn MT. During the Tenth Plan, cement production grew at a CAGR of 8.67 per cent. With the growth in the construction sector, the consumption of cement has grown at a rate which is 2–3 per cent higher than the growth of GDP.

The cement industry comprises of 125 large cement plants and more than 300 mini cement plants. Half of the mini plants are in clusters while the rest are spread across the country. The installed capacity, which was initially 300 TPD, has now been enhanced to 900 TPD. These plants do not come under the MSME sector as the plant and machinery cost is more than ₹100 mn. The cement industry is dominated by 20 companies which account for almost 70 per cent of the market while the top six contribute almost 50 per cent of production.

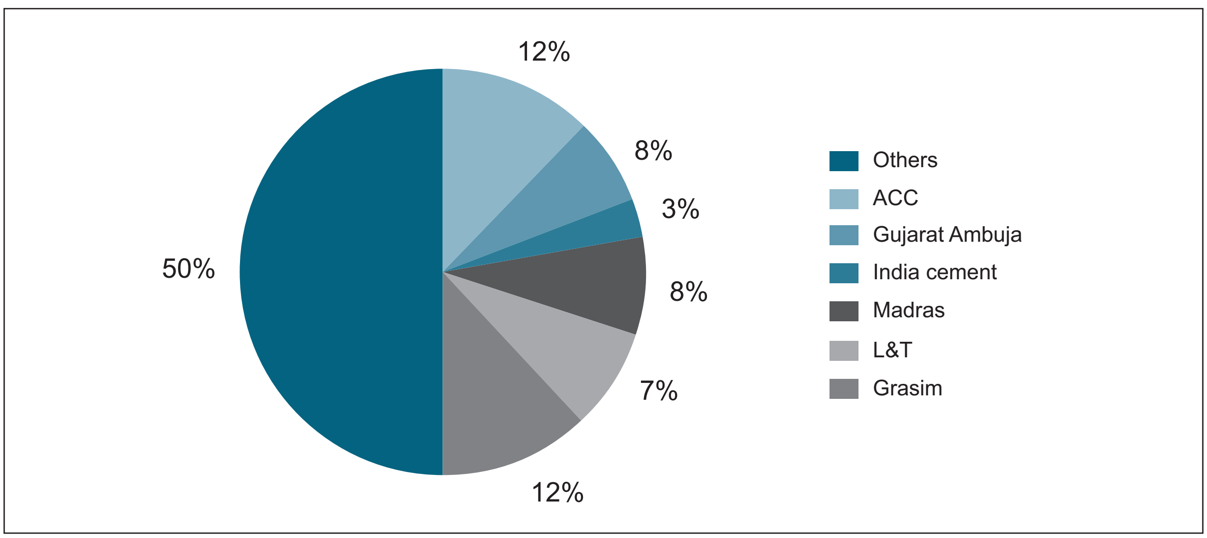

Figure: 10.1 Percentage share of various manufacturers

10.1.2 The Cement Corporation of India, a public sector undertaking, has 10 units and there are 10 large cement plants owned by various state governments. The cement industry in India has also made tremendous strides in technological upgradation and assimilation of latest technology. Presently, 96 per cent of the total capacity in the industry is based on modern and environment-friendly dry process technology.

10.1.3 The booming demand for cement, both in India and abroad, has attracted global majors to India. In 2005–06, four of the top five cement companies in the world entered India through mergers, acquisitions, joint ventures or green-field projects. These include France's Lafarge, Holcim from Switzerland, Italy's Italcementi and Germany's Heidelberg Cements.

10.2 Geographic concentration of clusters

The origin of mini cement plants dates back to the 1970s. The acute scarcity of cement in the mid-1970s and inadequate investment in this core sector led to the promotion of mini cement plants by the government to meet the local demand. The Government of India came announced a policy for the promotion of mini cement plants in early 1979. As a result of the Government's encouragement, backed by technical support by National R&D laboratories in the country, a number of mini cement plants came up in different parts of the country — mainly in areas close to limestone reserves. A majority of the mini plants are thus clustered in Andhra Pradesh, Karnataka, Madhya Pradesh and Rajasthan. Table 10.1 below provides a list of mini cement plant clusters in India along with their total number of units and turnover.

Table: 10.1 Spread of mini cement plants in India

State	Location	Units	Production Capacity (millions tonnes/annum)
Madhya Pradesh	Satna	-	11.77
Madhya Pradesh	Bilaspur	-	9.7
Maharashtra	Chandrapur	-	9.59
Karnataka	Gulbarga	-	6.83
Andhra Pradesh	Yerranguntla	-	1.9
Andhra Pradesh	Nalgonda	-	5.85
Rajasthan	Chandoria	-	7.03
Orissa	Rourkela	-	-
Jharkhand	Ramgarh, Hazaribagh	-	-
Gujarat		90	-

Source: Discussions with experts

10.3 Production process

In India, the cement manufacturing process is of three types: wet process, semi-dry and dry process. Wet process manufacturing of cement is an age old practice and has been replaced by the dry process. Till the late 1970s, a major share of production was through use of the wet process technology. By 2006, 96 per cent of the production had shifted to the dry process. The various stages of cement manufacture in dry process are shown in Figure 10.2.

Mining	The major raw material for cement manufacture is limestone, which is mined through drilling and blasting.
Crushing	The raw material is then crushed through dumpers and ropeways to a size of about 25-75 mm.
Raw mill grinding	The lime stone is mixed clay, ground in a crusher and fed into the additive silos. Sand, iron and bottom ash are then combined with the limestone and clay in a carefully controlled mixture which is ground into a fine powder.
Pyroprocessing	Raw meal is heated in the pre-heating system (cyclones) to start the dissociation of calcium carbonate to oxide. It then enters the calciner, where CO2 is released and leaving CaO. The meal goes further into the kiln for heating and reaction between calcium oxide and other elements to form calcium silicates and aluminates at a temperature up to 1450 0C: so-called clinker burning.
Clinker storage	The hot clinker is cooled as quickly as possible to improve the quality and stored in silo/stock pile.
Cement grinding	The clinker is combined with small amounts of gypsum and limestone and finely ground in a finishing mill to form cement.
Coal milling	The process of making cement clinker requires heat. Coal is used at the fuel for providing heat. Raw Coal received from the collieries is stored in a coal yard. Raw Coal is dropped on a belt conveyor from a hopper and is taken to and crushed in a crusher. This is called coal slurry.

Figure 10.2: Various stages of cement manufacture in dry process

10.4 Energy intensity in cement sub-sector

10.4.1 The production of cement is highly energy intensive and accounts for almost 45 per cent of the manufacturing cost, as estimated in the IREDA-CII Report. The total value of energy consumed is estimated at around ₹ 63,000 mn. Energy is consumed at various stages of cement production. However, the degree of energy consumption is dependent on the typology of the production process undertaken.

10.4.2 Energy is mostly consumed during the process of raw mill grinding and pyro-processing, where the raw meal is heated to form clinker. This is done in a kiln. Coal continues to be the main fuel for the cement industry. At present, 60 per cent of the coal requirement of the cement industry is met through linkages and fuel supply agreements, while the remaining is met through open market purchases, import and use of petroleum coke. The most widely used kilns in India are the vertical shaft kiln and rotary kiln. The electrical energy requirements for different sections are given in table 10.2 below.

Table 10.2: Electrical energy requirements

Section	Electrical Energy in Kwh/tonne of materials
Crushing	1 to 3
Raw mill	28 to 35
(Including mill auxiliaries)	20 to 25
Vertical Shaft Kiln (VSK)	12 to 15
Rotary Kiln (RK)	25 to 35

Source: CPCB Sector report

10.3.3 As the consumption of energy is lower in a vertical shaft kiln (VSK) as compared to a rotary kiln (RK), most units have changed to VSK. For a modern cement manufacturing unit in India, the best thermal and electrical energy consumption is as low as 667 kcal per kg of clinker and 68 kWh per mt of cement, which is comparable to the global standard of 650 kcal per kg of clinker and 65 kWh per mt of cement.

10.4.4 The consumption of coal and electricity in cement plants is 40 mn tonnes and 11.44 bn units per annum, respectively. The estimated value is ₹195.5 bn {(4*4000)/5000 + (11.44*5)/50}.

10.5 Environmental issues in cement sub-sector

10.5.1 The cement industry is one of the high polluting industries which cause considerable air pollution. The sector contributes significantly to air pollution levels in the vicinity of the plants as large quantities of pulverised material are handled at each stage of manufacturing, from crushing of raw material to finally packing of cement. The impact of pollution by cement plants on the environment is localised, i.e., limited to a maximum distance of 10 km from its place of installation.[65] The regulations issued till date in various countries are all primarily intended to bring local air pollution under control, both in the vicinity of as well as inside factories. The dominating environmental problem in Indian cement plants is the emission of dust into the atmosphere. The Central Pollution Control Board (CPCB) has categorised the cement industry under "Red Category" in terms of emission. The standards that have been set by CPCB are given in Table 10.3.

65 Central Pollution Control Board

Table 10.3: Emission standards under CPCB

Plant Capacity	Pollutants	Emission limit (mg/Nm^3)
200 tonnes per day and less (all sections)	Particulate matter	400
More than 200 tonnes per day (all sections)	Particulate matter	250

Source: CPCB website

10.5.2 The environmental issues in cement manufacturing are:

- Air emissions
- Wastewater
- Solid waste generation
- Noise pollution

Table 10.4: Environmental issues

1.	Air Emission
(i)	*Dust and particulate matters:* These are generated at each step of the production process. The major sources of dust are crusher, raw mill, kiln, clinker cooler, coal mill, cement mill and packaging plant.
(ii)	*Nitrogen Oxide:* These emissions are caused by high kiln temperatures and the oxidation of nitrogen.
(iii)	*Sulphur Oxides:* These are emitted from volatile or reactive sulphur in the raw materials and fuels used for power generation.
(iv)	*Greenhouse Gases:* Such emissions are associated with fuel combustion and with the decarbonation of limestone which is 44 per cent CO_2 by weight. CO_2 emission is 76.3 mn tonnes by coal and 116.2 mn tonnes by limestone. (Assuming coal has 52 per cent carbon and 48 per cent impurities, 40 mn MT coal will emit 76.3 mn tonnes of CO_2; 1 tonne of carbon produces 3.667 tonnes of CO_2; 254 mn tonnes of limestone is consumed to produce 176 mn MT of cement; 45.83 per cent by weight of limestone is CO_2.)
(v)	*Heavy Metals and Other Emissions Due to Waste Fuel:* Use of high calorific value waste fuels like used solvent, waste oil, used tires, waste plastics, etc leads to emission of volatile organic compounds, hydrogen fluoride, hydrogen chloride and toxic metals and their compounds if not properly controlled and operated.

2.	Solid Waste
	Solid waste in cement manufacturing includes clinker production waste, which is removed from the raw material during raw mill preparation. Other waste materials includes alkali or chloride/fluoride containing dust build up on the kiln.
3.	Waste Water
	The most significant use of water in cement manufacturing is for cooling purposes in different phases of the process. The water is high in pH and suspended solids.
4.	Noise
	Noise pollution is caused at different stages of the production process. This includes raw material extraction; grinding and storage; raw material, intermediate and final product handling; and operation of exhaust fans.

Positive aspect: The cement industry consumes around 25 per cent of the fly ash (a by-product) produced in thermal power plants and is difficult to dispose off.

10.6 Social issues in cement sub-sector

10.6.1 There are several health and safety hazards related to cement manufacturing. The dust produced in the cement-making process is a nuisance within the plant and its surroundings and workers are exposed to fine particulates of dust, heat, noise and vibration. The workers are also exposed to unhealthy practices like lifting of heavy weights and over-exertion in this polluted environment. Cement dust impairs lung function, causes chronic obstructive and restrictive lung diseases, pneumoconiosis and carcinoma of the lungs, stomach and colon. Other studies have shown that cement dust may enter into the systemic circulation and thereby reach the essential organs of the body and affect the different tissues including the heart, liver, spleen, bones, muscles and hairs, and ultimately affect their micro-structure and physiological performance.

10.7 Bibliography

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CHAPTER B11

Pulp and paper

11.1 Economic significance

11.1.1 The Indian paper industry accounts for about 1.6 per cent of the world's production of paper and paperboard. The estimated turnover of the industry is ₹ 270,000 mn, approximately. The industry provides direct employment to more than 0.12 mn people and indirectly to another 0.34 mn people. During 2007–08, the operating capacity of the industry was 9.3 mn tonnes. However, experts in the industry have estimated the total production to be 10.5 mn tonnes during 2008–09 and per capita consumption was pegged at more than 8.3 kg.

11.1.2 Paper mills with the capacity of producing up to 10,000 tonnes per annum (TPA) of paper, board, etc., are classified as small paper mills.[66] However, they do not come under the MSME category as the plant and equipment cost is more than ₹ 100 mn even for the smallest unit. The shortage of paper in early 1970s led to the setting up of small- and medium-sized paper mills. The government supported the import of cheap second-hand plants that helped in the setting up of small paper mills in many parts of the country.

11.2 Geographical spread of paper sub-sector

By 1992, there were around 300 small- and medium-sized paper mills in the country, which accounted for almost 50 per cent of installed capacity and production. The capacity of the small paper mills ranges from 3 to 30 tonnes per day (TPD). A few of these small paper mills exist in clusters, the list of which is given in Table 11.1.

Table: 11.1 Spread of paper sub-sector in India

State	Location	No of units	Cluster Production Capacity (tonnes/day)
Gujarat	Vapi	30–40	400–600
Uttar Pradesh	Muzaffarnagar	30–40	400–600
Uttarakhand	Udhamsingh Nagar	12–15	800–850
Tamil Nadu	Coimbatore	9	1,000–1,100

Source: Discussions with experts

66 Comprehensive Industry Document, CPCB

However, these small units are burdened with problems such as high production costs, uneconomical operations, poor quality and negative impact on the environment. The high production costs are also attributable to the rising energy prices, which accounts for almost 25 per cent of the total production cost.

11.3 Production process

The pulp and paper sector is highly energy intensive with 75–85 per cent of the energy requirement being used as process heat and 15–25 per cent as electrical power. The energy is consumed at various stages of production. The amount of energy consumed is also dependent on the type of raw material used for the production. Three types of raw materials are used for making paper: wood, agriculture residue and waste paper. In general, the production process consists of five stages, which are explained in the following sections.

11.3.1 *Stage 1 Raw material preparation:* The conventional raw material for small paper mills comprises rice and wheat straw, bagasse, jute, cotton rags, different types of grasses, waste paper, purchased pulp and occasionally gunny and hessian. In large- and medium-sized mills, wood is the predominant source of cellulose fibre for paper manufacturing. Wood preparation involves breaking wood down into small pieces, i.e., debarking and chipping. This process requires some energy.

11.3.2 *Stage 2 Pulping:* Pulping can be performed using chemical, mechanical (hydro-pulping) or combined chemical-mechanical techniques. The chemical process involves digestion of raw materials like agricultural residue, jute, etc., at high temperature and pressure in the presence of chemicals like sodium hydroxide and/ or lime. The temperature maintained for digesting material is around 150°C and around 1.2–1.5 tonne of steam is required for each tonne of raw material digested. The mechanical process is used for waste and recycled paper. A hydro-pulping unit comprises a high-speed rotating disc that chops the paper to fibre in the presence of steam. Chemical-mechanical techniques make use of both chemical and mechanical processes. The raw material is soaked in 3–5 per cent caustic soda solution at 90°C for 15–30 minutes.

11.3.3 *Stage 3 Bleaching:* This is done in the manufacture of bleached paper for writing, printing and decorative papers. The chemicals used to bleach are mainly chlorine, alkali solution, hydrogen peroxide, sodium hydrosulphite, etc., but varies according to the type of raw material used. In small units, only calcium hypochlorite or bleaching powder is used and the conventional steps are not followed.

11.3.4 *Stage 4 Chemical Recovery:* This process regenerates the spent chemicals used in Kraft chemical pulping. It produces a waste stream of inorganic chemicals and wood residue known as black liquor. The black liquor is concentrated in evaporators and then incinerated in recovery furnaces, many of which are connected to steam turbine cogeneration systems. Wood residues provide the fuel and the chemicals are separated as smelt which is then treated to produce sodium hydroxide. Sodium sulphide is also recovered.

11.3.5 *Stage 5 Paper Making:* Paper making consists of preparation, forming, pressing and drying. During preparation, the pulp is made more flexible through beating — a mechanical pounding and squeezing process. Pigments, dyes, filler materials and sizing materials are added at this stage. Forming involves spreading the pulp on a screen. The water is removed by pressing and the paper is left to dry. In one of the most common paper making processes, the paper is pressed, drained and dried in a continuous process. In another, a pulp matt is formed in layers with water removal and treating occurring between deposits.

11.4 Energy intensity in small paper mills

Given the production process, most of the energy is used in the form of heat within the pulping process when the raw materials are cooked and mechanically or chemically treated. Furthermore paper making consumes energy as heat and electricity for forming, pressing and drying of the paper. The amount of energy consumed varies with the typology of raw material used in the production process. In the case of waste paper, the energy requirement is almost 2.5 times less than when wood chip or agricultural residue is used. This is because less intensive pulping is needed for waste paper. The main fuel used in this industry is coal. Other fuels used are furnace oil, low sulphur heavy stock (LSHS), rice husk and coffee husk. Light diesel oil (LDO) and high speed diesel (HSD) are also used in diesel generators. The energy consumption in Indian paper mills is provided in Table 11.2 below.

Table 11.2: Energy consumption in Indian paper mills

Equipment	Steam (t/t of Paper)	Fuel (gJ/t of Paper)	Electricity (kWh/t of Paper)	Final Energy (gJ/t of Paper)
Chipper			112–128	0.4–0.5
Digester	2.7–3.9	12.5–18.0	58–62	12.7–18.2
Evaporator	2.5–4	11.5–185		11.5–18.5
Washing & Screening			145–155	0.5–0.6
Bleaching	0.35–0.4	1.6–1.8	88–92	1.9–2.2
Soda Recovery	0.5–1.1	2.3–5.1	170–190	2.9–5.8
Stock preparation			275–286	0.99–1.03
Paper machine	3.0–4.0	13.8–18.5	465–475	15.5–20.2
Deaerator	0.8–1.2	3.7–5.5		3.7–5.5
Utilities & Other			248–252	0.89–0.91
Total	**10–16**	**46.2–73.8**	**1.500–1,700**	**51.6–80.0**

Notes: The energy content of Indian coal is expressed in "Useful Heating Value" (UHV). UHV is derived from the ash and moisture contents for non-coking coals according to a Government of India notification. UHV is calculated as:
UHV kcal/kg = (8900-138 x [percentage of ash content + percentage of moisture content]).
The ash content in Indian coal ranges from 35–50 per cent; the average value is 42.5 and moisture is 6 per cent.
Indian coal (non-coking) is classified by grades (A–G) defined on the basis of UHV.
Source: http://www.indopedia.org/Calorific_Value_of_Coal.html

Hence, the total consumption of electricity is 16.80 bn units and that of coal is approximately 84 mn tonnes per annum. The estimated value of total energy consumption is ₹ 381.6 bn [{(8.4*4000)/5000) + (16.8*5)/50}*45*100]. Approximately 160.1 mn tonnes of carbon dioxide is produced. (Assuming coal has 52 per cent carbon and 48 per cent impurities in 840 mn MT coal, and 1 tonne of carbon yields 3.667 tonnes of CO_2.)

Since plants using second grade technology were imported to set up paper mills, the cost of upgradation is very high and the payback is 6–10 years. The huge investment in old technology has given very low returns due to inefficiencies in the plants. Imported machines of latest technology are exorbitantly expensive. Fluctuation in raw material costs has reduced margins to very low levels and has also impacted production volumes. Economy of scale can be achieved if raw material supply is increased and affordable, indigenous technology is developed. The payback should not be more than 3–4 years.

Several actions have been taken by the paper manufacturing industry and government research bodies to reduce costs. These have mainly been some process and technology improvements for use of indigenous raw material like bagasse, bamboo grass, etc., and have been developed by the scientists of Indian Agricultural Research Institute (IARI), and Central Pulp and Paper Research Institute (CPPRI).

11.5 Environmental issues in paper sub-sector

11.5.1 Global studies have raised very high concerns about the effect of the paper industry on energy and the environment, some of which are:

- A tonne of paper requires 98 tonnes of input materials/ resources.
- A tonne of paper uses as much energy as much as a tonne of steel in its manufacturing (according to USA Environmental Protection Agency).
- Deforestation causes more damage in comparison to emissions caused by global transport which is 17.4 per cent and 13 per cent, respectively.
- In industrial countries, the paper industry is the biggest user of water.[67]

11.5.2 Paper and pulp making has been listed under the "Red Category" industries on the basis of its emissions/discharges of high/significant polluting potential or generating hazardous wastes. CPCB has set standards for industry specific emissions both for effluents and emission. In the case of paper-making, the standard has been set for effluents, which are given in Table 11.3.

67 http://www.shrinkpaper.com

Table 11.3: Effluents standards for pulp and paper sub-sector

Standards for liquid effluents		
Mode of Disposal	**Parameter**	**Concentration not to exceed (mg/f) (except for pH and sodium absorption ratio)**
Inland Surface Water	pH	5.5–9.0
	Suspended solids	100
	BOD at 27^{0}C, 3 days	30
Land	pH	5.5–9.0
	Suspended solids	100
	BOD at 27^{0}C, 3 days	100
	Sodium absorption ratio	25
Wastewater Discharge Standards		
Category		
Agro Based	200 cum/tonne of paper produced	
Waste Paper Based	75 cum/tonne of paper produced	

Source: EPA Notification S.O 64(e), 16 January 1998

11.5.4 The environmental issues associated with this sector primarily include the following:

- Wastewater
- Air emissions
- Solid waste

11.5.4.1 *Wastewater*

11.5.4.1(i) The paper industry depends very heavily on water. All the processes in paper-making require water and accordingly release wastewater. Small mills using chemical processes do not recover chemicals thus leading to intense pollution problem. Chemical recovery is not done mainly due to the high cost involved in the treatment.

11.5.4.1(ii) The composition of wastewater effluents from mills using both agricultural residue and waste papers varies according to the proportion of the raw materials used and hence cannot be generalised. The pollution load from mills using agricultural residue and waste paper include BOD, COD, lignin, sodium and suspended solids.

11.5.4.1(iii) In the case of agriculture residue, wastewater is generated as black liquor from the cooking section, pulp wash water from the poucher, beater section, bleaching section, thicker, and paper machine. Black liquor is the most polluting of all the different streams. It is generally not segregated and ends up in pulp washing wastewater. The pulp washing section accounts for 80 per cent of the total pollution load and contributes an appreciable amount of suspended solids.

11.5.4.1(iv) In the case of waste paper-based mills, wastewater is generated from the bleaching section, thickener and paper machine.

Assuming the total production of paper in India in the year 2008–09 as 10.5 mn tonnes, the waste generation for the same period has been calculated and shown in Table 11.4.

Table 11.4: Wastewater generated from different input raw materials

Type of input	Production (%)	Actual waste production (mn tonnes)	Average wastewater generated (m^3/ tonne)	Wastewater generated (mn m^3)
Agriculture residue/wood	82	8.61	250	2152.5
Waste paper	18	1.89	7	202.2

Source: Wastewater per tonne calculated from CPCB COINDS

The amount of wastewater generated in the year 2008–09 was 2.35 bn m^3.

11.5.4.2 *Air Emission*

11.5.4.2(i) The problems of air pollution in small paper mills are limited to gases escaping during digester blow-off which cause aesthetic pollution (e.g., vision in the presence of smoke) in limited areas. As part of the manufacturing process, pulp and paper mills generate sulphur dioxide and particulate matter, dust, soot and ashes from the burning of fossil fuels (like coal) for energy. Pulp and paper mills are sources of large quantities of the standard air pollutants like carbon dioxide, nitrous oxides, carbon monoxide and particulates. These contribute to ozone warnings,[68] acid rain, global warming and respiratory problems.

11.5.4.2(ii) Greenhouse Gas: Approximately 160.1 mn tonnes of carbon dioxide is produced from the total amount of coal used annually

11.5.4.3 *Solid Waste*

11.4.4.3(i) Waste paper mill sludge originating from different effluent treatment and de-inking installations are complex mixtures of inorganic and organic particles. Due to their favourable physio-chemical and microbiological characteristics, they may be conveniently reused for

68 Ozone warning is a caution that is given in advance when ozone is declared at ground level. This warning is given because ozone gas is very reactive and is hard on lung tissue.

different purposes as such or after appropriate pre-treatment. Paper fibres can be recycled only a limited number of times before they become too short or weak to make high quality paper. This means the broken low-quality fibres are separated to become waste sludge. All the inks, dyes, coatings, pigments, staples and "stickies" (tape, plastic films, etc.) are also washed off the recycled fibres to join the waste solids. The shiny finish on glossy paper is produced by using a fine kaolin clay coating, which also becomes solid waste during recycling.

11.5.4.3(ii) Approximately 0.609 mn ton per annum (from 58 kg per ton of paper produced) of solid waste is being generated by the paper industry. (Small- and medium-sized paper mills have 35 per cent share of the total production and hence almost 35 per cent share of solid waste and ash.) This waste excludes boiler ash which is produced at the rate of 1.3 tonne per tonne of paper produced, i.e., 13.6 mn tonne ash per annum. These are dumped in low-lying areas. Therefore the total solid waste generated by the paper industry which includes waste from paper, wood residues and ash is 14.2 mn tonnes per annum (0.609 + 13.6 mn tonnes per annum)

11.6 Institutions/associations

11.6.1 The following associations represent this industry:

- The Indian Paper Manufacturers Association
- Indian Agro & Recycled Paper Mills Association
- Central Pulp and Paper Research Institute (CPPRI) — a premier institute working in the field of research for the pulp and paper industry.
- Department of Paper Technology, IIT, Roorkee.
- Shree Ram Institute of Industrial Research — doing research on paper technology.
- Forest Research Institute — has a paper division to train manpower for the paper industry.
- Indian Agriculture Research Institute, PUSA, New Delhi.
- Development Council for Pulp Paper & Allied Industry — working on projects with CPPRI and National Council of Biomechanics (NCBM).
- NGOs such as Development Alternative (DA), CSE, Chintan and waiste2wealth — contribute to spreading awareness about best practices.

11.7 Bibliography

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Annex I

Relevant social sector schemes that are applicable in MSME clusters

Sr. No.	Name of Scheme	Objective/focus of the scheme
Ministry of Woman and Child Development		
1.	Employment-cum-income Generating Unit for Women (NORAD) www.wcd.nic.in/rus15.htm http://planningcommission.nic.in/plans/annualplan/ap2021pdf/ap2021ch5-6-1.pdf	Formulation and documentation of projects Provide tie-up of marketing arrangements Providing skills, management and training
2.	SWAYAMSIDHA (IWEP)-Integrated scheme for women's empowerment (IWEP) www.wcd.nic.in/iwepdraft.htm	Establishment of self-reliant women's Self-Help Groups (SHGs); Women will be encouraged to form groups according to their socio-economic status and felt needs, after which they will network with other groups. In addition to empowering SHG members per se, by federating and networking strong pressure groups for women's empowerment/rights will be formed. Creation of confidence and awareness among members of SHGs regarding women's status, health, nutrition, education, sanitation and hygiene, legal rights, economic upliftment and other social, economic and political issues. Strengthening and institutionalising the savings habit in rural women and their control over economic resources. Improving access of women to micro-credit. Involvement of women in local-level planning. Convergence of different agencies for women's empowerment and integrated projects accessing delivery of different schemes from a single window. Inculcating a subsidy-free approach to women's empowerment.

Sr. No.	Name of Scheme	Objective/focus of the scheme
3	General Grant-in-Aid Scheme for Assistance to NGOs/Voluntary Organisations http://labour.nic.in/cwl/Grant-In-Aid.pdf www.wcd.nic.in/us9.html#b9	To prohibit child labour in hazardous employment and regulate their working conditions in other employment/ occupations. To formulate income generating schemes and other action projects for women labour.
4	Support to training and employment programme for women (STEP) www.wcd.nic.in/rti_step.pdf http://www.wcd.nic.in/rti_stepenclosure1.pdf http://www.wcd.nic.in/rti_stepenclosure2.pdf	To mobilise women in small viable groups and make facilities available and access to credit. Provide training for skill upgradation, enable groups of women to take up employment-cum-income generation programmes by providing backward and forward linkages. Provide support services for further improving training and employment conditions for women.
5.	Crèche & Hostel, for working women www.wcd.nic.in/us12.hctml	To provide accommodation for single working women, unmarried, widows, divorced, separated, married when husband is out of town: Accommodation to women who are being trained for employment provided the training period does not exceed one year. The number of working women falling in this category should not be more than 30% of the total number of women in the hostel. Accommodation to the girl students for a period of five years on the condition that first preference will be given to working women only. In case of any vacancies accommodation will be provided to the students also but amongst them, preference will be given to those studying in post-school professional courses. The category of women who are being trained for employment and the girl students together should not be more than 30% of the total number of women in hostels.

Sr. No.	Name of Scheme	Objective/focus of the scheme
6.	Rashtriya Mahila Kosh (RMK) www.wcd.nic.in/ar2007/English/Chapter/ch11.pdf	RMK extends micro-finance services through a client friendly, without collateral and hassle-free loaning for livelihood activities, housing, micro-enterprises, family needs, etc. RMK has also taken a number of promotional measures to popularise the concept of micro-financing, thrift credit, formation and stabilisation of Self Help Groups (SHGs) and also enterprise development for poor women.
7.	Scheme of Assistance to Voluntary Agencies for Early Childhood Education for 3–6 Age Group Children www.wcd.nic.in/us17.html	A significant start will be made for the development of early childhood education (ECE) for the first generation learning families in backward areas. First programmes of training of ECE teachers and early childhood education centres as adjuncts of primary/middle schools will be started under the State Sector of Plan. Secondly, UNICEF has agreed to extend assistance for the development of ECE programmes in 11 states during the 1981–83 period of Master Plan of Operation. Significant inputs have been offered by UNICEF on workshop/seminars for developing and producing training materials, orienting administrative and supervisory personnel, providing short-term training of early childhood educators and supplying play materials and equipment of a selected number of ECE centres in each of the 11 states.
8.	National crèche fund scheme, 1994 www.wcd.nic.in/childdet.htm	To meet the growing demands for crèches and to provide day care facilities to the children in the age group of 0–5 years.

Sr. No.	Name of Scheme	Objective/focus of the scheme
9.	Gender Budgeting Scheme http://wcd.nic.in/schemes/gbscheme.pdf	To initiate an integrated approach and guide the Gender Budgeting Cells (GBCs) setup by different Central Ministries/Departments by disseminating the concept, tools and strategy of gender budgeting. To coordinate and monitor gender budgeting exercises of GBCs and facilitate gender budgeting analysis. To organise workshops to facilitate capacity building and training for various stakeholders including officials of Central and State Governments, PSUs, corporate sector, Panchayati Raj Institutions (PRIs) and NGOs, etc. To provide assistance to develop training modules/packages, training material and information booklets and manuals for gender budgeting for all stakeholders To encourage State Governments and PRIs in evolving plans and strategies for undertaking gender budgeting by providing assistance, support and consultancy services for organising workshops, seminars, training programmes, etc. To provide assistance to support research studies, surveys, etc., to research institutes, NGOs, etc., for gender budgeting. To pilot action on gender sensitive review of national policies such as fiscal, monetary, environment, trade etc. To pilot action on gender review and gender audit of important legislations Guide and undertake collection of gender disaggregated data. Conduct gender based impact analysis, beneficiary needs assessment and beneficiary incidence analysis Collate and promote best practices on gender budgeting.
10.	Scheme for welfare of working children in need of care and protection http://wcd.nic.in/schemes/workchild.pdf	Provision of opportunities including non-formal education, vocational training, etc., to working children to facilitate their entry/re-entry into mainstream education in cases where they have either not attended any learning system or where for some reasons their education has been discontinued, with a view to preventing their continued or future exploitation.

Sr. No.	Name of Scheme	Objective/focus of the scheme
11.	Balika Samridhi Yojana http://wcdhry.gov.in/balika_samridhi_yojana.htm	To change negative family and community attitudes towards the girl child at birth and towards her mother. To improve enrolment and retention of girl children in schools. To raise the marriage age of girls. To assist the girl to undertake income generating activities.
12.	Kishori Shakti Yojana http://wcd.nic.in/KSY/ksyintro.htm	To improve the nutritional, health and development status of adolescent girls, promote awareness of health, hygiene, nutrition and family care. Link them to opportunities for learning life skills, going back to school, help them gain a better understanding of their social environment and take initiatives to become productive members of the society.
13.	Integrated child development services scheme http://wcd.nic.in/icds.htm	To improve the nutritional and health status of children in the age-group 0–6 years. To lay the foundation for proper psychological, physical and social development of the child. To reduce the incidence of mortality, morbidity, malnutrition and school dropout. To achieve effective coordination of policy and implementation amongst the various departments to promote child development. To enhance the capability of the mother to look after the normal health and nutritional needs of the child through proper nutrition and health education.
Central Social Welfare Board		
14.	Working women's hostel scheme www.wcd.nic.in/cswb1.htm#Support	To provide assistance to organisations to enable them to provide safe and secure hostel facilities for working women.
15.	Crèches (Rajiv Gandhi National creche scheme for the children) www.wcd.nic.in/cswb1.htm#Support	Provide assistance to NGOs for running crèches for infants (0–6 years). Provide assistance to ensure sleeping facilities, health care, supplementary nutrition, immunisation, etc., for running a creche for 25 infants for eight hours i.e., from 9:00 am to 5:00 pm.

Sr. No.	Name of Scheme	Objective/focus of the scheme
Small Industries Development Bank of India (SIDBI)		
16.	Mahila Vikas Nidhi (MVN) (Enterprise Promotion) http://www.sidbi.in/MVN.ASP http://www.smallindustryindia.com/schemes/tread.html	MVN is SIDBI's specially designed fund for economic development of women, especially the rural poor, by providing them avenues for training and employment opportunities.
17.	Micro Credit Scheme (Entrepreneur Development) http://www.smallindustryindia.com/schemes/microfinance.htm http://www.sidbi.in/Micro/index.htm	To create a national network of strong, viable and sustainable Micro-finance Institutions (MFIs) from the informal and formal financial sector to provide micro-finance services to the poor, especially women. To support and promote men and women of low-income families to develop micro enterprises through entrepreneurship development to create employment and income generating opportunities to reduce poverty.
18.	Scheme for Energy Saving in MSMEs http://www.smeforum.in/index.php?option=com_content&view=article&id=171:sidbi-financing-scheme-for-energy-saving-projects-in-msme-sector&catid=36:across-the-globe&Itemid=110	The Japan International Cooperation Agency (JICA) has extended a Line of Credit to Small Industries Development Bank of India (SIDBI) for financing energy saving projects in Micro, Small and Medium Enterprises (MSMEs) Sector. The project is expected to encourage MSME units to undertake energy saving investments in plant and machinery/production process to reduce energy consumption, enhance energy efficiency, reduce CO_2 emissions and improve profitability in the long run.
Ministry of Youth Affairs & Sports		
19.	Scheme for Assistance to Youth Club www.yas.nic.in/yasroot/schemes/clubs.html http://goicharters.nic.in/youthaffairs.htm	In order to enable youth to mobilise themselves for their own as well as the community's welfare.

Sr. No.	Name of Scheme	Objective/focus of the scheme
Ministry of Social Justice and Empowerment		
20.	Scheme for Grant-in-Aid to Voluntary Organisations Working for Scheduled Castes http://www.socialjustice.nic.in/ngosch1.pdf	The main objective behind the scheme is to involve the voluntary sector and training institutions of repute to improve educational and socio-economic conditions of the target group i.e., Scheduled Castes with a view to upgrade skills to enable them to start income generating activities on their own or get gainfully employed.
21.	Assistance to NGOs working for SC ST & OBC http://www.socialjustice.nic.in/obcngosch.pdf	To involve the voluntary sector to improve educational and socio-economic conditions of the target group, with a view to upgrade skill to enable them to start income generating activities on their own.
22.	Scheme of Assistance for the Prevention of Alcoholism & Substance (Drugs) Abuse http://www.socialjustice.nic.in/drugsabuse.pdf	To support activities of non-governmental organisations, working in the areas of prevention of addiction and rehabilitation of addicts. Create awareness and educating the people about the ill-effects of alcoholism and substance abuse on the individual, the family and society at large. Develop culture-specific models for the prevention of addiction and treatment and rehabilitation of addicts. To evolve and provide a whole range of community based services for the identification, motivation, detoxification, counselling, after care and rehabilitation of addicts. To promote community participation and public cooperation in the reduction of demand for dependence-producing substances, collective initiatives and self-help endeavours among individuals and groups vulnerable to addiction and considered at risk. To establish appropriate linkages between voluntary agencies working in the field of addiction and government organisations.

Sr. No.	Name of Scheme	Objective/focus of the scheme
23.	Income Generating Programmes for the Disabled http://www.karmayog.org/library/libartdis.asp?r=152&libid=128	Promote economic development activities and self-employment ventures for the benefit of persons with disability. Extend loan to persons with disability for upgradation of their entrepreneurial skill for proper and efficient management of self-employment ventures. Extend loan to persons with disability for pursuing professional/technical education leading to vocational rehabilitation/self-employment. To assist self-employed individuals with disability in marketing their finished goods.
24.	Scheme of assistance to disabled persons for purchase of Aids/Appliances http://www.socialjustice.nic.in/adipmain.php	To assist needy disabled persons in procuring durable, sophisticated and scientifically manufactured, modern, standard aids and appliances that can promote their physical, social and psychological rehabilitation, by reducing the effects of disabilities and enhance their economic potential.
25.	Deendayal Disabled Rehabilitation Scheme to promote Voluntary Action for Persons with Disabilities (Revised DDRS Scheme) http://www.socialjustice.nic.in/ddrs.php	To create an enabling environment to ensure equal opportunities, equity, social justice and empowerment of persons with disabilities. To encourage voluntary action for ensuring effective implementation of the People with Disabilities (Equal Opportunities and Protection of Rights) Act of 1995.
26.	Integrated Programme for Older Persons http://www.socialjustice.nic.in/ipop.php	To improve the quality of life of the elderly by providing basic amenities like shelter, food, medical care and entertainment opportunities and by encouraging productive and active ageing by providing support for capacity building of Government/Non-Governmental Organisations/Panchayati Raj Institutions/local bodies and the community at large.
Department of Elementary Education and Literacy, and Department of Secondary and Higher Education, Ministry of Human Resource Development		
27.	Integrated Education for Disabled Children (IEDC) http://www.education.nic.in/iedc_sch_draft.asp	To educate students with disabilities in accordance with the principles of inclusive education by incorporating the 'social model of disability' – the scheme aims to create an environment that respects and values diversities and attempts to increase enrolment, retention and achievement of students with disabilities in general education/regular schools.

Sr. No.	Name of Scheme	Objective/focus of the scheme
28.	Scheme of Support to Voluntary Agencies for Adult Education and Skill Development http://education.nic.in/MHRD.pdf	To improve the occupational skills and technical knowledge of neo-literates and trainees and to raise their efficiency and increase productive ability. To provide academic and technical resource support to zilla saksharata samities in taking up vocational and skill development programmes for neo-literates in both urban and rural areas. To serve as nodal continuing education centres. To organise training and orientation courses for key resource persons, master trainers on designing, development and implementation of skill development programmes. To organise equivalency programmes through 'open' learning systems. To widen the range of knowledge and understanding of the social, economic and political systems. To promote national goals such as secularism, national integration, population, etc.
29.	Environmental Orientation to School Education http://www.iesglobal.org/environemntal-orientation.htm	To promote experimentation and innovation, and to complement in diverse ways the goals spelt out in NPE-86 and NCF-2005 for creating environmental consciousness and related behavioural practices among students. Some of the activities envisaged under the scheme are: Encouraging and undertaking curriculum enrichment projects in the area of environment, including making environmental education an integral part of curriculum in school education, leading to development of local-specific teaching-learning materials (e.g., brochures, posters, maps, charts, art and artifacts, models, audio and video materials as well as CDs and websites), organisation of exhibitions, literary gatherings, dramas, debates and discussions, dances, film shows, street-plays, melas and other such activities including those which the panchayats may suggest. Action research/experimental/innovative activities, including activities aimed at generating good primary data on local environmental parameters wherever necessary involving the panchayats.

Sr. No.	Name of Scheme	Objective/focus of the scheme
30.	Scheme on Non-Formal Education http://www.education.nic.in/cd50years/r/2P/8R/2P8R0301.htm	The broad aim of the scheme is to effectively involve voluntary agencies, public trusts, non-profit making companies, social activist groups etc., in the implementation of non-formal education programme for elementary age-group children. There are two types of non-formal centres: one run under SSA, and the other under the National Child Labour Project (NCLP). Under both the schemes, NGOs run the centres with funding from the government.
Ministry of Development of North Eastern Region		
31.	Capacity Building and Technical Assistance http://mdoner.gov.in/index2.asp?sid=263	To provide employable skills to the youth of the region, entrepreneurial skills, competencies that will enable them to become self-employed, organise job fairs within and outside the region, disseminate information and counseling on options relating to career, education including vocational and technical education, both in physical and electronic form, assist in surveys, evaluation in the field of skills and competencies, assist institutions/organisations in the public/private/non-profit/joint sector who can assist in testing of competency levels and certification so as to enhance employability especially in the unorganised sector, assist in providing any other specialised inputs required for human resource development for building of skills and capacities in any sector that is critical for the development of the region, provide technical assistance for development of human resources and capacity building. Emphasis of the scheme will be on actual delivery of skills and not only on sensitisation or advocacy.
National Minorities Development and Finance Corporation		
32.	Educational Loan Scheme http://www.nmdfc.org/schems&prog.html http://www.nmdfc.org/refer_manuals11.html	To facilitate job-oriented education amongst the weaker sections of Minorities.

Sr. No.	Name of Scheme	Objective/focus of the scheme
Ministry of Environment and Forests		
33.	Industrial Pollution Abatement through Preventive Strategies http://moef.gov.in/report/0910/Annual_Report_ENG_0910.pdf#page=5	To assist the primary small units and some medium scale units who do not have access to the requisite technical expertise to achieve waste minimisation but excludes procurement of equipment and hardware. Establishing and running Waste Minimisation Circles (WMCs) in clusters of small & medium industries. Capacity building in the area of waste minimisation/cleaner production through training. Waste minimisation demonstration studies in selected industrial sectors. Preparation of sector specific technical manuals on waste reduction, reuse and recycling. Awareness programmes and preparation of compendium of success stories on cleaner production/waste minimisation.
34.	Common Effluent Treatment Plants (CETP) http://envfor.nic.in/funding/chap2.pdf	To encourage use of new technologies for CETPs for existing units in SSI clusters, a scheme for financial assistance has been formulated. This promotional scheme is being instituted and will be implemented during the Tenth Five Year Plan. To reduce the treatment cost to be borne by an individual member SSI to a minimum while protecting the water environment to a maximum. Wastewater treatment and water conservation are the prime objectives of the CETP.
35.	Clean Technologies http://moef.gov.in/report/0910/Annual_Report_ENG_0910.pdf#page=5	To develop and promote programmes for clean technologies. To develop tools and techniques for prevention of pollution. To formulate strategies and programmes in sustainable development.

Sr. No.	Name of Scheme	Objective/focus of the scheme
36.	GRANT-IN-AID for Greening India http://envfor.nic.in/funding/chap3.pdf	To create an enabling environment through capacity building at various levels for tree planting, and production and use of quality planting material. To make available quality planting material by establishment of high tech nurseries. To create awareness amongst people for improved technology of tree planting and use of quality planting material. To develop and facilitate linkages between production systems of quality planting material and user groups. To contribute towards increase in tree cover in the country by focusing on non-forest lands.