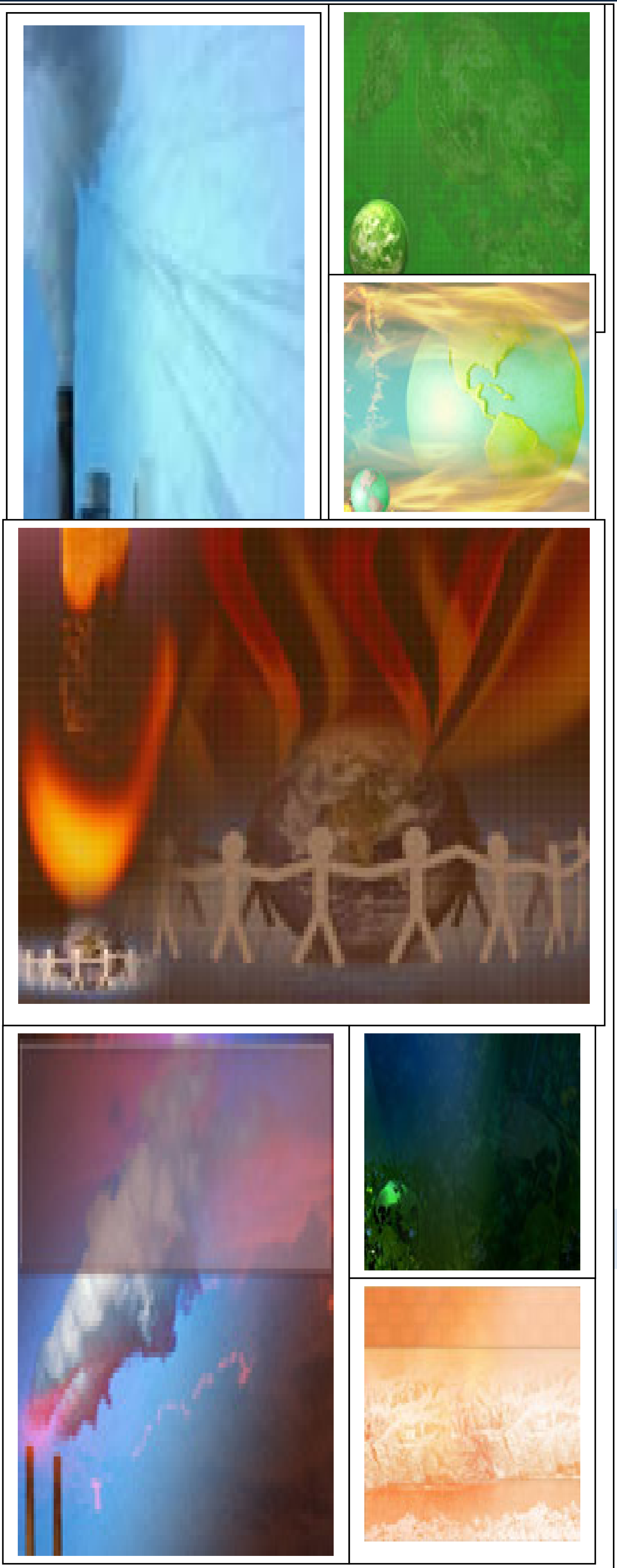

Mapping of Environmentally relevant MSME Clusters and their significance in India for inclusive growth of MSME clusters

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FOREWORD

In India, MSMEs have a share of 40% in the industrial production and 45% of the total manufactured exports of the country. In terms of employment generated, this sector is next only to agriculture employing approximately 41 million people. The number of MSMEs has grown manifold over the years, it has increased from an estimated 0.87 million units in the year 1980-81 to over 13 million (as per the latest data) and approximately 70% of these MSMEs exists in clusters. More than 46% of these MSMEs access electricity and another 12% access other non-renewable forms of energy as their main power source.

Controlling pollution and social issues in different sub-sector has been of a major concern since they are a threat to the workers and local community in specific but planet at large. Enterprises, whether large or small, contribute to environmental degradation more among select sub-sectors compared to others. This study is an initiative taken to map the quantum of energy consumed and pollution created by different sub-sectors identified, with a specific focus on MSME clusters. Some of these clusters have both the large and small enterprises, while in others, nature of industry leads to majority of them being smaller enterprises.

The purpose of this mapping is to understand environmentally relevant clusters, their economic and social significance vis-à-vis industrial sub-sectors/ sectors, their contribution to environmental degradation, social issues, potential options for improvement and ways to scale up positive pilot actions already undertaken by several institutions. Such a study has not been carried out in the past although some of the relevant issues have been highlighted in their respective sectoral studies by some of the engaged institutions in the past.

The potential users for this study can be the knowledge & implementing institutions, national and international funding agencies, relevant ministries/ departments of the Government, industry associations, policy makers that are looking for addressing environmental issues through an approach that has a potential for greater outreach and sustainability. The study will also help in development of specific tools like schemes, methodology and capacity building for addressing environmental and social issues in clusters.

ACKNOWLEDGEMENT

This document tries to identify the relevant environmental and social issues in the different energy intensive sub-sectors identified as per the pollution levels set up Central Pollution Control Board and also the initiatives taken by different national and international agencies taken so far in different areas. We would therefore like to acknowledge various academics and practitioner instititutions, from whose knowledge and expertise we got an insight into different environment, social issues and energy intensity in the units of different sectors. We are sincerely thankful to Institute of Indian Foundrymen, Sponge Iron Manufactures Association, office of Textiles Commissioner, MSME–DI Ahmedabad, MSME DI –Andhra Pradesh, Central Glass and Ceramics Research Institute, All India Small Agro and Recycled Paper Association, Central Pulp and Paper Research Institute, All India Brick Manufactures Federation, Metal Finishers Association of Faridabad, All India Skins Hides Leather Tanneries Manufactures Association , Central Pollution Control Board for sharing their valuable time and insight on this issue.

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The document has been authored by Foundation team comprising of Mr. Sudhir Rana, Advisor, Ms. Sukanya Banerjee, Project Co-ordinator, Mr. Sanjeev Kumar Fauzdar and finally Ms. Neetu Goel, Project Associate who stitched the document together at the closing.

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Mukesh Gulati
Executive Director

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Abbreviations

MSME	Micro Small and medium enterprises
FMC	Foundation for MSME Clusters
GTZ	German Technical Cooperation Agency
CDP	Cluster Development Program
BR	Business Responsibility
MCA	Ministry of Corporate Affairs
BDS	Business Development Service
EG	Expert Group
PPP	Public Private Partnership
GDP	Gross Domestic Product
RBI	Reserve Bank of India
SME	Small and medium enterprises
CPCB	Central Pollution Control Board
NIC	The National Industrial Classification
ASI	Annual Survey of Industries
TERI	Tata Energy Resource Institute
IFC	International Finance Corporation
IIF	Institute of Indian Foundrymen
CLE	Council of Leather Exports
CLRI	Central Leather Research Institute
AISHTMA	All India Hides and Leather Tanner Merchant Association
ATIRA	Ahmedabad Textiles Industry Research Association
BTRA	Bombay Textiles Research Association
NITRA	Northern India Textiles Research Association
SITRA	South Indian Textiles Research Association
ICCTAS	Indian Council of Ceramic Tiles and Sanitaryware
CGCRI	Central Glass and Ceramics Research Institute
MoEF	Ministry of Environment and Forests
UNEP	United Nations Environment Programme
CETP	Common Effluent Treatment Plants
EPCA	Environment Pollution Control Authority
NEAA	National Environmental Appellate Authority
SPCB	State Pollution Control Board
EIA	Environmental Impact Assessment
GOI	Government of India
ENVIS	Environmental Information System
ICEF	Indo-Canada Environment Facility
UNDP	United Nation Development Program
NGO	Non-Government Organisation
SHGs	Self Help Groups
SIDBI	Small Industries Development Bank of India
NCLP	National Child Labour Project
RRA	Regional Resource Agency
CDAs	Cluster Development Agents
TISCO	Tata Iron and Steel Co Ltd
IREDA	Indian Renewable Energy Development Agency
CII	Confederation of Indian Industry

CFR	Coke Feed Ratio
DBC	Divided Blast Cupola
PCRA	Petroleum Conservation Research Association
SIEMA	The Southern India Engineering Manufacturer's Association
COINDIA	Coimbatore Industrial Infrastructure Association
SPV	Special Purpose Vehicle
IIUS	Industrial Infrastructure Upgradation Scheme
RIICO	Rajasthan State Industrial & Investment Corporation
SDC	Swiss Agency for Development and Corporation
PSCST	Punjab State Council of State of Technology
DST	Department of Science and Technology
SBI	State Bank of India
IIDC	Infrastructure Development Corporation Limited
CFC	Common Facility Centre
MSECDP	**Micro, Small Enterprises Cluster Development Programme**
GITCO	Gujarat Industrial and Technical Consultancy Organisation
PPDC	Process and Product Development Centre
DRI	Direct Reduced Iron
SIMA	Sponge Iron Manufactures Association
NCM	Normal cubic meter
TPD	Tonnes per day
MT	Metric Tonnes
NSIC	National Small Industries Corporation
DGCI&S	**Directorate General of Commercial Intelligence and Statistics**
E.I.	East India
COD	Chemical Oxygen Demand
BOD	Biochemical oxygen demand
NIFT	National Institute of Fashion Technology
CFTI	Central Footwear Training Institute
UNIDO	United Nations Industrial Development Organisation
SIPCOT	State Industries Promotion Corporation of Tamil Nadu
ETPs	Effluent Treatment Plants
MANTRA	Man – made Textiles Research Association
AEPC	Apparel Export Promotion Council
RFC	Rajasthan Financial Corporation
TWRFS	Textile Workers Rehabilitation Scheme
LDO	Light Diesel Oil
PNG	Pressurised Natural Gas
TDS	Total Dissolved Solids
TDA	Tonnes Per annum
GDMA	Gujarat Dyestuff Manufacturers' Association
GCA	Gujarat Chemical Association
CAI	Chemical Association of India
GSPMA	Gujarat State Plastic Manufacturers' Association
VIA	Vatva Industries Association
NIA	Naroda Industries Association
ACTI	Association of Chemical Technologist India
OIA	Odhav Industries Association
BEE	Bureau of Energy Efficiency

EPMFAT	Electroplating and Metal Finishers Association of Tamil Nadu
CECRI	Centre for Electro chemical research institute
DIPP	Department of Industrial Policy and Promotion
CAGR	Compound Annual Growth Rate
HSD	High Speed Diesel
LSHS	Low Sulphur Heavy Stock
DA	Development Alternative
OSIMA	Orissa Sponge Iron Manufactures Association
WBSIMA	West Bengal Sponge Iron Manufactures Association

Executive Summary

Rising level of pollution and its emissions has been the major concern for the environment. This study is initiated for understanding the BR scenario with respect to MSME Clusters in India in order to identify and devise appropriate models of interventions to enable the MSMEs to become responsible and competitive for sustainable development. In this study an attempt has been made to understand the current scenario of MSMEs in India in terms of energy consumption, environmental degradation, economic (employment, output, and exports) and social significance at a cluster level. We have tried to identify the total number of clusters of the sub-sectors identified and also the approximate number of units in each cluster. The BDS providers and the initiatives undertaken in different clusters so far have also been identified.

As per the data complied with Foundation for MSME Clusters there are 636 industrial clusters but in our study we have identified 887 clusters in the 11 sub-sector as the handloom itself comprises 594 clusters. These industrial clusters are 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. An attempt has been made to quantify the energy consumption and the environment pollution generated (wherever possible).

In terms of economic significance textiles provides employment to maximum number of people followed by brick kilns and the ranking of most of the sub-sector in terms of global significance is amongst 1st -5th except for some of them like electroplating .

According the study the high energy intensive sub-sectors are foundry, sponge iron, Textiles, Bricks, Ceramics, Glassware, Mini-Cement Plants and Paper industry in which maximum energy is consumed by textiles followed by cement plant and paper industry. The sub-sector which has environmental impact in terms of emissions in air are foundry, sponge iron, electroplating, brick, ceramics, Mini Cement Plants. It can be seen that mostly sub-sectors consuming more energy generate larger air pollution due to the consumption of fuels like coke, oil etc. The maximum amount of green house gas is emitted by paper industry. Water pollution is caused by leather, dyes and chemicals, electroplating, paper industry and solid waste by electroplating followed by textiles. It has been estimated that electroplating is the most hazardous water polluting industry.

It has been found that industry associations are often weak and lack technical knowhow which leads to lower production, increasing costs and also poor quality of the product thus produced. They are unwilling to upgrade their knowledge on better processes and

systems. Concerted efforts will have to be made to upgrade the skills of the workers by conducting training sessions and making them aware of the occupational health and safety measures.

Cluster development agents (CDAs) have to be trained through specialised designed training programmes that help him/her to diagnose BR issues better and then design interventions accordingly. There is a need to reorient the ongoing programmes of assistance to focus on sustainable competitiveness instead of just economic competitiveness.

Structure of the Study

This study is divided into two sections- Section A and Section B.

Section A of the study discusses about the Indian economy and significance of MSMEs with special reference to economic and environmental aspects. We have identified six significant industrial sectors and eleven sub –sectors in those sectors in India based on contribution to economic development and energy intensity. In this section a compiled list of all identified clusters has been provided, environmental and social issues and the various sources from where information has been collected for the research study. It also provides a detailed list of environmental and social schemes. This section provides a consolidated analysis of the studies undertaken for the 11 sub-sectors that are energy intensive and environmentally sensitive in the context of MSME clusters. The estimates provide only a broad understanding to the level of ranking and significance of the economic, energy and environmental issues.

Section B of the study includes the detailed studies about all the 11 sub-sectors. The detailed studies of each sub-sector follow almost a similar structure:

- Economic significance
- Geographical concentration of sub-sector
- Process
- Environmental Issues
- Social Issues
- Institutions
- Clusters Intervention
- Way Forward

Introduction

Project Backdrop

Climate Change is of major concern as it represents one of the greatest environmental, social and economic threats facing the planet. This is attributable to the various human activities that need to be controlled to bring a halt to the precarious changes in climate. Both developed and developing countries have taken initiatives to fight the environmental degradation in their own approach. Various large and medium corporate firms have taken endeavour to combat climate change and have incorporated energy and environmental concerns along with social in their corporate responsibility agenda. However, one needs to ponder on the fact that environmental and social concerns are not only restricted to large and medium enterprises but to small and micro enterprises as well. The pollution per unit of production is generally higher in MSMEs than that of the corresponding large units partly due to use of obsolete technologies and poor management practices, and partly because most of the units do not come under the orbit of regulatory authorities. To understand the current scenario of MSMEs in India from the BR relevance in terms of energy consumption, environmental degradation, economic and social significance at a cluster level, a study to map the existing issues is imperative. The Foundation for MSME Clusters (FMC) and GTZ, a German institute supported by its Government, have entered into a 'Partnership towards attaining an understanding for the BR scenario with respect to MSMEs Clusters in India in order to identify and devise appropriate models of interventions to enable the MSMEs to become responsible and competitive for sustainable development'. This project is a part of GTZ and Ministry of Corporate Affairs, Government of India, agreement under the Indo-German Bilateral Development Cooperation Programme to ***"Strengthen the Corporate Social and Environmental Responsibility Movement in India"*** with the objective to foster an enabling environment in India for responsible business practices in pursuit of sustainable economic development.

The GTZ- MCA Project: The project espouses the approach based on consultation and consensus building among all stakeholders (government, business and civil society groups) to achieve the overarching objective of the project '*to foster an enabling environment in India for responsible business practices in pursuit of sustainable economic development'* .

Towards this end, the project has strived towards marrying experiences and ideas on corporate social responsibility generated at the top (national and international levels) with ground realities in the Indian context. It aims to do so by arming itself with a body of knowledge through surveys and assessments, creating platforms that facilitate networks and partnerships, evolving processes and building capacity of institutions that ultimately help Indian corporate sector to integrate BR into mainstream business as well as to contribute, not just respond, to international developments in the realm.

In order to translate the approach into actionable items, four broad areas of activity were visualized, as originally conceived by MCA-GTZ and strengthened by the advice of the Expert Group (EG). These were:

1. Overview and analysis of global movement and practices in BR

2. Development of Indian concept of BR, corresponding guidelines, and a system of voluntary disclosure

3. Pilot implementation of Selected Innovative Approaches through projects in PPP mode

4. Up scaling through meso level institutions as well as public events and competitions

5. Project Steering through the Expert Group

The six broad indicators to be achieved as a part of the project objective were as follows:

1. Development of an Indian concept of BR

2. Implement five pilot measures with the Ministry of Corporate Affairs (MCA)

3. Uptake by 100 companies of the BR services of at least three business/industry associations

4. Development of Indian BR Guidelines, and/or Indian system of BR reporting

5. Implementation of social and environmental standards in at least three supply chains

6. Five PPP projects based on the Indian concept of BR

The Objective of the Study

The objective of the study is to map energy and environment relevant clusters in India, their environmental significance and social impact and suggest the way forward.

Scope of the Study

- The study pertains to Indian industrial clusters only although there are several non-industrial clusters as well, but they do not contribute significantly to environment degradation.
- Economically significant clusters where energy, environmental and social aspects are also significant will only be mapped.
- The study is not meant to be conclusive research from the academic point of view but is meant to provide ground for developing actionable agenda. The secondary information available and

the details therein do not offer scope for a detailed census based and exhaustive primary based information.

The Methodology

The methodology undertaken to conduct the study is provided in the table below.

1.	Identification of industrial sectors based on economic significance to the country- employment, output, total number of units and exports- energy intensity and environmental issues based on secondary data.
2.	Identification of sub-sectors of the selected sectors based on pollution and MSME relevance.
3.	Identification of clusters present across the country based on the selected sub-sectors.
4.	Identification and listing of major energy, environmental and social issues /areas within the clusters and quantification of environment degradation in relevant clusters through secondary research, consultation with sector or cluster expert.
5.	Assess the potential for improvement in environmental degradation and energy intensity by identifying various support institutions- Industry Association, BDS providers and knowledge institutions, etc- through secondary research and consultation with cluster experts.
6.	Asses the role of Government in addressing the identified issues and understand the current status of Government in addressing energy, environment and social issues.
7.	Prepare a detailed report based on the findings and suggest way forward.

The significance of addressing energy and environmental issues

India is both a major energy producer and consumer. Availability and access to energy are vital for economic growth of a country. The global ranking of India is seventh in terms of energy production, accounting for about 2.49 per cent of the world's total energy annual production and fifth in terms of consumption, accounting for about 3.45 per cent of the world's total annual energy consumption in 2004[1]. The major concern with regard to energy is the availability of energy to foster the desired economic growth in a cost-effective way. The various energy sources are coal, lignite, oil, natural gas, hydro power, nuclear power and wind power. India is not endowed with large primary energy reserves and the distribution of primary commercial energy resources is quite skewed. Coal is abundant and almost 70 per cent of the reserves are in eastern region. Around 70 per cent of the hydrocarbons reserves are concentrated in the western region of the country. The southern region has most of the lignite deposits occurring in the country.

[1] Eleventh Five Year Plan, Planning Commission, 2007-12.

Similarly, economic growth of a country should be in line with the acceptable environmental quality as it is directly linked to the quality of life. The question is why economic growth, if it leads to creation of an environment that is hazardous to live in. The protection of environment is inevitable. "…An expanding global population, rapid conversion of critical habitat to other uses, and the spread of invasive species to non-native habitats pose a serious threat to the world's natural resources and to all of us who depend on them for food, fuel, shelter and medicine..... Every year, there is a net loss of 2.2 crores acres of forest area worldwide. Every year, toxic chemicals, some capable of travelling thousands of miles from their source and lasting decades in the environment, are released into the earth's atmosphere." (Environment and Conservation, U.S Department of State) . The domestic and industrial effluents are leading to environmental degradation. The major forms of pollution[2] are air pollution, water pollution, soil contamination, radioactive contamination, noise pollution, light pollution, visual pollution, and thermal pollution.

Given the significance of energy and environment in economic development, the main focus of our study is to identify the sectors and thereby clusters that are energy intensive and impact heavily on environment through air pollution, energy consumption, land and water pollution, hazardous waste and bio diversity.

[2] http://en.wikipedia.org/wiki/Pollution

SECTION - A

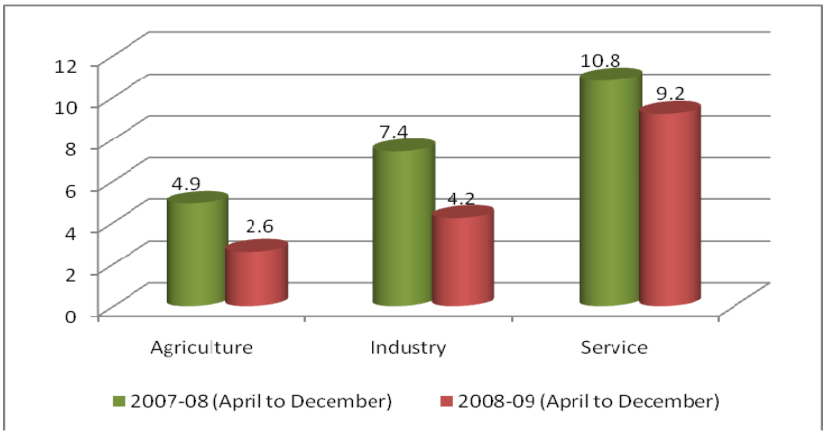
Chapter A1

Indian economy and significance of MSMEs with special reference to economic and environmental aspects

1.1 Introduction to Indian Economy and significance of MSMEs therein

1.1.1 The Indian economy witnessed a sharp deceleration in the GDP growth during the third quarter of 2008-09 in comparison to the corresponding period in the previous year. The real GDP growth was lower at 5.3 per cent in the third quarter of 2008-09 as compared to 8.9 per cent in the corresponding period of 2007-08[3], reflecting deceleration of growth in all the constituent sectors- agriculture, industry and service sector. The cumulative position reveals that the real GDP growth was 6.9 per cent during 2008-09 (April to December) as compared to 9.0 per cent in the corresponding period of 2007-08. This is mainly attributable to the global financial crisis and the economic downturn. The sectoral performance of the India economy during 2008-09 and the previous year is illustrated in the graph below.

Figure 1.1: Sectoral performance of the Indian economy (in percentage)



1.1.2 As evident from the figure all the three sectors recorded some moderation in growth during 2008-09. The services sector recorded a decline from its double digit growth due to subdued performance of all the segments, except community social and personal services. The slowdown of the industrial growth was largely an outcome of the cyclical downturn and adverse global factors. The industrial growth that recorded a steady acceleration during the period 2002-03 to 2006-07, moderated in 2007-08. During 2007-08, the industrial sector

[3] RBI Bulletin May 2009.

recorded a growth of 8.1 percent, contributing around 19.4 per cent of the GDP[4]. During the period 2008-09, April to February, the sector witnessed a slowdown in 15 industry groups accounting for 74.4 per cent of the total weight in the IIP recorded negative growth, this includes jute, most of the textiles, rubber, plastic, petroleum and coal products, food products, leather and fur products, wood and wood products, furniture, fixture, etc. In contrary only two industry groups recorded accelerated growth during this period, i.e. beverages, tobacco and related products and textile products.

1.1.3 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, touch upon the lives of most vulnerable and marginalised like women, backward community, 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 Micro, Small & Medium Enterprises Development (MSMED) Act, 2006 the MSMEs are classified in two classes.

- Manufacturing Enterprises- The 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). The Manufacturing Enterprise is defined in terms of investment in Plant & Machinery.
- Service Enterprises: The enterprises engaged in providing or rendering of services and are defined in terms of investment in equipment.

The micro, small and medium enterprises are defined as 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 Rs 25 lakh	Up to Rs 10 lakh
Small	More than Rs 25 lakh and up to Rs 5 crore	More than Rs 10 lakh and up to Rs 2 crore.
Medium	More than Rs 5 crore and up to Rs 10 crore	More than Rs 2 crore and up to Rs 5 crore

Source: Annual Report 2006-07, Ministry of MSME, Government of India

4 Annual Report 2007-08, RBI.

1.1.4 The micro enterprises also play a pivotal role in generating employment in the country. The micro and small enterprises (MSEs) provide employment to an estimated 312 lakh5 people in the urban and rural areas of the country. As on March 31, 2007, there are around 128.44 lakhs MSEs in the manufacturing sector. "...In India, MSEs (micro and small enterprise) account for almost 40 percent of the total industrial production, 95 percent of the industrial units (includes medium industries), and 34 percent of exports. They manufacture over 6000 products ranging from handloom sarees, carpets, and soaps to pickles, papads, and machine parts for large industries..." (Eleventh 5 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 marginalized and the most skilled.

1.1.5 Though MSMEs are social and economic significance, there are 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[6]. The pollution per unit of production is generally higher in SMEs than that of the corresponding large units partly due to use of obsolete technologies and poor management practices, and partly because most of the units do not come under the orbit of regulatory authorities. Of the selected list of sub-sectors that lead to environmental degradation, almost all the sub-sectors have significant presence in MSMEs except Coke, petroleum products and nuclear fuel sector. Therefore table below provides the final list of sub sectors that are listed by CPCB and Ministry of Environment and Forests and have significant presence in MSMEs under the selected sectors.

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

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'[7]. 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 ASI data 2005-06, these 23 sectors are ranked as per their contribution to employment, output and total number of units as shown in the table below. The significance of the sectors are determined on the basis of the ranking, if a sector is ranking between 1 to 10 in three or two of the above mentioned parameters, then it is considered as 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 for the other two

[5] Economic Survey, 2007-08.

[6] India: Strengthening Institutions for Sustainable Growth Country Environmental Analysis, World Bank.

[7] Ministry of Statistics and Programme Implementation, NIC- 2004.

parameters. Hence, in this case we consider textile products as significant industrial sector but not tobacco and related products.

Table: 1.2

NIC-2004		Total persons Engaged	Rank	Gross output	Rank	No of Units	Rank
15	Food products and beverages	1391616	1	22849381	4	25725	1
17	Textiles products	1337007	2	12859395	5	13810	3
24	Chemicals and chemical products	825435	3	24155401	3	10995	4
27	Basic metals	643594	4	25530306	2	7228	8
26	Non-metallic mineral products	579170	5	5522123	9	13999	2
18	Wearing apparel, dressing & dyeing of fur	541848	6	2779618	15	3649	11
16	Tobacco & related products	473608	7	1339567	19	3344	12
29	Machinery and equipment n.e.c.	466239	8	9458075	7	9531	5
28	Fabricated metal products (except machinery & equipments)	372726	9	5094134	11	8534	6
34	Motor vehicles, trailers and semi-trailers	359936	10	12072889	6	3069	14
25	Rubber and plastic products	317414	11	5270075	10	7353	7
31	Electrical machinery and apparatus, n.e.c	274467	12	6779461	8	4069	9
35	Other transport equipments	199230	13	5010309	12	1886	18
36	Furniture & other manufacturing n.e.c.	189725	14	4483306	13	2562	16
21	Paper and paper products	177696	15	2488761	16	3749	10
19	Leather & related products	173892	16	1532340	18	2443	17

22	Publishing, printing and related activities	134888	17	1689395	17	3319	13
32	Radio, television and communication equipments	115890	18	3409923	14	1036	20
23	Coke, petroleum products and nuclear fuel	85283	19	29455904	1	1037	19
33	Medical, precision and optical instruments	71015	20	1031243	20	987	21
20	Wood and wood products	56387	21	491907	22	3033	15
30	Office, accounting and computing machinery	21776	22	891766	21	180	22
37	Recycling	2036	23	38204	23	88	23
	All industries	**8810878**		**184233483**		**131626**	

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

1. Food product and beverages
2. Textile Products
3. Chemicals and chemical products
4. Basic metals
5. Non metallic mineral products
6. Machinery and equipment n.e.c.
7. Fabricated Metal Products (except machinery and equipments)
8. Rubber and plastic products
9. Electrical machinery and apparatus
10. 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. The industrial sectors that have been contributing significantly in exports are leather and manufacturers (3.39%), chemicals and related products (20.23%), engineering goods (heavy, medium and light engineering) (36.32%), textile and textile products (18.81%) and gems and jewellery (19.44%)[8].

[8] Eleventh Five Year Plan (2007-12).

Therefore based on the economic performance indicators the combined list of significant sectors are-

1. Food and beverages.
2. Textile and textile products.
3. Chemical and chemical products
4. Engineering Goods (includes basic metal, machinery and equipment n.e.c. fabricated metal products and electrical machinery and apparatus)[9]
5. Non metallic mineral products
6. Rubber and plastic products
7. Motor Vehicles, Trailers and Semi-Trailers.
8. Gems and jewellery.
9. 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 the 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 few sectors that are highly energy intensive in comparison to other sectors. The energy intensity of the sectors are determined based on the ASI data on fuel consumption for the year 2005-06. Of the selected economic significant sectors, the energy intensive sectors are-

1. Engineering Goods (includes basic metal, machinery and equipment n.e.c. fabricated metal products and electrical machinery and apparatus)
2. Food and beverages.
3. Textile and textile products.
4. Chemical and chemical products
5. Non metallic mineral products
6. Rubber and plastic products

1.3.2 Apart from the listed six sectors, 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 those are economically significant and energy intensive is-

[9] Basic metal, machinery and equipment n.e.c. fabricated metal products and electrical machinery and apparatus are listed as Engineering goods.

(i) Engineering Goods
(ii) Food and beverages.
(iii) Textile and textile products.
(iv) Chemical and chemical products
(v) Non metallic mineral products
(vi) Rubber and plastic products
(vii) Motor Vehicles, Trailers and Semi-Trailers.
(viii) Gems and jewellery.
(ix) Leather and manufacturers.
(x) Paper and paper products
(xi) Coke, petroleum products and nuclear fuel

1.4 Selection of significant sub-sectors from the above mentioned listed sectors

1.4.1 Sub-sectors leading to Environmental Degradation: The sub-sectors from the selected list of sectors are selected based on the criteria of their contribution to the pollution as per the norms of Central Pollution Control Board (CPCB). The Central Pollution Control Board (CPCB)[10] has classified 64 types of polluting industries/ industrial activities as "Red Category" industries on the basis of high emissions/ discharge of significant polluting or generating hazardous wastes. The industries where the degree of pollution is less, the industries 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). Out of the selected 64 types of "Red Category" polluting industries, 17 of them have been identified by Ministry of Environment and Forests, Government of India as heavily polluting and covered under Central Action Plan and has significant presence in MSME sector are Pulp and paper (Paper Manufacturing with or without pulping), Dyes and Dyes Intermediaries, Tanneries, Cement and Iron and Steel (involving process from ore/ scrap, and integrated steel plants)[11]. The table below provides the list of sub-sectors that leads to environmental degradation from the selected list of sectors are:

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[10]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 of the provisions of the Environment (Protection) Act, 1986. Principal Functions of the CPCB is 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

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

Table 1.3: Sub-sectors leading to environmental degradation

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

1.4.2 As inferred from the above table, the sectors and thereby the sub-sectors that do not lead to environment degradation are- Rubber and plastic products, motor vehicles, trailers and semi-trailers, and gems and jewellery. Therefore these three sectors do not fall into the domain of our study. The selected list of sub-sectors is given in the table below.

Table 1.4: List of Sub-sectors leading to environmental degradation

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

Source: Compiled from various sources- CPCB, Ministry of Environment and Forests, CII-MSME and various sector 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). 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 that can create difficulty in finding a sizeable number of similar firms, with commonalities that enable interconnectedness. Similarly, while defining geographical spread of a cluster, too wide an area hinders the units to exploit developmental potential through proactive joint action. In India, there are around 6600 clusters spread across the country, of which, 636 are industrial clusters that have been documented by the Foundation for MSME Clusters. 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. The table 2.1 below provides the geographic spread of some of the industrial clusters in India.

Table: 2.1

	State (Clusters)	District 1	District 2	District 3	District 4	District 5
1	UP (83)	Kanpur (14)	Meerut (8)	Gautam Buddha Nagar (9)	Allahabad (4)	Agra (4), Ghaziabad (3)
2	Maharashtra (74)	Mumbai (11)	Nagpur (8)	Pune (8)	Kolhapur (8)	Thane (8)

3	Gujarat (63)	Ahmedabad (21)	Rajkot (13)	Bhavgar (6)	Surat (4)	Vadodara (2)
4	Tamil Nadu (61)	Coimbatore (10)	Chennai (7)	Virudhnagar (6)	Madurai (6)	Erode (3), Salem (3)
5	AP (55)	Hyderabad (9)	E. Godavari (6)	Guntur (5)	Krishna (7)	Chittoor (3), Kurnool (2)
6	Kerala (50)	Ernakulam (9)	Khozikode (7)	Thrissur (6)	Kannur (5)	Malappuram (5)
7	Punjab (36)	Ludhiana (12)	Jalandhar (9)	Amritsar (3)	Gurudaspur (3)	Kapurthala (2)
8	West Bengal (36)	Kolkata (8)	Howrah (7)	Nadia (3)	Bankura(3)	
9	Rajasthan (29)	Jaipur (13)	Ajmer (2)	Alwar (2)	Bikaner (3)	
10	Haryana (26)	Gurgaon (5)	Faridabad (4)	Panipat (4)	Karnal (2)	Ambala (2)
11	Karnataka (24)	Bangalore (10)	Belgaum (3)			
12	Delhi (21)	Delhi (21)				
	(558) Total 636	143	74	52	45	37

Source: Data compiled with FMC

India has 636 industrial clusters. Of the 636 industrial clusters, the above mentioned 12 states command 88% of the clusters and 52 districts (9% of India's districts) in those 12 states cover 55% of the clusters.

2.1.4 In this chapter, we will look into the total number of clusters that are present across the country of the selected sub-sectors (sub-sectors selected in chapter 1). 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 is 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 Expanse of the selected clusters

2.2.1 As mentioned earlier based on the economic, energy and environmental issues sectors and thereby 11 sub-sectors are selected. These selected sub-sectors have clusters spread across the country. The number 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 the table below.

Table 2.2: Geographical spread of the clusters[12]

	Sectors	Sub sectors	Total number of clusters	State wise spread of the clusters
1	Engineering	Foundry	28	AP-2, Chhattisgarh- 1, Gujarat-4, Haryana-1, J&K-1, Jharkhand-2, Karnataka-1, MP-1, Maharashtra-4, Orissa-2, Punjab-4, Rajasthan-1, TN-1, UP- 2, WB-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
2	Leather and Footwear	Leather Tanning	17	AP-1, Bihar-1, Karnataka-1, Punjab-1, TN-9, UP-3, WB-1.
3	Textile and Garments	Textile and Garments Dying and Processing	707	*As per the list at the footnote given below
4	Chemical	Dyes and Chemicals	12	Gujarat-9, Maharashtra-5
		Electroplating	20	AP – 1,Delhi-4,Gujarat -3,Haryana – 1, Himachal Pradesh – 1, Karnataka- 1, Maharashtra – 3, Punjab-2, TN-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.

*it is difficult to segregate the textile clusters state wise as this sector is diverse and the handloom sector itself covers 594 clusters.

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
Handloom	594	Tirupur, Bangalore
Readymade Garments	18	Bangalore, Indore
Wet Processing	16	Maharashtra, Gujarat, Tirupur, Punjab
Total	707	

5	Non-metallic Industries	Brick Kilns	40	Assam – 1, Chattisgarh-3, Gujrat-1, Haryana-5, Jammu and Kashmir-1, Karnataka -1, Madhya Pradesh-6, Maharashtra-1, Orissa-2, Punjab-4, Rajasthan-1, Tamil Nadu -1,Tripura-1, UP-10, West Bengal - 2
		Ceramics	16	AP-6, Gujarat-6, Maharashtra-1, Rajasthan-1, UP-1.TN-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.
6	Paper and Paper Products	Paper Industry	4	Gujarat-1, Tamil Nadu -1, Uttaranchal – 1, Uttar Pradesh - 1.
	Tl		**887**[13]	

Source: Compiled from data available with FMC

Note: Detailed cluster lists are provided sub-sector wise in the following sections.

The above cluster list prepared do not match with the list of industrial clusters as the industrial cluster list do no includes the list of handloom cluster which itself comprises 594 clusters.

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 under consideration, whereas clusters mainly comprise of medium, small and micro units (except high-tech clusters). Therefore to understand the energy and environmental issues those are prevalent in clusters and the degree of intensity, it is imperative to look into the various facets of functioning of a cluster. Detailed studies of the identified clusters are provided later in this chapter section wise. 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.

[13] The list includes 594 handloom clusters and therefore does not match with the total number of industrial clusters

- Overall cluster scenario in terms of prevalent social issues.

The table below provides an overall status of the identified clusters in terms of energy and social issues.

Table: 2.3

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 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 textile sector includes 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 labours 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 is mainly related to occupational health and safety issues

Brick	High	High	Low	Moderate	The social issues pertaining to brick kilns is 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 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 Glass sector are mainly related to occupational health and safety issues and low wages paid to the labours.
Mini Cement Plants	High	High	Moderate	Low	The social issues pertaining to Mini Cement plants sector are mainly related to occupational health and safety issues
Paper Industry	High	High	High	Moderate	The social issues pertaining to paper sector are mainly related to occupational health and safety issues

2.4 Sources of Information

2.4.1 The detailed cluster studies are provided the following sections. The information on clusters has been gathered from various sources. This includes reference of various cluster diagnostic studies and libraries of various organisations, meeting various cluster and sector experts, secondary research on clusters and sectors, etc. the table below provides the sources of information cluster wise.0020

Table: 2.4

Foundry Cluster
Reports • Investors Manual for Energy Efficiency • Towards Cleaner Technologies, TERI • 42nd Census of World Casting Production-2007 • Environmental, Health and Safety Guidelines (IFC)
Institutions/ Organisations

• Institute of Indian Foundrymen • TERI
Sponge Iron
Reports • Comprehensive Industry Document (CPCB) • Risk appraisal study: Sponge iron plants, Raigarh District Jan Chetana • Diagnostic Study , Rourkela • Energy Mapping in Rourkela Sponge Iron and Induction Furnace Clusters • World Direct Reduction Statistics,2008 • Environmental, Health and Safety Guidelines (IFC)
Institutions/ Organisations • Sponge Iron Manufacturers Association • Ministry of coal • Ministry of Steel • Orissa Sponge Iron Manufacturers Association • West Bengal Sponge Iron Manufacturers Association
Leather
Reports • Ambur – Diagnostic Study • Leather Clusters in India – CLE • Comprehensive Industry Document – CPCB • IFC Environmental, Health and Safety Guidelines
Institutions/ Organisations • Council for Leather Exports (CLE) • Central Leather Research Institute (CLRI) • Central Pollution Control Board (CPCB) • All India Hides and Leather Tanner Merchant Association (AISHTMA)
Textiles
Reports • Ministry of Textiles, Annual Report ,2008-09 • Diagnostic Study – Powerloom, Kishangarh • Investors Manual for Energy Efficiency (IREDA Report) • IFC Environmental, Health and Safety Guidelines

Institutions/ Organisations • Apparel Export Promotion Council • Ministry of Textiles • Ahmedabad Textiles Industry Research Association (ATIRA) • Bombay Textiles Research Association (BTRA) • Northern India Textiles Research Association (NITRA) • South Indian Textiles Research Association (SITRA)
Dyes and Chemicals
Reports • Study by Bureau of Energy Efficiency • Environmental, Health and Safety Guidelines (IFC) • Comprehensive Industry Document – CPCB • www.gujexim.com
Institutions/ Organisations • Department of Chemicals and Petrochemicals • Central Pollution Control Board • MSME – DI Gujarat • MSME – DI Maharashtra
Electroplating
Reports • Comprehensive Industrial document, COINDS, 2008- CPCB. • Metal Finishers Association of Faridabad, Sector 58, Faridabad. • Waste minimisation Circle news-National Productivity Council, Vol 3, No.2, June, 2002)
Institutions/ Organisations • Centre for electro chemical research Institute, Karaikudy, Tamil Nadu. • Central Pollution Control Board, N.Delhi. • UNEP (United Nations Environment Programme). 1992. *Environmental Aspects of the Metal Finishing Industry: A Technical Guide*. Paris. • National Productivity Council(NPC) N.Delhi.
Brick Kilns
Reports • Brick By Brick,by Sameer Mathel • The Brick Industry, Central Pollution Control Board. • Sameer Maithel and Urs Heierli, 2008. • Development Alternatives , Development Alternatives, Newsletter, September 2006 • EPA Notification [GSR 682(E), October 5, 1999]

- FAO study of year 2000
- Times of India, February 1, 2009
- TERI, N. Delhi

Institutions/ Organisations

- All India Brick manufacturer’s Federation. New Delhi.
- Central Pollution Control Board, New Delhi

Ceramics

Reports

- Morbi Diagnostic Study
- Roofing tiles, Murlu Diagnostic Study
- Investors Manual for Energy Efficiency (IREDA)
- Environmental, Health and Safety Guidelines (IFC)

Institutions/ Organisations

- Central Glass and Ceramics Research Institute (CGCRI)
- Indian Council of Ceramic Tiles and Sanitaryware (ICCTAS)
- Central Pollution Control Board
- MSME DI – Ahmedabad
- MSME DI- Andhra Pradesh
- MSME DI- Kolkata
- Federation of Ceramics Industry
- Terra tiles Consortium (P) Ltd., Trissur

Glassware

Reports

- Glass Sector Study, CPCB.
- Towards Cleaner Technologies, TERI.
- http\\www.indiamarkets.com

Institutions/ Organisations

- Central Glass and Ceramics Research Institute
- Central Pollution Control Board
- MSME DI- Agra
- The Energy Research Institute, New Delhi

Mini Cement Plants

Reports

- All India mini cement plant Association, Hyderabad.

• Care Rating on Cement Industry. Mumbai. • WebSite http://www.indiamarkets.com • The economic times 16 Feb, 2008, • Market survey by dr. I satya sundaram • Performance of indian cement industry: By L. G. Burange, Shruti yamini, Mumbai.
Institutions • CBRI Roorki • Central pollution Control Board CPCB

Chapter A3

Role of Government in fostering BR in Clusters

3.1 Analysis of promotional and regulatory framework to address energy and environmental issues

3.1.1 Government's role in addressing the environmental issues is inevitable for sustainable inclusive growth strategy. To effectively manage the environmental issues, action is required at several areas that lie under the purview of several ministries. This requires internalisation of environmental concerns in policy making for large number of sectors. There are few programmes tailored towards addressing environmental issues under the purview of Ministry of Agriculture (Scheme on Balanced Use of Fertiliser) and Ministry of New and Renewable Energy (National Programme on Energy Recovery). The scheme on Balanced Use of Fertiliser strengthens the soil testing programme in the country and encourages efficient fertiliser use and of urban biodegradable waste. The National Programme on Energy Recovery has been initiated with the objective to accelerate the promotion of setting up of projects for recovery of energy from urban wastes; to create conducive conditions and environment, with fiscal and financial regime, to develop, demonstrate an disseminate utilisation of wastes for recovery of energy; and to harness the available potential of MSW-to-energy by the year 2017 [14]. However the main schemes and programmes addressing environmental issues are under the purview of the Ministry of Environment and Forests (MoEF).

3.1.2 The MoEF is the nodal agency in the administrative structure of the Central Government, for the planning, promotion, co-ordination and overseeing the implementation of environmental and forestry programmes. The Ministry is also the Nodal agency in the country for the United Nations Environment Programme (UNEP). The principal activities undertaken consist of conservation & survey of flora, fauna, forests and Wildlife, prevention & control of pollution, afforestation & regeneration of degraded areas and protection of environment, in the frame work of legislations[15]. The Ministry has established a set of policies for proper management of environmental aspects. This includes setting up of pollution standards industry wise, enactment of laws and regulations on violation of environmental standards, strengthening of regulatory framework for environment management etc. Regulatory framework should be combined with incentives. The Ministry proposes several schemes and programmes to provide support in the areas of major concern.

3.1.3 During the Tenth Five Year Plan 2002-07, Government of India, around 73 schemes were supported by the MoEF in the areas of environment, river conservation, forestry and wildlife, animal welfare and afforestation. The actual expenditure amounted to Rs. 5119.14

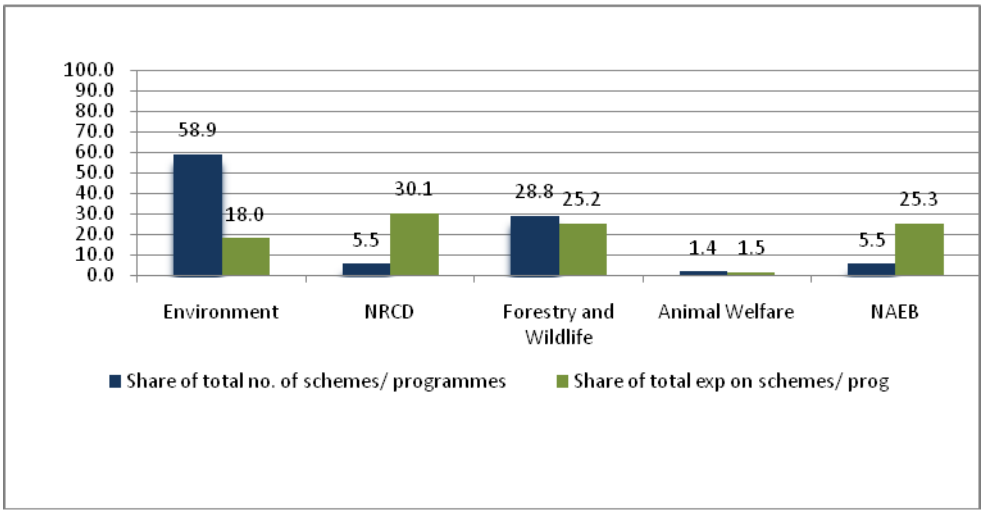
[14] http://mnreda.gov.in/schemeB.htm

[15] Ministry of Environment and Forests website.

crore. As shown in the graph below, the maximum number of schemes are under the area of environment (58.9%) followed by forestry and wild life (28.8%). However, the share of expenditure is maximum in the area of river conservation (30.1) followed by forestry and wildlife (25.2). The share of expenditure on environment is only 18 per cent of the total expenditure under the Tenth Five Year Plan 2002-07.

Figure 3.1

Schemes/Programmes under the Ministry of Environment and Forests (In %)



Source: Compiled from the Eleventh Five Year Plan 2007-12, Government of India.

3.1.4 In our study our focus is mainly to address environment issues related to industrial production in SMEs or clusters, for which we will analyse only those schemes/ programmes that are supporting either SMEs or clusters. The table below provides the list of such schemes and programmes as mentioned above-

Table 3.1: List of schemes/ programmes addressing environmental issues in SMEs/clusters.

	Schemes/ Programme	Purpose	Implementation	Financial Expenditure during 10th Plan (Rs crore)
1.	Central Pollution Control Board (CPCB)	i) To promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution, and (ii) To improve the quality of air and to prevent, control or abate air pollution in the country.	CPCB undertakes project/ programmes through various institutions, research organisations relating to assessment and monitoring of air and water quality. During the Tenth Five Year Plan, air quality monitoring at 321 locations and water quality monitoring at 1091 locations were completed.	140.06
2.	Industrial Pollution Abatement through Preventive Strategies	This scheme is an amalgamation of 3 existing schemes- i) Environmental Audit (ii) Adoption of clean technologies in small scale industries and (iii) Environmental Statistics. The objective is to assist SSIs in adoption in adoption of cleaner production practices and reduction in waste generation.	The scheme is implemented through the Central and State Pollution Control Boards, expert institutions and other concerned agencies to seek viable solutions to the pollution problems with specific reference to small and medium scale industrial sectors.	1.48
3.	Common Effluent Treatment Plants (CETP)	Centrally Sponsored Scheme for enabling the small scale industries (SSI) to set-up Common Effluent Treatment Plants (CETP) in the country. In order to encourage use of new technologies for CETPs for existing SSI clusters of units a scheme for financial assistance has been formulated.	CETPs to be initiated in industrial estates or in a cluster of SSI units are encouraged. Central Assistance available only for clusters of SSIs. The CETPs are to be set up and managed by the State Industrial Infrastructure Corporation (by whatever name known) or through an appropriate institution including a cooperative body of the concerned units as may be decided by the State Governments/SPCBs concerned.	20.10
4.	Establishment of Environment Protection Authorities and Environment	Established with the purpose of providing environmental compliance and enforcement of various activities.	The 3 authorities constituted for the purpose are- (i) National Environmental Appellate Authority (NEAA) to hear appeal with respect to industries,	13.83

	Commission and Tribunal		operations or processes. (ii) Loss of Ecology Authority for the state of Tamil Nadu to deal with pollution created by tanneries and other polluting industries in Tamil Nadu.(iii) Environment Pollution Authority (EPCA) for the National Capital Region for compliance relating to environmental standards, emission or discharge of pollutants, steps to control vehicular pollution, restriction of industries etc.	
5.	Assistance for Abatement of Pollution and Environment Policy and Law	This scheme is to strengthen various State Pollution Control Boards (SPCBs) and the State Environment Departments for enforcing the statutory provisions for initiating pollution abatement measures, upgradation of facilities for analysis, capacity building etc.	Most of the State Boards are provided funds for strengthening the laboratories and to undertake various research projects as well.	25
6.	Environmental Health	The key purpose is to evolve a strategy for health risk reduction. It also offers a comprehensive approach to the environmental health management plans, which would be a systematic approach to estimate the burden of disease and injury due to different environmental pollutants.	The Ministry has brought out a "Vision Statement on Environment and Human Health" for setting up the priority regarding Environmental Health and for chalking out Action Plans evolving strategies for protection of public health from natural and man – made environmental pollution and hazards.	1.03
7.	Clean Technologies	Adoption of Cleaner Technologies and cleaner production strategies is considered to provide a balance between Development and Environment through economic benefits by way of increased resource efficiency, innovation and reduced cost for environmental management. The grant-in-aid scheme on	MoEF does not provide financial assistance for Primary Research projects under the scheme, "Promotion and Development of Clean Technology". Financial Assistance are provided only for those projects whose Primary Research has already completed and are ready for Pilot Scale Demonstration Research on any	5.18

		development and Promotion of Clean Technology was initiated in 1994 with the following objectives:- 1. Development & Promotion of Cleaner Technologies. 2. Development of tools and techniques for pollution prevention. 3. Formulation of Sustainable Development Strategies	innovative technologies in the areas of highly polluting categories of industries.	
8.	Environmental Impact Assessment (EIA)	EIA is a management tool to improve decision-making and to ensure that development options are environmentally and socially sound and sustainable. The developmental activities have been categorized into Category 'A' and Category 'B' based on potential impacts instead of investment criteria. During the last two years, large number of projects has been granted environmental clearance.	The procedure for environment appraisal of development projects has been standardized and an updated questionnaire for collection and assessment of environment data in various development sectors has been published. To promote transparency and wider dissemination of information, Ministry has started posting details of clearances issued as well as pending development projects on the Ministry's web site.	
9.	Industrial Pollution Prevention Project (EAP)	The objective of the project is to promote cost-effective pollution abatement from industrial sources. The specific goals are : i) to strengthen four SPCBs in respect to their facilities, equipments and skills, to enable them to more effectively perform their mandate while continuing the programme of supports to the Boards already assisted, ii) facilitate priority investments dedicated to prevent pollution from industrial sources by encouraging the use of clean technologies, waste minimization and resource recovery by industry or pollution control where cost effective, and where these investments have a significant demonstration and replicability potential, and iii) provide technical assistance for (a) adoption of modern tools of information, management and control of residues. (b) organisation of a	Under this Scheme, funds released by GOI is reimbursed by the World Bank. The participating States under this Scheme are – Andhra Pradesh, Gujarat, Karnataka, Rajasthan and Madhya Pradesh.	

		clean technology institutional network and (c) the set up of an extension service on environmentally sound practices for small scale industry.		
10.	Hazardous Substances Management	The main objective is to promote safe handling, management and use of hazardous substances including hazardous chemicals and hazardous wastes, in order to avoid damage to health and environment. The activities of the division can be grouped under three main thrust areas, viz., Chemical Safety; Hazardous Wastes Management and Solid Waste Management.	The Hazardous Substances Management Division (HSMD) is the nodal point within the Ministry for planning and overseeing the implementation of policies and programmes on management of chemical emergencies and hazardous substances.	
11.	Environmental Information System (ENVIS)	The focus of ENVIS has been on providing environmental information to decision makers, policy planners, scientists and engineers, research workers, etc. all over the country. A large number of nodes, known as ENVIS Centres, have been established in the network to cover the broad subject areas of environment with a Focal Point in the Ministry of Environment & Forests.	ENVIS due to its comprehensive network has been designed as the National Focal Point (NFP) for INFOTERRA, a global environmental information network of the United Nations Environment Programme (UNEP). In order to strengthen the information activities of the NFP, ENVIS was designated as the Regional Service Centre (RSC) of INFOTERRA of UNEP in 1985 for the South Asia Sub-Region countries. Sustainable Development Networking Programme (SDNP) is a UNDP initiative launched worldwide in 1990 to make relevant information on sustainable development readily available to decision-makers responsible for planning sustainable development strategies. SDNP-India will be implemented by the ENVIS over a period of three years.	
12.	Indo-Canada Environment Facility (ICEF) (EAP)	ICEF works directly with Indian institutions and organizations to enhance and promote environmentally sound development, with principal focus on building and sustaining institutional capacity and related management capability in natural resource and environmental management.	ICEF operates as a registered society under the Indian Societies Registration Act, 1860 and is managed jointly by representatives from the Governments of India and Canada. The decision-making body of ICEF in respect of the sub-projects is the Joint Project Steering Committee (JPSC). The JPSC has 8 members, 4 nominated by the Government	

			of India and 4 by the Government of Canada.	
13.	GoI- UNDP-CCF Programme (EAP)	The four thrust areas on which the Environment programme stands are:- • management of natural resources, • strengthening of capacity for decision making, • management of development, and • Spread of information, advocacy & participation. The programme focuses on growth with equity, poverty alleviation and human development as the central concerns. The CCF-I strategy places emphasis on technology up gradation, poverty eradication and environmental preservation etc.	The Ministry of Environment and Forests has signed the Programme Support Document under the Country Cooperation Framework-I with the UNDP which provides a comprehensive focus on UNDP support to environment programme. To recommend, implement and manage the projects under this programme, a programme management Board (PMB) has been constituted in the Ministry which comprises of senior officers of the Ministry, representatives of other Concerned Ministries, representatives of UNDP and 4 NGOs, 1 each for the 4 identified thrust areas.	

3.2 Analysis of promotional framework to address social issues

3.2.1 The impetus to invigorate responsible behaviour has mostly been limited to large and medium enterprises. Generally, SMEs are associated with businesses that are conducted informally, that provides them the opportunity to evade tax, exploit labour, provide intolerable working conditions, pollute the environment and apply production methods that jeopardize workers' health. However such preconceptions can hinder the realisation of the SMEs' responsible behaviour and to their contributions to labour, community and the environment. Recently, the role of SMEs in addressing responsible behaviour is well appreciated across the country and several measures have been undertaken by the government and institutes to support the same.

*3.3 **Social Schemes at the cluster level***

Table: 3.2

	Name of Scheme	**Details**	**Type of assistance**
1	Scheme of organisational assistance to voluntary organisation for women and child development	The Department of Women and Child Development have, therefore, a scheme for giving maintenance grants to voluntary organizations Assistance under this scheme shall be admissible for the following items :-	The quantum of assistance shall be determined in each case on merit. The total assistance of the Government of India for a year shall not exceed Rs. 50,000/- per annum or the annual deficit,, whichever is less

		(a) Salaries and allowances of professional and non-professional staff. (b) Purchase of office equipment. (c) Travelling anti daily allowances for professional and honorary workers. (d) Stationary, telephone, postage and other contingencies.	
2	Support to training and employment programme For women (STEP)	To extend training for up-gradation of skills and sustainable employment for women through action oriented projects which employ women in large number. Scheme covers traditional sectors of employment viz. Agriculture, small animal husbandry, dairying, fisheries, handlooms, handicrafts, khadi village industries, sericulture, social forestry and wasteland development	(a) 100% assistance • Project staff and administrative cost. • Training, stipend, raw – material for training, etc. • All works related to training. 2. 50% assistance Construction of individual work – sheds and production centres not related with training. o 50% will be borne by the Government of India. 50% will be borne by the implementing agency
3	Development micro credit scheme (entrepreneur)	To meet out small loan requirement of Rural poor with emphasis on women through ngos. Assistance is made available in small amounts and members are encouraged to plough back their savings to the Group Corpus Fund to build strong equity base. . Micro-credit (SIDBI Foundation) has an initial corpus of Rs. 100 crores. Provides loan to rural poor to promote SSI and meet out working capital needs. Informal arrangements for credit supply through the forum of self-help groups (SHGS). It is fast emerging as a promising scheme for job creation and income generation amongst rural poor women.	Maximum amount to be lent by MFI to a single borrower is Rs, 25000/-. Interest rate @ 11% p.a. To MFI and on lending to shgs/Individuals at the rate determined by them for covering operational expenses. Mfis repay loan to SIDBI in 4 tears including moratorium, of 6 months.
4	Scheme for non-formal	The broad aim of the scheme is to	Under the SSA scheme, NGOS

	education	effectively involve voluntary agencies, public trusts, non-profit making companies, social activist groups etc., in the implementation of non-formal education programme for the 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	are given Rs 845 per child per annum for NFE centres. In the NCLP scheme an amount of Rs 100 per month is even allotted as stipend for each child in a non-formal centre. The scheme's annual budget for one school works to about Rs 2.5 lakh Eligible agencies will be given grants on a cent per cent basis for non-formal education both at the primary and middle stages.
5	Scheme for grant-in-aid voluntary organisations Working for scheduled castes	To involve voluntary sector to improve educational and socio-economic conditions of the scheduled castes. To upgrade their skill to enable them to start income generating activities on their own or get gainfully employed in some sector or the other.	Quantum of assistance shall be determined in each on merit. Govt. Of India may meet 90% of the approved expenditure on any or all the items. The remaining expenditure is to be met by the concerned Voluntary Organisation from its own sources.
6	National minorities development & finance corporation	The scheme envisages micro credit to poorest among poor through selected NGOS of proven bonafide and their network of Self Help Groups. It is an informal loan scheme which ensures quick delivery of loan at the door steps of the beneficiaries with a constant follow up. It also envisages a pre-requisite that the beneficiaries are first organised into Self Help Groups and get into habit of effecting regular savings, however small.	Under the scheme, loan upto maximum of Rs.25,000 per beneficiary can be provided. The funds are made available to NGOS @1% interest p.a. Who further lend to the SHGs @ 5% interest p.a. The repayment period is maximum of 36 months.
7	Establishment of a Regional Resource Agency (RRA) for national environment awareness campaign (NEAC)	The main theme for the campaign for example is covering our water resources. However, in view of the wide range of interrelated environmental problem facing the country, the campaign will not limit itself to programme on this theme alone.	The annual allocation is about Rs. 75 lakhs which is given to about 200 NGOs selected on the basis of the merits of their proposal.

8	Eco-development camps	The objective of the scheme is to create environmental awareness and to undertake short-terms demonstrative environment activities like tree plantation, soil conservation, management of water resources, health, hygiene and sanitation, promotion of non-conventional sources of energy and creation of environmental awareness by organizing eco-development camps of school children, youth and the local people.	Lectures / workshops, Exhibitions, charts, posters, Use of folk arts, Demonstration projects. Lecture workshop may cover such topics as air pollution, water pollution, land pollution, water-borne diseases, sanitation family planning, population and environment, energy utilization, fire protection, afforestation, wildlife protection etc.The camps must be manageable in size and should not cost more than Rs. 30,000/

Chapter A4

Economic significance and major BR issues among select sub-sectors – Way forward

This chapter provides a consolidated analysis of the studies undertaken for the 11 sub-sectors that are energy intensive and environmentally sensitive in the context of MSME clusters. Section 4.1 provides economic significance of these subsectors, while section 4.2 provides an estimation of energy intensity. Section 4.3 attempts to highlight the environmental issues while section 4.4 deals with the significant social issues of these subsectors. Section 4.5 provides possible way forward. The details provided herein are at best estimates and based on select interviews and literature available as per wide array of sources mentioned in chapter 3. The estimates provide only a broad understanding to the level of ranking and significance of the economic, energy and environmental issues. The detailed studies about all the 11 sub-sectors are annexed under section B of the report. The detailed studies of each sub-sector follow a similar structure:

- Economic significance
- Geographical concentration of sub-sector
- Process
- Environmental Issues
- Social Issues
- Institutions
- Clusters Intervention
- Way Forward

4.1 Economic significance of sub-sectors

The table below shows the consolidated analysis of the identified sub-sectors

Table 4.1

Sub- sectors	Employment	Total Production	Total Clusters	International Significance
Foundry	6.5 lakhs	81.8 lakh tonnes per annum	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	5.2 lakhs	212 lakh tonnes per annum	29	India ranks 1st in terms of total production
Leather Tanning	25 lakhs	5.31 lakh tonnes (Rs 30,000 crores)	17	The leather industry ranks 8th in term of foreign exchange earnings of the country and has 3% share in global trade.

Textiles	3.5 crore	5496.6 crores sq. Meters of cloth	707	The Indian textile industry is the second largest in the world.
Dyes and Chemicals	NA	28.7 MT	12	The global market share of Indian dyes industry is between 5 - 7%
Electroplating	50,000	28000 tonnes	20	World share is very less.
Brick Kilns	1crores	14,000 crore Bricks	40	The Indian Brick kiln Industry is the second largest in the world after China.
Ceramics	5,50,000	3400 lakhs sq. meters- Ceramic tiles	16	India ranks 5th in the world in terms of production of ceramic tiles and is growing at a healthy 15% per annum
Glassware	8 lakhs		1	The exports in 2008-09 (April-Dec) was Rs 1,47,457.11 lakhs
Cement Plants	1.4 lakhs	1760 lakhs MT	10	India is the second largest producer of cement in the world after China
Paper Industry	4.6 lakhs	105 lakhs tonnes	4	The Indian Paper Industry accounts for about 1.6% of the world's production of paper and paperboard

4.1.1 From the above table it can be seen that textiles sector employs maximum number of people followed by brick kilns and leather sub sector with textiles constituting maximum number of clusters. Sponge iron industry of India is the largest in the world while textiles, brick kiln, foundry and cement plants ranks second in the world.

4.2 Energy Intensity in the subsectors

Table 4.2

	Total Energy Consumption			**Major Source of Energy**
Sub – sector	**Volume**	**Energy as a Percent of manufacturing cost**	**Estimated Value**	
Foundry	Coke consumption with 12% ash – 4.84 lakh tonnes per annum	25%	Rs 2500 crores	Coke, Natural Gas
	24% ash – 9.19 lakh tonnes per annum			
Sponge Iron	Coal consumption – 256.8 lakhs tonnes	12.8%	NA	Coal, gas
	Gas consumption – 1.848 billion normal cubic meter (ncm)			
Leather Tanning	NA	NA	NA	
Textiles	6556.27 crores KWh*	5-17%	Rs.32781 crores	Electricity, Diesel

					Generator
Dyes and Chemicals	Electricity	10,30,68,423 units	5-8%	NA	Electricity, coal/Hard Coke
	Firewood / Husk	801655 tonnes			
	LDO	3,40,63,636.3 litres			
	PNG	7,84,20,000 kg			
	Coal / Hard Coke	4.12 lakh tonnes			
Electroplating	Electricity – 28.8 Crore Units		30%	Rs. 150 Crore	State Electricity, Diesel
Brick Kilns	Coal – 2-3 Crore Tons		35 to 50%	Rs.5000 Crore	Coal, Biomass
Ceramics	NA		35%	Rs 235 crore	LPG, Natural Gas, Coal
Glassware	Coal – 77 lakh tons		40%	Rs.1925 crore	Coal, Natural, Gas.
Cement Plants	Coal—4 Crore tons Electricity—1144 crore units		45%	Rs.13000 Crores	State electricity, Coal
Paper Industry	Coal—2.73 crore tons State Electricity- 1680 Crore units		25%- 30%	Rs.7500 Crore	State Electricity, Coal

*This does not include readymade garments as the data is not available.

4.2 The highest energy consuming sub-sector is textiles followed by cement plant and paper industry. Maximum amount of coal is used in cement plants which is 4 crore tonnes followed by paper at 2.73 crore tonnes and then sponge iron which is 2.57 crores tonnes per annum. The share of energy is highest in cement and glass sub-sectors.

4.3 Environmental issues in the subsectors

Table 4.3

Sub-sectors	Estimated Air Pollution	Estimated Water Pollution	Estimated Solid Pollution
Foundry	CO_2 – 23.6 lakhs tonnes	NA	2.21lakhs tonnes
Sponge Iron	CO_2- 3.21 crore tonnes	NA	NA
Leather Tanning	NA	2.4 cores m^3 per annum	NA
Textiles	NA	5.8 - 7.25 crores cubic meters per annum	NA
Dyes and Chemicals	NA	16600 m^3 litres	NA
Electroplating	Air pollution emitted is 1530 crore metre cube of harmful gases per year.	Water discharged with toxics is 3.6 lakh m^3 per year.	Solid waste (toxic) generated is 365 tons in a year.

Brick Kilns	5.91 crore tons of CO_2 is emitted per annum	NA	NA
Ceramics	NA	NA	NA
Glassware	MSME's produce around 648 Tons per annum of PM The CO_2 emission was 147 lakh tons.(Based on 2006 figures).	NA	NA
Cement Plants	CO_2 emitted was 19.25 crore tons	NA	NA
Paper Industry	CO_2 emitted was 161 crore tons per year	Waste water generated was 235.47 Crore cu m in the year 2008-09.	142 lakh tons of solid waste is generated per annum

4.3 The highest amount of green house gas emitted is by paper industry followed by cement and sponge iron. Maximum waste water is discharged by paper sector which is 235.47 crores cu m followed by textiles and leather which is 5.8 crores and 2.4 crores cu m respectively. Electroplating is the most hazardous water polluting industry followed by dyes and chemicals industry. Solid waste is largely generated in the paper industry.

4.4 Social Issues in the sub-sectors

Table 4.4

Sub-sectors	Most Significant
Foundry	• Contact with hot metal or hot water resulting in severe burn as the workers are not properly guarded • The workers wear loose garment to work and some are also bare chest, which is a safety hazard. The workers are not aware of the safety measures that need to be followed at work. • In some of the foundries in Southern India women labour is also employed.
Sponge Iron	• Heavy metals which are released in 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 the pollutants like Sulphur dioxide (SO2), nitrogen dioxide (NO2) 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 hides or as part of the manufacturing process. Some allergic reactions are developed due to these diseases – agents • Obnoxious smell comes from the hides and skins which makes breathing difficult for workers

	• Child labour is said to be employed in the tanneries.
Textiles	• The exposure of workers to dusts 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, the 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 waste water discharge in the ground. • Since the workers are working with different dye colours, it is usually found that their skin colour changes to the colour of dye
Electroplating	• The workers are exposed routinely and persistently to the pollutants in the environment of the electroplating unit and suffer from various health problems. • The employed labours 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 brick kilns industry child labour and bonded labour is the problem
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 weight and over-exertion in the polluted environment
Paper Industry	• The workers are exposed to air pollution

From the above table it can be seen that most of the social issues are related to occupational health and safety of the workers. There are some sub-sectors where child labour is an issue like leather, textiles and brick kilns.

4.5 ***Way forward*:**

4.5.1 The sub-sectoral studies provide an insight into the extent of BR issues in greater detail. They also provide a glimpse of the institutions that have so far been involved in undertaking positive interventions to remedy the problems highlighted therein. It is clear that all the sub-sectors and clusters therein are very diverse in terms of the extent, scope and typology of interventions undertaken so far. Wherever a development agency or an industry association is interested in taking up relevant agenda for the said sub-sectors, a deeper study will need to be undertaken before designing interventions.

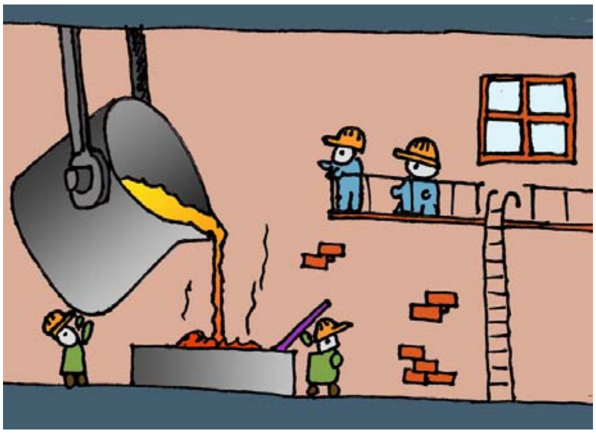
4.5.2 At the policy level however, this study along with the sub-sectoral studies provides enough information to select the sub-sectors and possible areas of interventions. The customised interventions required for every sub-sector and cluster will also need to be appropriate to the level of absorption by the cluster actors and also the regulations that are in force currently and potentially. It has been found that drawing knowledgeable BDS providers to smaller clusters that are in most need for such interventions has been a critical problem. The local industry associations in such clusters are often quite weak and unwilling to adopt new technologies, processes and systems. This calls for concerted medium to long term initiatives running from 3-5 years with local presence of the development agency representative. In the past several agencies have undertaken initiatives for cluster based development but their focus has been limited to addressing economic aspects of the clusters. The schemes of assistance for cluster initiatives have in the past been limited to addressing broader competitiveness issues that deal with reduction of costs, finding new markets, developing new products, developing skills of workers, all with an eye on reduction of costs and increasing of business for the local enterprises. There is a greater need to focus on the energy, environment and social issues that have generally not been the focus of past cluster based interventions.

4.5.3 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. Ongoing cluster development programmes should ideally add a special component on BR issues by bringing in relevant BDS providers, linkages with institutions that deal with such issues and help the regulatory agencies to re-orient their role to go beyond mere prosecution. This calls for reorientation of ongoing programmes of assistance to focus on sustainable competitiveness instead of just economic competitiveness.

SECTION - B

Chapter-B1

Foundry



1.1 Economic Significance

1.1.1The impetus of Foundry Sector in India was given by machinery manufacturing for Jute Industry in Bengal and textile machine cotton Industry in Mumbai in late 19th century. The establishment of TISCO, Bengal Iron Company and IISCO led to a remarkable use of castings in both domestic and Industrial Area. A foundry is a factory which produces metal castings from either ferrous or non-ferrous alloys.

The typology of products produced under this sector are-

- 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 Clusters

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 states of West Bengal, Gujarat, Haryana, Maharashtra, Punjab, Tamil Nadu, Karnataka, Andhra Pradesh and Jharkhand. 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 the

Belgaum clusters for automotive castings and the Rajkot cluster for diesel engine castings. A number of units range from 100 to 700 at different foundry cluster. The foundry produces a wide variety of castings used in automobile industry, flour mill parts & components, electric motor, manhole covers, oil engine, pump sets, sanitary items, pipe and pipe fittings, sugar machinery etc. The table below provides the list of significant cluster (clusters with registered units), number of units, production and the typology of products manufactured in each cluster.

Table: 1.1 List of Significant Foundry Clusters in India

	Name of Cluster	Total Unit	Approx. Production (tones/ annum)	Typology of Products
	North			
	Registered			
1	Jalandhar	350	240000	Agricultural implements, machine tools
2	Agra	125	315000	Generator set parts, engine parts and agricultural implements
3	Batala	200	150000	Agricultural implements, machine tools
4	Faridabad	140	2,04,000	Auto components, agricultural implements
5	Samalkha	30	36,000	Chaff cutters, Auto components Manhole Covers, Oil engine, Pump sets, Sugar/Textile Machinery
6	Kaithal – Narwana	25	25,000	Centri fugal pumps, agricultural implements
7	Goraya	30	45,000	Chaff cutters.
8	Jaipur	96	100000	Agricultural implement and machinery, sanitary fittings special water pumps and CID joints, civil machine stands, ceiling fans body, floor mills, granite and marble cutting and polishing machine, railway inserts, transmission hardware, automobile components, etc.
9	Others (Panipat, Karnal, Mandi Gobindgarh, Bahalgarh, Gurgaon, Bahadurgarh, Rohtak etc.)	100	72,000	-
10	Unregistered units in North	250	180000	Producing low end products.
	Total (North)	**1346**	**1367000**	
	West			
11	Ahmedabad	250	300000	Pumps and pumps part and

				automotive.
12	Rajkot	400	250000	Automotives, textile machinery, machine tools, diesel engines.
13	Pune	100	370000	OEM Automotive.
14	Kolhapur	300	200000	Automotive, pumps.
15	Baroda	70	135000	
16	Others (Mumbai, Nagpur, Aurangabad, Kirloskarvadi, Indore etc.)	530	1026020	-
17	Unregisterd units in West	430	309600	
	Total (West)	**2080**	**2590620**	
	East			
18	Howrah	300	1200000	Manhole covers, sanitary fittings
19	Others (Kharagpur,Uttarpara,Liluah etc)	249	482036	-
20	Unregistered units in East	370	266400	
	Total (East)	**919**	**1948436**	
	South			
21	Belgaum	250	360000	Automotive, pumps, machine tools
22	Chennai	105	250000	
23	Coimbatore	400	372000	Pumps and pump parts, textile machinery
24	Others (Hyderabad, Bangalore,Shimoga,Mysore, Dindigul, Nallore, etc.)	500	967944	-
25	Unregistered units in South	450	324000	
	Total (South)	**1705**	**2273944**	
	Total India	**6050**	**8180000**	

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 (4550 units) – after China - and fourth in terms of total production (78 lakh tonnes) (42nd Census of World Casting Production-2007). Apart from the registered 4550 units there are several unregistered units, which according to various sources range approximately from 1500 to 5000 units. As per the IREDA-CII Report[16] 2004, there are around 10,000 foundry units present in India including registered and unregistered units. Considering that 4550 units are registered, the total number of units unregistered is around 5450 units. As per the estimation

[16] Indian Renewable Energy Development Agency Limited (IREDA) and Confederation of Indian Industry (CII).

of experts of the foundry sector, there are around 1500 unregistered foundry units that are scattered across the country. This discrepancy in unregistered units is mainly due to the fact that the 5450 units included all kinds of micro and small units engaged in castings. Whereas the 1500 units data incorporates only those foundry units that are engaged to grey iron casting and use conventional cupola and excludes those units that are too micro in nature and use crucible for melting of metals. Also several foundry units had closed due to non compliance with the pollution standard set by the government, e.g. 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 cluster size ranging from 30-500 units.

1.2.4 Similar, discrepancies exist in total production, where as per the 42nd Census of World Casting Production-2007, there are 4550 units producing 78 lakh tonnes of castings whereas as per the IIF data, there are 4550 units producing 71 lakh tonnes of casting. In our study we will consider the data provided by IIF. Considering there are 1500 unregistered units producing grey iron castings, the total production capacity of the unregistered unit is 11 lakh tonnes per annum. Therefore the total casting production in India, including both registered and unregistered unit is 82 lakh tonnes. The industry is labour intensive and employs around 5 lakh people directly and around 1.5 lakh 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 mechanized. The export of castings from India is worth Rs 384000 lakhs for the financial year 2005-06. These exports are mainly to 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 casting and the rest (around 3050) are engaged to grey iron casting. The total production of castings of these units are approximately 71,00,000 tonnes per annum. Of the total production of registered castings, 72% are grey iron, 10% steel casting, 10% SG Iron and 8% non-ferrous castings.

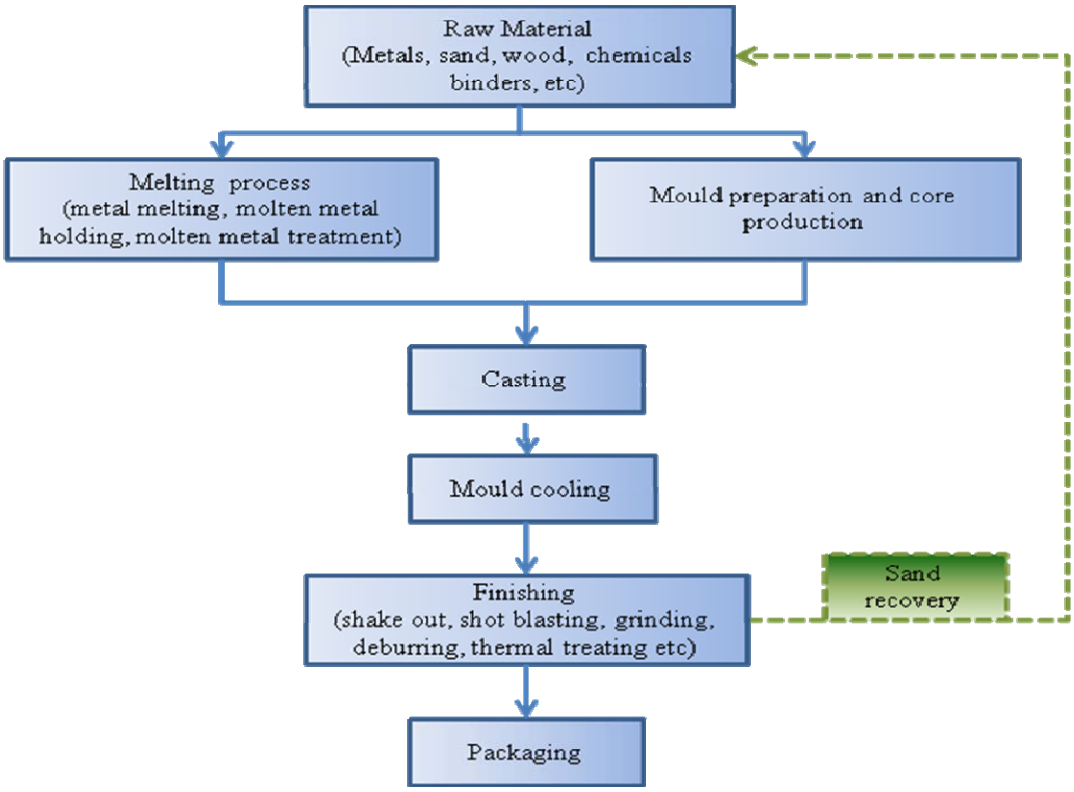
1.3 Energy intensity in Indian foundries

1.3.1 The foundry industry of India is highly energy intensive and accounts for almost 25 per cent[17] of the manufacturing cost. It has been estimated that the total energy cost in Indian foundry industry is around Rs 4500 crores. 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.

[17] IREDA Report.

1.3.2 A typical foundry process includes the following activities- melting and metal treatment in the melting shop; preparation of molds and cores in the molding shop, casting of molten metal into the mold, cooling for solidification, and removing the casting from molds in the casting shop; and finishing of raw casting in the finishing shop- as shown in the figure below.

Figure 1.1: Process flow diagram of a Foundry Industry



1.3.3 Melting of metal in cupola furnaces is the most energy intensive operation in a foundry unit. The table 1.2 below provides an estimate of the distribution of energy consumption in the foundry process.

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 and Jeffrey (2009), Indian Foundry Congress.

1.3.4 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 to 65 percent, to save energy through adoption of improved cupola design. Coke is the main source of energy in cupola furnace 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 for molten metal temperature in the range of 1380-1410^{o}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 case of conventional cupola 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[18].

1.3.5 The power consumption in induction melting furnace of capacity 12-15 tonnes 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 furnace electric loss consist of losses in transformer, frequency converter, capacitor banks cable and coil losses and heat losses from furnace wall to coil side (carried away by cooling water), radiation from melt surface and slag removal. Efficiency of medium frequency furnace (operating efficiency in the range of 55-60%) is higher compared to main frequency furnaces (operating efficiency in the range of 45-50%)[19].

1.3.6 The type of furnaces used for melting of metal varies according to the type of castings produced in the foundry. The table below provides the types of furnaces used for various types of castings.

[18] Towards Cleaner Technologies, TERI.

[19] IREDA Report.

Table 1.3: Production of different castings

Typology of casting	Production (tones)	Type of furnace
Grey Iron	5112000	Cupola/ Electric arc furnace
Steel Casting	710000	Electric arc furnace
SG Iron	710000	Electric arc furnace
Non- ferrous	568000	Crucibles/ furnace
Total	**7100000**	

1.3.7 Of the listed types of furnaces, cupola is most polluting in comparison to the other types of furnaces. Coke is mainly used for cupola furnaces and depending on the ash content in the coke, it has been bifurcated into two types- coke with 12% ash content and coke with 24% ash content. Most of the foundry clusters in the southern and western region of the country use coke with 12% ash content whereas clusters in northern and eastern region use coke with 24% ash content or 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.

1.3.9 It has been estimated that of the total grey iron castings in the registered units, 75 per cent of the castings are done by using conventional cupola 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 38,34,000 tonnes per annum. Apart from the registered units, there are around 1500 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 10,80,000 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 49,14,000 tonnes per annum.

1.3.10 In Agra, the there are around 125 units producing 3,15,000 tonnes per annum of casting and the energy utilised for casting is oil. In our study, as our main focus is on reduction of coke consumption we are excluding the production of castings done in Agra from the total castings production using conventional cupola. Therefore, the total production of castings in India using conventional cupola and coke as energy is approximately 45,99,000 tonnes per annum. Now, considering the two types of coke used for melting of metals in conventional cupola, there may arise two possible cases as illustrated below.

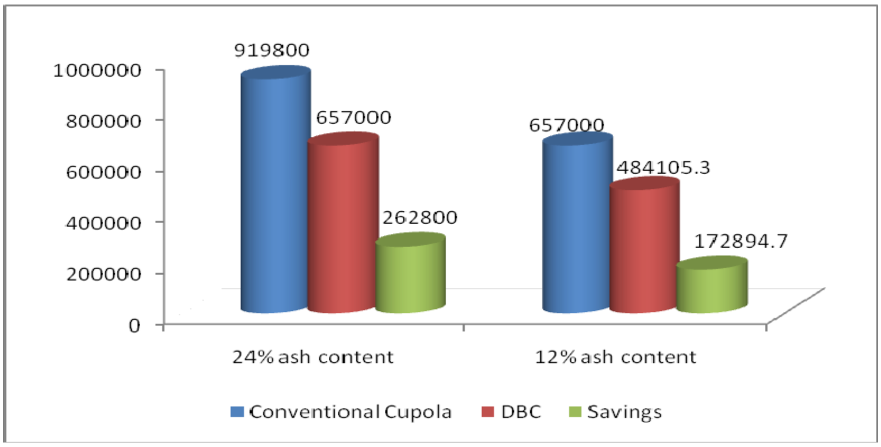
Case 1: Using cold blast cupola with coke having 24% ash content.

In case of coke with 24% ash content is used, the coke feed ratio (CFR) is 1:5[20]. Now, considering that all the casting production of 4599000 tonnes per annum is done with this type of coke, the coke consumption will amount to 919800 tonnes per annum. If the cupola is upgraded to DBC (CFR 1:7), the total coke consumption will be 657000 tonnes per annum. Approximately, the total coke saved will be 262800 tonnes per annum (28.6%) and the production cost will be reduced by Rs 394.2 crore per annum. Therefore, the equivalent carbon emission[21] reduced is 657000 tonnes of CER.

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

In case of coke with 12% ash content is used, the coke feed ratio is 1:7. Now, considering that all the casting production of 4599000 tonnes per annum is done with this type of coke, the coke consumption will amount to 657000 tonnes per annum. If the cupola is upgraded to DBC (CFR 1:9.5), the coke consumption will be 484105.3 tonnes per annum. Approximately, the total coke saved will be 172894.7 tonnes (26.3%) and the production cost reduced by Rs 259.3 crores. Therefore, the equivalent carbon emission reduced is 432236.8 tonnes of CER.

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



1.4 Environmental Issues in Indian Foundries

1.4.1 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

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[20] Inferred from field experience and discussion with foundry experts.

[21] 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.

both for effluent and emission. In case of the foundry industry the standard is set for emission. The emission standard is given in the table 1.4 below.

Table 1.4: Foundries- Emission Standards

	Typology of furnace	Pollutant	Concentration (mg/Nm3)
1.	Cupola Capacity (melting rate): Less than 3 tonne/hr	particulate matter	450
2.	Cupola Capacity (melting rate): 3 tonne/hr & above	particulate matter	150
3.	Arc Furnaces Capacity: All sizes	particulate matter	150
4.	Induction Furnaces Capacity: All sizes	particulate matter	150
Note: (i) It is essential that 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 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 clusters

	Environmental Issues
1.	**Air Emission**
(i)	*Dust and particulate matters:* are generated at each step of the production process with varying levels of mineral oxides, metals and metal oxides. It also arise from thermal (e.g. melting furnaces) and chemical / physical processes (e.g. molding 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 furnace produces the most significant amount of particulate matter. In electric furnace PM is emitted during charging at the beginning of melting, during oxygen injection, and during the decarburizing phases. Lower emission rates are associated with other melting furnaces types, particularly induction furnaces. Dust and fumes are also generated when metal is poured in mould and mould cooling, punch out and shake out, hot sand cleaning, casting cleaning and sand handling.
(ii)	*Nitrogen Oxide:* emissions are caused by high furnace temperature and the oxidation of nitrogen.
(iii)	*Sulphur Oxides:* emissions are emitted from waste gases in cupola furnaces. Other emission sources include gas hardening processes in mold- and core-making with chemically bonded sand, and in magnesium (Mg) melting.
(iv)	*Carbon Monoxide:* are off gases generated from cupola furnaces and 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 melting and refining phases. CO is also emitted when sand molds and cores come into contact with the molten metal during metal pouring activities.
(v)	*Chlorides and fluorides:* 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 organics (e.g. phenols and formaldehyde) are primarily generated by the use of resins, organic solvents, or organic based coatings in molding 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 molds, resulting from the thermal decomposition of the organic compounds (carbonaceous additives contained in green sand moulds and different core binders) during metal pouring.
(vii)	*Metals:* emissions are emitted through volitization and condensation of metals during molten metal pouring 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 (CO2), primarily associated with fuel combustion. The total Greenhouse gas emitted is 23.6 lakhs tonnes (Assuming: 24% ash, 6% moisture, 70% coke)
2.	**Solid Waste**
(i)	*Sand Waste:* Sand waste from foundries using sand moulds is a significant waste by volume. Molding and core sand make up 65 to 80 percent 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 the 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 nonferrous metals melting.
(iii)	*Other Solid Waste:* Solid waste from storage areas of sand, carbon powder, coke and other additives used in foundries. In the pattern shop wooden chip and dust are released. Assuming coal with 24% ash is used. Total coal consumed is 919800 tonnes. So total ash generated is = 919800*0.24= 2.21 lakh tonnes.
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 dedusting systems. In high-pressure diecasting, 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 mold 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.

1.5 Social Issues in Indian Foundries

1.5.1 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 etc. Some of the blatant issues are:

- In foundries high temperatures leads to fatigue and dehydration of the workers. Risk of injury from flying fragmented or from metal scrap during charging, or in the yard adjacent to the charging machinery. Men handling raw material should wear hand leathers and protective boots.
- Direct infrared radiation during the process of melting leads to eye diseases as most of the workers in foundry units do not use any kind of sun glasses or protective shield for eyes.

- Contact with hot metal or hot water resulting in severe burn 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 highly poisonous gas. Breathing apparatus should be available in case of emergency.
- The workers wear loose garment to work and some are also bare chest, which is a safety hazard. The workers are not aware of the safety measures that need to be followed at work. Proper training to the workers regarding the health hazards and the 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 to workers, for they are exposed to heat and high level of CO_2 at the cupola charging door.
- The units are very poorly lit.
- Cupola repair and refractory lining maintenance workers are susceptible for accidents. The workers generally do not wear the any safety helmets or safety belts when working at heights.
- Exposure to electrical hazards due to the presence of heavy-duty electrical equipment throughout foundries.
- Handling of liquid metal may generate a 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 noise.
- Most of the workers are contract workers who all are appointed through a contractor. These workers do not enjoy the facilities (e.g. leaves, bonus, health facilities etc) of that the permanent workers have.
- In India, foundry workers are mainly male labourers, except for Coimbatore where female labourers are also present, given the typology of work environment prevailing in the foundry units.

1.6 Institutions/Associations

1.6.1 The table below shows the list of institutions and associations of 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 • Defense Metallurgical Laboratory, AP • NSIC- National Small Industries Corporation Limited • SNIST- Sree Nidhi Institute of Science and Technology. • CBIT- Chaitanya Bharati Institute of Technology • A P Productivity Council • Belgaum Material Testing Center • Product and process	• 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 • Minstry of Petroleum and Natural Gas

Development Center , Agra • Field Testing Station, National • Test House, MNIT				

1.7 Cluster Intervention

The table below shows the list of intervention in foundry clusters in India.

Funding Agency/ Donor	Name of Cluster/ places intervened/	Year of Intervention	Type of Intervention	No of units intervened	IA
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, trouble shooting for adaptation of cleaner technologies.	50	TERI
PCRA	Ahmedabad	2008	In 2008 workshop 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, organized technical seminars, and training shop floor personnel, under this scheme Rs. 5.00 Lakh was given to testing center to acquire radiograph equipments.		
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 cluster 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

Chapter -B2
Sponge Iron

2. 1Economic 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 due to its porous nature. Sponge iron is an alternative to steel melting scrap. Recently the use of sponge iron has increased in the manufacture of wrought iron and is used as a substitute of scrap during steel making.

2.1.2 India is the largest producer of sponge iron in the world accounting almost 30.97%[22] of the global output i.e. 684.5 lakh tonnes. The three main producers in the world are:

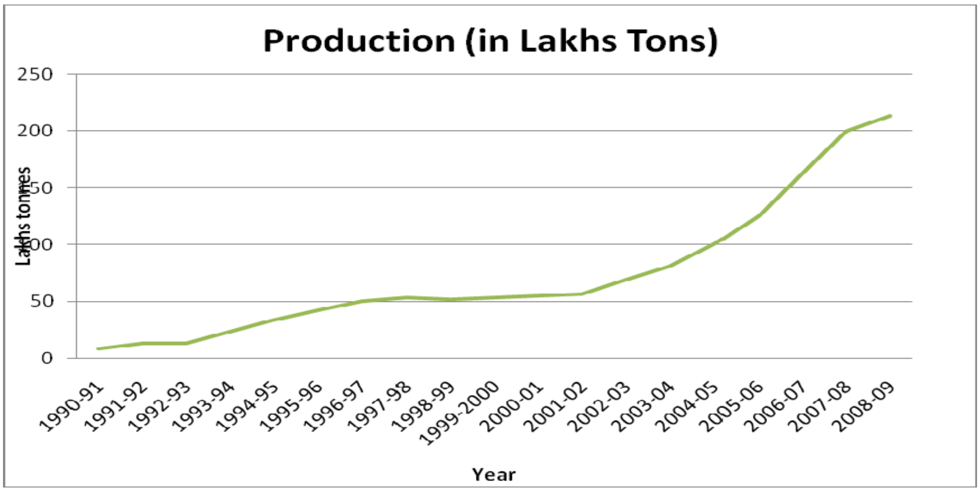
Table: 2.1

Country	Production (in lakhs tonnes)
India	212
Iran	74.6
Venezuela	68.7

Source: SIMA

The following figure shows the growth trend in the production of sponge iron in India.

Figure: 2.1



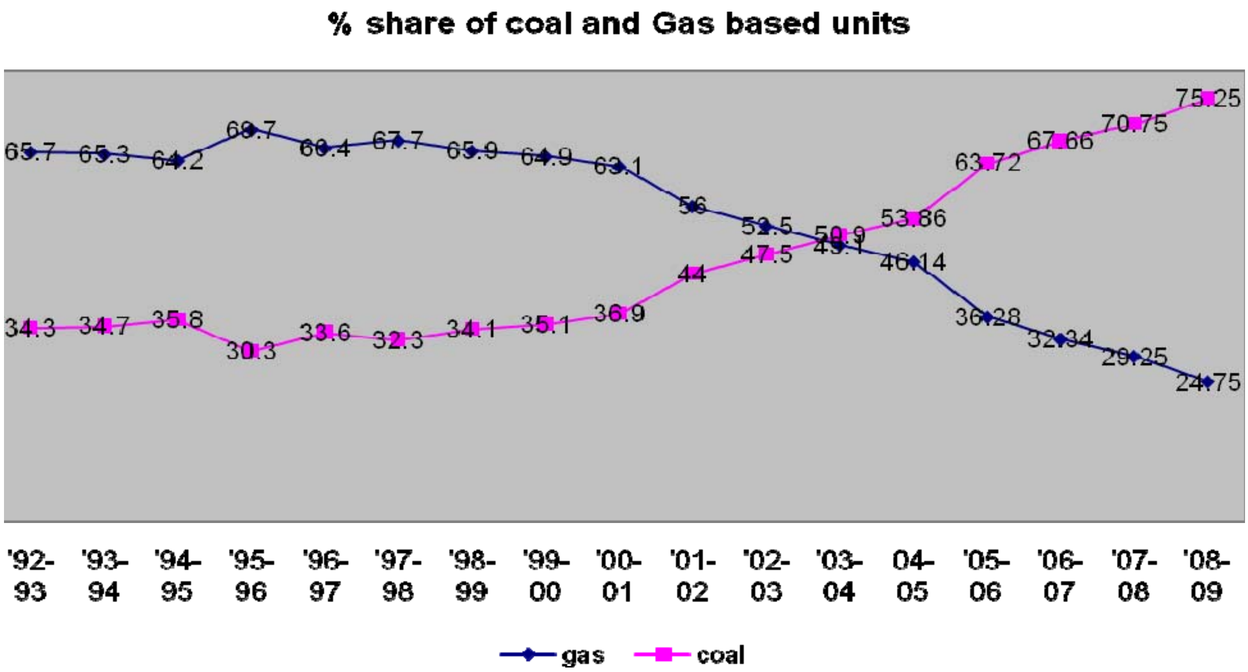
2.1.3The DRI production in India in 1990-91 was 8.6 lakhs tonnes and increased to 53.7 lakhs tonnes in 1997-98. After rising till 1998 there was a marginal decline in 1999-2000 and

[22] SIMA

increased thereafter at the rate of approx.20-30%. In 2008-09 it reached 213.3 lakhs tonnes. This sector provides employment to about 5,20,000[23] people.

2.1.4 While sponge iron is used as a raw material for steel industry, in some of the countries pellets are being used for making steel. In the first quarter of 2008 the industry experienced the shortage of pellets and created disequilibrium in demand and supply. As a result, the high demand existed during the first half of the year. Thereafter, as the financial crisis took hold, demand levels evaporated, supplies became more than sufficient and prices of many types of raw materials declined. As a result, the margins of industry declined in the second half of 2008. By the end of the year 2008, the demand and prices had dropped until approximately one-third of all DRI capacity was at idle, awaiting an economic rebound. These international imbalance impacted Indian sponge iron industry to a large extent[24].

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 13.6 lakhs tonnes in which production by gas based units was 8.9 lakhs tonnes and that of coal based units was 4.68 lakhs tonnes. With time the production of gas based plants declined and that of coal based units increased.
The figure below shows the comparison of percentage share of gas and coal based units from 1992-93 to 2008-09 **Figure : 2.2**



Source: Sponge Iron Manufactures Association

[23] SIMA

[24] World Direct Reduction Statistics, 2008, Pg 3

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

Table: 2.2

Growth Analysis of Indian DRI Production			
	2007- 08	**2008- 09**	**Growth (%)**
A. Gas Based Production (in lakhs tons)	5,84,52,870	5,28,02,960	(-9.66)
B. Coal Based Production (in lakhs tons)	14,14,24,370	16,05,04,150	13.49
Total (A+B)	19,98,77,240	21,33,07,110	6.72

Source: Sponge Iron Manufacturers Association (SIMA)

2.1.7 Coal based units are also finding 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, 600 lakhs tonnes of coal was imported and this is likely to increase every year by 20-25%.

Out of total number of sponge iron units in India, approx. 75% constitutes large units while remaining 25% are medium and small units*. However the share of the top 10 large units in total production is 70%.[25]

2.1.8 The biggest sponge iron unit in India is M/s. Jindal Sponge Iron Ltd, at Raipur. As per the National Steel Policy issued by the Ministry of Steel – India will produce 1100 lakhs tons of steel by 2020 so the requirement of Sponge Iron will be 300 lakhs tons. The sponge iron plants in India are located near the source of raw materials.

[25] Discussion with Industry expert

2.2Geographical concentration of Sponge Iron Clusters

2.2.1 There are approx. 355 units[26] 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 the states like Chhattisgarh, Gujarat, Orissa, West Bengal, Karnataka, Goa and Jharkhand as shown in the table below.

Table: 2.3

Name of the cluster	Area of Concentration	No. of units	Production Capacity in (lakh tonnes /annum)
Chhattisgarh	Raipur	40	520
Chhattisgarh	Bilaspur	7	
Chhattisgarh	Raigarh	20	
Maharashtra	Raigad	2	19
Maharashtra	Nagpur	10	9.1
Maharashtra	Kolhapur, Pune, Thane	3	0.5
Orissa	Jharsuguda,	22	76.4
Orissa	Bhubaneswar	16	
Orissa	Keonjhar	23	
Orissa	Rourkela	42	
West Bengal	West Mednipur	5	32
West Bengal	Bankura	11	
West Bengal	Purulia	12	
West Bengal	Burdwan	33	
Jharkhand	Saraia Kela Kharswa	15	18
Jharkhand	Giridih	5	
Jharkhand	Ramgarh	10	
Karnataka	Bellary	31	22.46 million tonnes
	Bellary (data not available)	10	
Karnataka	Koppal	7	
Goa	Goa	7	2.62 million tonnes

[26] Discussion with Sponge Iron experts

* Units with production capacity of minimum 30,000 tonnes per annum (plant and machinery cost 10 crores) are considered as large scale unit.

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 – third of the balance 113 units.

Gujarat	Hazira	11	64 million tonnes
Gujarat	Kutch		
Gujarat	Gandhidham		
Gujarat	Surat		
Gujarat	Bhuj		
Gujarat	Vadodra , Gandhidham	2	(data not available)
Andhra Pradesh	Hyderabad	5	1.5
Andhra Pradesh	Hyderabad	3	(data not available)
Tamil Nadu	Chennai	4	2.4
	Total	**355**	**301.9 ** **

** Complete list of all units and the production capacity of some of the known units is not available.

2.2.2 From the above table it can be seen that there are 7 clusters of sponge iron in India namely, Raipur, Raigarh, Jharsuguda , Rourkela, Keonjhar, Burdwan, Bellary with number of units 20 or more. As per the data of sponge iron production[27] , the total installed capacity in India is 301.9 lakh tonnes in 2008-09.Since the total production of sponge iron in India is 212 lakh tonnes this shows the units are producing at a much lower rate as compared to their production capacity. **Total coal consumption of sponge iron industry in India is 256.8 lakh tonnes* and total gas consumption is 1,848,103,600 normal cubic meter (ncm)**

(According to SIMA 350 normal cubic meters per tonne of gas is required to produce 1 tonne of sponge iron)

Average capacity utilisation of all the sponge iron units is 70.72% in 2008

Table: 2.4

		Available Data (mn tonnes)	**Unavailable Data**	**Total (mn tonnes)**	**Calculation**	**Total Production[28] (mn tonnes)**
A.	Total Production capacity of all sponge iron units in India	30.19 mn tonnes				
B.	Total production capacity of known units	26.025				
C.	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)

[27] SIMA

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

[28] 72.43 % is actual capacity utilization

D.	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	4.165				

** Data available for only 242 units out of 355. For the remaining 113 units information is not available. In this out of 113, one third is assumed as large and $2/3^{rd}$ as 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 employing 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 reductant. Limestone or dolomite is used as de-sulphurising agent. The normal operating practice is to feed the kiln with 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 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 reducing atmosphere at 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. Chemical reaction 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 duration of approximately ten to twelve hours inside the kiln during which 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 water-cooled cylindrical rotary cooler to a temperature of 100–200 degree centigrade. The discharge from cooler consisting of sponge iron, char other contaminations are passed on through magnetic separators so that sponge iron can be separated from other impurities. Subsequently the Sponge Iron is stored into Bins through conveyor belts.

2.4 Energy Intensity of Sponge Iron Cluster

2.4.1 The main fuel used in the production process of sponge iron is coal and gas. As mentioned earlier 160.5 lakh tonnes of sponge iron is coal based and 52.8 lakh tonnes is gas based (2008-09). The maximum energy is consumed in the process of reduction of iron ore in the kiln. All the small units are using indigenous technology. There are several ways of improving the energy efficiency in sponge iron production process. Some of the suggested potential areas of improving energy efficiency are-

(i) Use of higher grade coal: Sponge iron requires specific characteristic of coal – IDT of coal ash should have 13000 degree C temperature, reactivity of coal – 2 cc of CO / gm of C/Sec., Fixed Carbon (FC) to the level of 42-44%. Other features like Volatile Matter between 26-32%, Ash 25%, Coking Index and Swelling index less than 1, etc. are required for maximization of good quality sponge iron production. This is causing a concern for the sponge iron industry as well as environment. The sponge iron industry is forced to use coal with ash content over 40%, FC LESS THAN 33%.

(ii) Waste Heat Recovery: For reduction process to takes place in the kiln the temperature is maintained in the range of 950-1050°C. The hot gas (CO_2) also bears the temperature in the same range. In the existing practice of the hot gas treatment the heat contained in the gas is lost in the environment. Hence there exists a great potential of Waste Heat Recovery in the process. Following Energy Efficiency measures can be implemented by utilizing the waste heat in productive ways.

(a) Preheating Kiln: Iron Ore enters the kiln at the environmental 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). The few zones (two or three) are dedicated for the preheating the Iron Ore. These zones are called Preheating Zones. In the preheating zones the Coal charged with Iron Ore acts as fuel to generate the heat for preheating. This Preheating can be done in a Preheating Kiln by utilizing the heat of the hot exhaust gas generated in the reduction process. Hence charging of Iron Ore at an elevated temperature will require lesser number (or nothing at all) of preheating zones. This will reduce the coal consumption for the purpose of preheating in 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 the Waste Heat Recovery Boiler. If a 100 MTD capacity kiln is operated at maximum capacity, it can generate approximately 10 Tons of steam which have the potential of generating approximately 2MW of electricity. Operation of WHRB 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 4MW electricity. Maximum electricity requirement of a 200 TPD SI unit comes out to be 0.7 MW. Hence the surplus Electricity available through Captive Power Generation can be utilized 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 Sector

2.5.1 Sponge iron industries are one of the most pollution creating industries having enormous demand of its product in the country with low capital investment, resulting mushrooming growth of plants causing huge pollution and loss of natural resources. Coal based sponge iron industry is prone to pollution because it is a dry thermal reduction process. It is prone mainly to air pollution and also water & noise pollution. The 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 discharges of hazardous wastes. CPCB has set up emission standard for Sponge Iron Sector. The minimum national standard is given in the table below:

Table: 2.5

Parameter	Standard
Stack Emission	100mg/NM^3 (coal based)
Standards for Kilns (Particulate Matter)	50mg/Nm^3 (Gas Based) 12& CO_2 correction if monitored CO_2 level is less than 12%
Carbon Mono-oxide	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

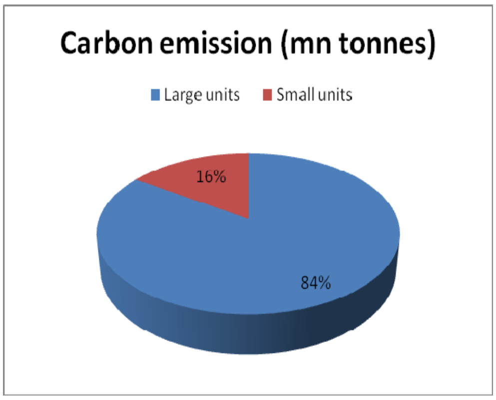
1. *Air Emission*

Table: 2.6

SNO.	Pollutants
1	During the raw material handling (unloading, stacking, reclaiming operations) large amount of fugitive dust is released to 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 to the environment. This also leads to noise pollution.
2	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.
3	Inside the rotary kiln, the hot DRI gases contains huge amount of fine dust comprising oxides and unburnt carbon and toxic carbon monoxide which requires treatment before discharging into the atmosphere.
4	The iron ore, coal and dolomite/lime stone are fed into the rotary kiln for converting it to sponge iron during this the fines are generated due to tumbling action. Part of fines comes out of the cooler through the double pendulum valve which leads to the generation of dust.
5	During product handling and separation large amount of dust is generated which causes air pollution

2.5.2 As per 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 160.5 lakh tonnes, the total carbon emission is 321 lakh tonnes.

Figure : 2.3



The above figure shows out of the total carbon emission about 84% is emitted by large units and remaining 16% by small units.

2. *Water Pollution*

Table: 2.7

SNO.	Pollutants
	In sponge iron plants water is used mainly for :
1.	**Cooling** the discharge feed from 950-1050˚C to below 100˚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

SNO.	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 equipments like DSC, ESP and Bag Filter of Product handling area
3.	Kiln accretion waste
4.	Dedusting dust from pollution control equipment of Cooler discharge area
5.	Scrubber sludge – Sludge is generated from the GCP when the plant is based on 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 the 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 the pollutants like Sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and particulate matter are the primary pollutants
- Noise is generated in the gas based plants from briquetting machines, compressors etc. In coal based plants noise is generated from the moving parts of kilns, cooler and associated equipments like gear boxes, fans etc that generates up to 90dB 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.

2.7 Industry Initiatives

- SIMA, the apex body for sponge iron plants has set up a membership criteria that only those units registered under State Pollution control board and has installed pollution control devices will be registered under them. For non – SIMA members information is not available.
- In many sponge iron units pollution control equipments 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 workers. Temples have been built in the nearby industrial areas.
- Some of the units have supported the formation of SHGs to provide employment to the local workforce especially women.

2.8 Institutions/Associations

The table below shows the list of Institutions and associations of sponge iron industry

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

2.9 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 needs to be extended to all the sponge iron units in India
- BR (Business Responsibility) initiatives need to be expanded in this industry to ensure the safety of the workers and the people living in close proximity of the industrial region.

2.10 Cluster Initiatives

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 Program

Chapter – B3
Leather Tanning Cluster

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 utilization of available raw material for maximizing 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 8th in term of foreign exchange earnings of the country and has 3% share in global trade. The annual production of leather and leather products in India is about US$ 6 bn (Rs 30,000 crores).The composition of export of leather products from India has undergone a structural change during the last three decades, from merely being an exporter of raw material in the sixties to value added products in the nineties. The exports are growing at the rate of 11.91% (5 years)[29]. Despite slowdown in US and EU, major importers of leather goods, leather exports grew 20 percent in the first half of financial year 2009, registering a 20 percent

[29] Council of leather exports

rise over the previous year. A large proportion of India's export of leather and leather products is mainly in four countries, namely USA, Germany, UK and Italy. This sector employs about 25[30] lakhs workforce with 30% women.

Table: 3.1

India's export of leather and leather products for five years

(Value in lakhs on US$)

	2003-04	**2004-05**	**2005-06**	**2006-07**	**2007-08**
Finished Leather	2667.408	2917.104	3054.096	3475.2	3681.264
Footwear	3685.104	4371.696	5017.152	5937.168	7083.984
Leather Garments	1445.184	1581.312	1599.84	1487.568	1651.152
Leather Goods	2588.208	2811.456	3168.816	3390.144	3767.76
Saddlery & Harness	253.008	296.208	372.096	395.184	507.888
Total	**2216.45**	**2495.37**	**2752.50**	**3059.43**	**3477.52**
% Growth	**18.20%**	**12.58%**	**10.30%**	**11.15%**	**13.67%**

Source: DGCI&S

3.1.3 The growth of the leather sector is directly related with the growth of livestock sector. India is the largest livestock holding country with 21% large animals and 11% small animals. Indian leather sector is a source for 10% global leather requirement with annual production value of 24000 crores. The estimated production capacity of hides and skins is 650 lakhs and 1700 lakhs[31] pieces.

3.2 Geographical concentration of tanneries

There are about 1381 tanneries spread out all over India. About 96% of these tanneries are in small and medium, and approx. 4% in the large sector.[32]

3.2.1 Since the tanning process requires large quantity of water, most of the units are located near river banks and they draw surface water. Most of the tanneries also use ground water from their own open wells/tube wells existing within their premises. The places where overhead water tanks are not available, there 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 mainly located in Tamil Nadu, West Bengal, Uttar Pradesh, Karnataka, Punjab and Maharashtra. The

[30] Council of leather exports

[31] CLRI

[32] Discussion with the expert

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.

The table below provides the list of Leather tanning clusters in India along with their total number of units.

Table : 3.2

Name of the cluster	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 finish to finish
	Vanniyambadi	110	100	Raw to finished leather
	Chennai	140	135	Semi finish to finish
	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 hide to wet blue 50 units – wet blue to finish 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	Vijaynagram,	1	15	Raw hides to finished

Pradesh	Hyderabad,	5		leather
	Warangal	2		
Bihar	Muzzafarpur	5	7	Processing raw material
Total		1381	1840	

3.2.2 The above table shows there are 12 clusters of leather tanneries with more than 20 units and of these there are 5 big clusters with more than 100 tanneries each. There are total 1,381 tanneries all over India with the production capacity of 1,840 tonnes per day. The top 5 clusters with more than 100 tanneries constitute approximately 70 percent of the total tanneries and production capacity is 962 tonnes per day (tpd) out of 1840 tpd which is 52 percent of total production capacity of tanneries in India. It has been calculated from the above table 2.5.3 that 52 percent is contributed by 70 percent tanneries and the remaining approx. 48 percent by 30 percent units. This clearly shows that in these 5 clusters maximum is medium and small units as compared to large units. The total number of large tanning units* in India is approx. 60 and the remaining 1,321 are small and medium tanneries[33]. The production capacity of all tanneries is 552,000 tonnes per annum. Out of the total production in India 50% is contributed by large and remaining 50% by the medium and small scale units.

3.3 Tanning Process

3.3.1 In the tanning industry large quantity of water is consumed. The quantity of water usage and nature of waste water discharge is dependent on the typology of tanning process and tannery. Generally, water consumption is maximum during the pre – tanning process, but significant amount of water is also consumed in the post tanning processes. Raw animal skins go through several steps during the tanning process. Depending on the type of hide used and the desired end – product, the steps taken during tanning can vary greatly. Different tanning processes are:

- Vegetable Tanning
- Chrome Tanning

The average water usage and wastewater discharge per kg of hide/skin for different process are:

Table: 3.3

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

[33] Discussion with the expert

*units producing more than 20 lakhs sqft of leather per day is considered large unit

** E.I. is vegetable tanning popularly known as East India tanning*
*** Wet Blue tanning is also known as Chrome tanning processing*

3.3.2 The composite waste water from raw to finishing process is alkaline with average contribution of about 575kg of total solids, 465kg of dissolved solids, 240 kg of Chloride, 135 kg of COD (Chemical Oxygen Demand), 100 kg of Sulphate, 65 kg of BOD (Biochemical oxygen demand), 7.5 kg chromium, 4 kg sulphide per ton of raw hides/skins for processing finished leather.

3.3.3 ***The common steps taken in different types of processes are-*** Firstly the animal skins or hides are *cured* which involves salting or drying the skin. Then they are soaked in water for several hours to several days. After soaking the flesh and hair is removed and then *deliming* is done i.e. 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. It 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 and therefore referred to as “wet blue”.

The table below provides the details of the tanning operations, water and other chemicals used and general constituents of waste water.

Table: 3.4

Important Operation 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, ammoniacalnitrogen, suspended solids, hair, pulp and dissolved solids

Deliming	Paddles/Pits/ drums	2.5-4.0	Ammonium salts, enzymatic bates	Alkaline, contains high amount of organic matter and ammoniacalnitrogen.
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 discharge water is alarming and needs attention not only from them who all are directly affected but also from the policy makers and civil society.

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

Table: 3.5

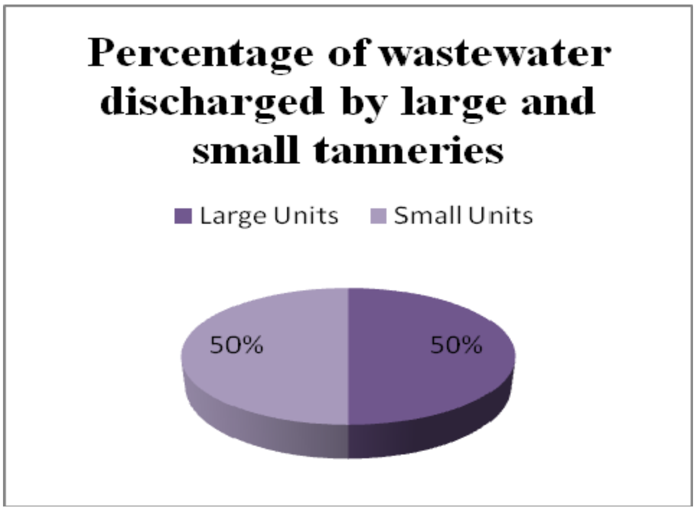
Name of the cluster	Area of Concentration	Type of Tanning	Estimated range of wastewater discharge in m^3 per day
Tamil Nadu	Melvisharam	Chrome Tanning	27,800
	Ambur,	Chrome Tanning	
	Ranipet,	Chrome Tanning	
	Vanniyambadi,		
	Chennai	Chrome Tanning	
	Trichy,	Vegetable tanning	
	Erode	Chrome Tanning	
	Dindigal	Major – Vegetable tanning and few units (10)follow chrome tanning	
	Pernambut	-	
West Bengal	Bantala	Chrome Tanning	18,000
Uttar Pradesh	Agra	Chrome Tanning	15,000
	Kanpur(Jajmau)	Only 50 doing chrome tanning and remaining 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

The total water discharged by tanneries is estimated to be 68,300 m^3 per day. As per discussion with the experts, the total water discharged by large units is approx. 24,150 m^3 and by small units is also same as both the sectors contribute 50% - 50% in total production.

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

Figure : 3.1



3.4 Environmental Issues in Leather Tanning Industry

1.4.1 The leather tanning 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 discharges of hazardous wastes. For leather sector environmental effluent standards has been set for waste discharges. The minimum national standard for tanneries is given in the table below:

Table: 3.6

Parameter	Limits not to exceed
pH	6.5 – 9.0
BOD_5, 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

Source: Central Pollution Control Board

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

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

- Wastewater
- Air emissions
- Solid waste
- Hazardous materials

2. *Waste Water*

3.4.2 The tanning process consumes large quantities of water. Most of this water is finally discharged as waste water carrying high amounts of suspended solids, salts and dissolved solids, Bio – Chemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). The waste water has a deep colour and bad smell. It depends on the type of chemical used during the tanning process. The total waste water discharge form Indian tannery industry is estimated to be *about 500 lakhs litres per day*[34]. The biggest polluting material in the tanning industry, which is difficult to get rid off is common salt. For every 10 tons of salted hide and skin processed, 2–3 tons of salt is removed and in addition another one ton of salt is removed while pickling.[35] It has been established that a single tannery can cause pollution of groundwater around a radius of 7 to 8 km.

[34] CPCB

[35] Impact of pollution due to tanneries on ground water regime by N.C. Mondal, V.K. Saxena, V.S. Singh – Ground water group , National Geophysical Research Institute, Hyderabad

Figure: 3.2

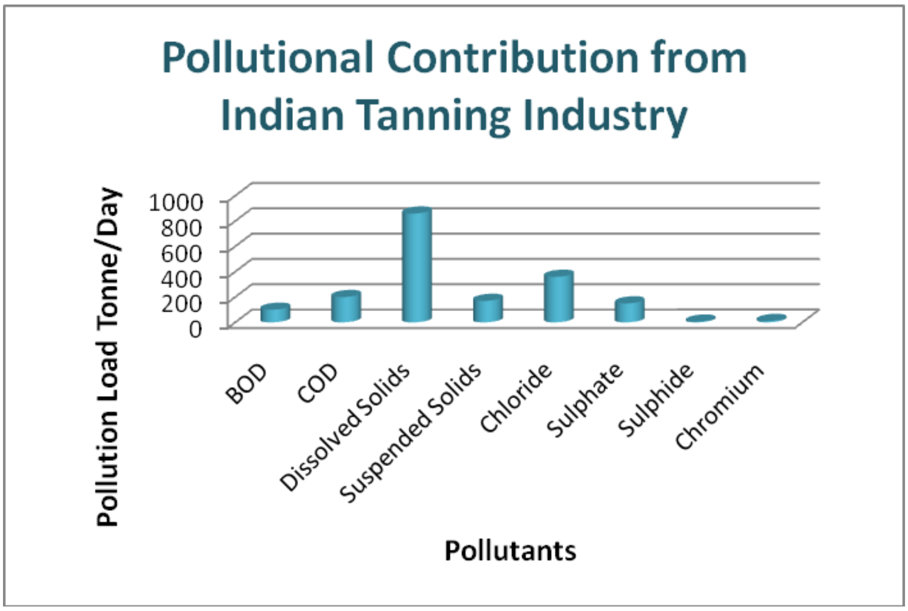


Table: 3.7

SNo.	Pollutants
1.	*COD/BOD and Suspended Solids: Approximately* 75 percent 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 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 percent of total chloride is produced from salt used for curing, which is subsequently released in the soaking effluent. The rest is generated mainly from 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, reduce fertility and damage farming in large areas.
3.	*Sulphides:* Inorganic sulphides (NaHS or Na2S) 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 percent). 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 the beamhouse operations, which, as a whole, account for approximately 85 percent of 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 the majority (approximately 75 percent) of the chromium in the wastewater stream. The remainder is typically generated from post-tanning wet processes, from stock drainage, and wringing.
6.	*Post-Tanning Chemicals:* Post-tanning operations involve 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 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, fatliquors, 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 to relocate to a self-contained leather-processing complex in the Bantala area. This was in response to public interest litigation filed by environmentalists alleging that pollution from the industries exceeded the state pollution standards. Similar attempts were also made in other states to combat water pollution in India.

3. Air Emission

Table: 3.8

Air Emissions	
1.	*Organic Solvents:* Organic solvents are used in degreasing and finishing processes. Untreated organic solvent emissions from the finishing process may vary between 800 and 3,500 mg/m³ in conventional processes. Approximately 50 percent of VOC emissions arise from spray-finishing machines, and the remaining 50 percent from dryers. Chlorinated organic compounds may be used and emissions released from 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 is generated from 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

4. Solid Waste

Table: 3.9

Solid Waste	
1.	Solid wastes problem arises in tanneries both in the tanning process and also during effluent treatment. Solid waste includes 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 (Cr2O3); wet-blue trimming, which is generated from finishing processes and contains chromium oxide, syntans, and dye; and buffing dust, which also contains chromium oxide, syntans, and dye.

5. Hazardous Materials

3.4.4 Tanning and leather finishing processes involve the use of a variety of hazardous chemicals, most importantly Chrome which needs to be recovered from the waste water. However a significant proportion of chrome is left in the drain water to mix with portable and ground water.

3.5 Social Issues

3.5.1 The social issues pertaining to 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 effluent. 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 are developed due to these diseases – agents.
- Obnoxious smell comes from the hides and skins which makes breathing difficult for workers.
- Since workers use acids like Benzene, chromic acid, they face many skin problems.
- In Kamatchipuram village located five kilometres away from Dindigul town only 16 of the 56 wells in the village are uncontaminated forcing people to walk two-three kilometres everyday to fetch water.
- Most of the tanneries have unhygienic working conditions, inadequate ventilation and lighting.

3.6 Institutions

The major technical & knowledge institutions for 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 Clusters Intervention

The table below shows the interventions undertaken in different clusters so far by different National and International agencies and institution in different time period.

Agency	Clusters	Program/Scheme	Type of Intervention	Time Duration
UNIDO	Kanpur, Calcutta, Tamil Nadu	Pollution control in the tanning sector in South East Asia	Pollution Control	1996-2002
UNDP, GOI	All over India	National Leather Development Program	Overall development of leather sector	1992-1998
UNDP, GOI	All over India	National Leather Development Program	Overall development of leather sector	1992-1998
UNIDO	Chennai, Shantiniketan		Consolidated project for SME development in India	2007-2010
Punjab State Leather Development Corporation	Jalandhar		Setting up a common Effluent Treatment Plan (CETP)	
Government of India and Industry	Jalandhar		Upgradation of the CETP of 5 MLD with the help of SPV called Punjab Effluent Treatment Society to resolve the environmental concerns of the leather complex	
State Industries Promotion Corporation of Tamil Nadu (SIPCOT)	Ranipet		Setting up an industrial complex which also houses many tanneries	
BIPCC* as per the advice of	Unnao	ASIDE scheme of GOI	Setting up CETP under this scheme	

corporation under a tripartite agreement with UPSIDC, Banther Industrial Pollution Control Company and CLRI, Chennai				

**a public limited company formed jointly in public interest by all tanneries to assist small scale units in the matters of Prevention & Control of Pollution*

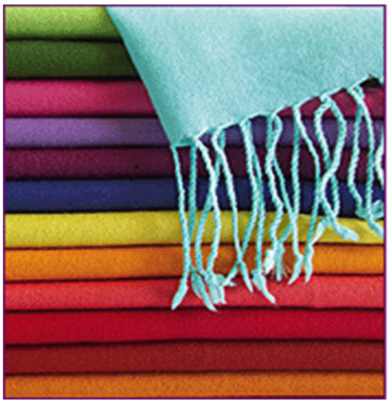
3.8 Way Forward

1.8.1 Initiatives needs to taken to ensure Effluent Treatment Plants (ETPs) are set up in all clusters in India to avoid large quantity of waste water discharge. In many clusters CETPs have been set up as the cost of setting up ETP is high. Same initiatives can be followed in other clusters where small units are largely concentrated and investment in ETP is costly for them. Leather complex like Jalandhar and Kolkata can be set up so that there is concentration of tanneries in a single location and the nearby areas are saved from the waste water and pollution generated by the tanneries. The organic loads (BOD and COD), sulphides, nitrogen compounds and other chemicals which are produced in the tanning process should be minimised.

3.8.2 In the workplace workers are exposed to chemical hazards, disease-agents. They also face problems like breathing and skin problems. The workers exposure to hazardous chemicals can be limited by promoting chemical handling procedures, and dosing and transferring chemicals in fully or partly closed systems using automated systems, using equipment and techniques (e.g. roller coating) to minimize indoor air pollution (e.g. during spraying and general application of finishing treatments), using personal protection equipment (e.g. gloves, glasses boots, aprons, masks, hoods, respirators) particularly in the wet activity areas of the tannery. Respirators / masks with particulate filters and glasses should be used when handling powder and liquid chemicals.

Chapter B4

Textiles Sector



4.1 Economic Significance

4.1.1 The Indian textile industry is the second largest in the world. The Indian textile industry contributes about 14% to the national industrial production, 4 % to GDP and about 17% to the total national export earnings[36]. 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 3.5 crore people which constitutes 21% workforce[37].

The products of textiles sector includes:

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

4.1.2 Currently, India has about 1726 spinning mills and 176 composite units with about 3.907 crore spindles and 6,21,000 rotors in the organised and unorganised sector. The total number of composite mills in the organised sector has decreased from 223 units in 2003- 04 to 176 units 2007-08[38].There are about 12,400 processing factories of which around 10,000 are engaged in manual processing. The handloom sector, with about 35 lakhs looms, provides employment to 65 lakhs persons out of which about 60.6% are women. During 2008-09, production in the

[36] Ministry of Textiles Annual Report – 2008-09, Page-3

[37] Official Indian Textiles Statistics, 2005-06

[38] www.txcindia.org

handloom sector is reported to be 667.7 crore sq. Meters[39]. There are 21.55 lakhs powerlooms in the country as on 31st December, 2008 distributed over approximately 4.82 lakhs units. The powerloom sector contributes about 62% of the total cloth production of the country, and provides employment to about 54.00 lakhs persons[40].

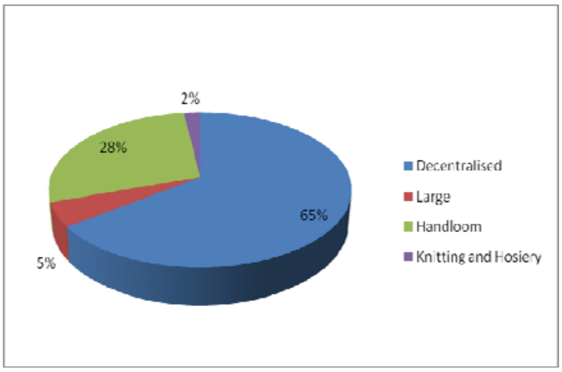
4.1.3 The power loom sector occupies a pivotal position in the Indian textiles industry. However the sector has been plagued by technological obsolescence, fragmented structure, low productivity and low-end quality products. In the power loom sector most of the looms are more than 20 years old and 75% of these are conventional type, not fit for the production of fault free fabric at higher efficiency.

4.1.4 India is the second largest producer of textile and garments; garment exports totaled Rs 48816 crores during the year 2008-09, giving it an enviable market share of 2.99%[41].They account for 42% [42]of the total textiles exports.

Out of the total fabric units in the country; 5% are in the organised sector, 62% in unorganised, 28% in the handlooms and remaining 5% in knitting and hosiery.

Figure: 4.1

Distribution of fabric units



[39] Ministry of Textiles Annual Report 2008-09

[40] Ministry of Textiles Annual Report 2008-09

[41] Apparel Export Promotion Council

[42] Ministry of Textiles, Annual Report 2008-09

Production of Cloth in different sectors (in crore sq meters)

Table: 4.1

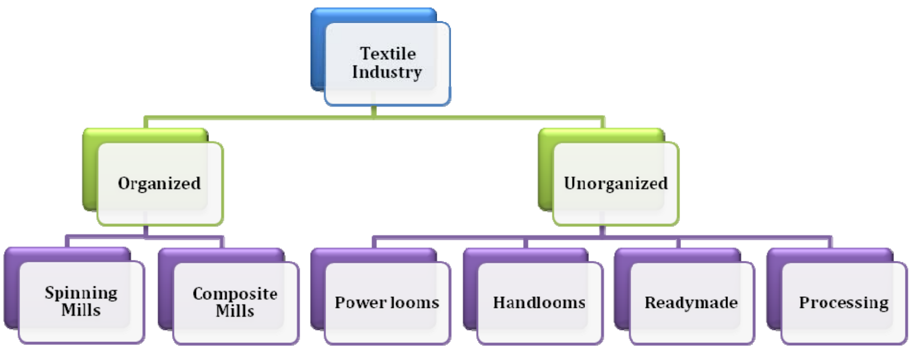
Sector	2007-08	2008 -09 (P)
Mill	178.1	179.6
Handloom	694.7	667.7
Decentralised Powerloom	3472.5	3364.8
Decentralised Hosiery	1180.4	1207.7
Khadi, wool and silk	76.8	76.8
Total	**5602.5**	**5496.6**

Source: Annual report 2008-09, Ministry of Textiles
(P) Provisional

4.1.4 The total production of cotton yarn and cotton fabrics for the year 2007-08 was 294.8 crores kg and 2719.6 crores square meters respectively. But its percentage share in the global trade of textiles and clothing continues to be low at about 3 percent. The major reason for such a small share in the world trade has been the technological obsolescence in weaving, processing and clothing sectors. At current prices the Indian textiles industry is pegged at Rs 249600 crores, 64% of which services domestic demand.

India's textile industry is divided into the organized and the unorganized sector.

Figure: 4.2



4.2 Geographical concentration of Textiles Clusters

The following table shows the list of textile clusters in India along with the number of units, employment and total production.

Table: 4.2

Sector	Number of Clusters	Number of units	Number of looms/spindle	Employment	Total Production	Locations with Maximum concentration
Spinning mills	20	1726	3.907 crores	-	400.3 crore kg	Coimbatore, Maharashtra, Punjab
Composite mills	14	176	-	1,76,000* (approx.)		Maharashtra, Gujarat, Punjab
Powerloom	45	4.82 lakhs	21.55 lakhs powerlooms	54 lakhs	5496.6 crores sq. meters (2008-09)	Maharashtra, Surat, Uttar Pradesh
Handloom	594	**	35 lakhs looms	65 lakhs	694.7 crore sq. Meters (2007-08)	Tirupur, Bangalore
Readymade Garments	18	40,000 (approx.)	-	70 lakhs		Bangalore, Indore
Wet Processing	16	8183	-		738.784 crore kg	Maharashtra, Gujarat, Tirupur, Punjab

**Assuming 1000 persons are working per unit.*
***95% looms are in households*

4.3 Process of Textile Sector

In textile sector the production process includes three main stages:

Figure :4.3

4.3.1 <u>Spinning</u>: Spinning 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 the most used 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 shuttleless. Shuttleless has higher productivity and produces better quality of output. Less than 1% of all powerlooms are shuttleless, and, in the organized mill sector, less than 6% are shuttleless 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, coloration, and finishing. It uses different types of technologies depending on the type of yarn or fabric that are dyed. Jigger, winch, padding, mangle and jet-dyeing are some of the important dyeing machines. Similarly, there are different types of printing: direct printing, warp printing, discharge printing, resist printing, jet printing, etc.

4.4 Energy Intensity in Textile Sector

4.4.1 Energy consumption in the textile industry has augmented with increased mechanization. Energy costs vary from 5 to 17% of the total manufacturing costs according to the type of process involved. The Indian textile industry consumes nearly 10.4%[43] of the total power produced in India.

4.4.2 The energy consumption in the textile sector in spinning mills is approx. 40 watts per spindle. In the case of *weaving*, which includes powerlooms and handlooms, in powerlooms it is approximately 4 kilowatts per loom and in handloom energy consumption is negligible. Steam consumption in a fabric dyeing unit may vary from 4 to 9 kg of steam per kg of fabric.

Table: 4.3

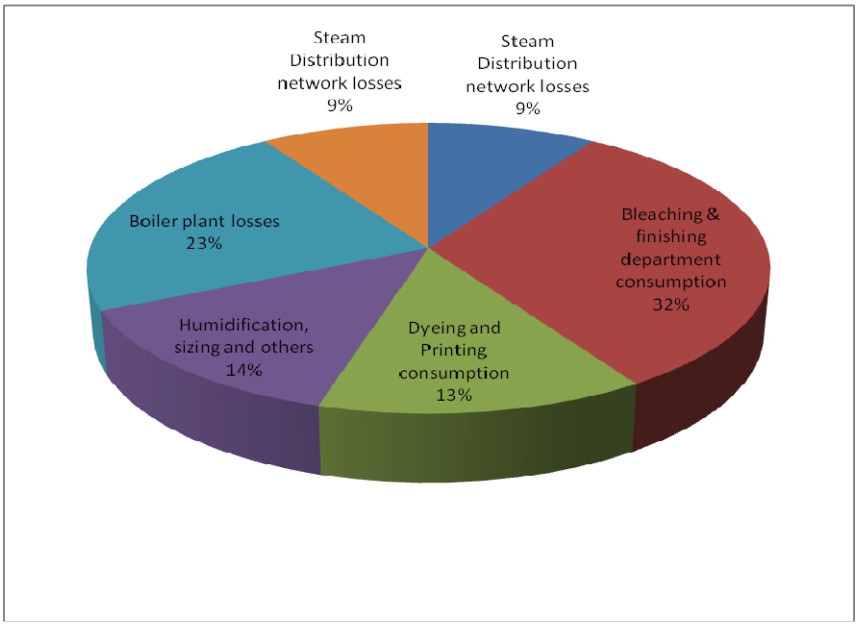
Sector	**Calculation**	**Small units**	**Large units**	**Electricity consumption (in Rs crores)**		
				Small units	**Large units**	**Total**
Spinning mills	Total number of spindles = 4 crore Energy consumption per spindle = 40 watts No. of working hours = 24 hours No. of working days = 350 days Energy cost per unit = Rs 5	10%	90%	672	6048	6720

[43] IREDA Report

	4 crore*(40/1000)*24*350*5 = Rs 6720 crore					
Weaving	Powerlooms and Handlooms					
Powerlooms	Total number of powerlooms = 21.55 lakhs Energy consumption per loom = 4 Kilowatts No. of working hours = 16 hours No. of working days = 350 days Energy cost per unit = Rs 5 21.55 lakhs*4*16*350*5 = Rs 24136 crores	95%	5%	22929.2	1206.8	24136
Handlooms	Negligible electricity consumption	95%	5%			
Processing	Total number of processing units = 8183 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 = Rs 5 8183*0.15*16*350*5 = Rs 3.43 crores			3.43		3.43
Composite mills	Total number of composite mills = 176 No. of spindles = 25,000 No. of powerlooms = 400 No. of working hours = 24 hours No. of working days = 350 days Energy cost per unit = Rs 5 [176{25000*(40/1000)*24*350*5}+{400*4*24*350*5}] =		100%		1921.920	1921.920

	Rs 1921.920 crores					
Total				23604.63	9176.72	32781.35

Figure: 4.4
Heat Consumption



Source: unep Dtie

4.4.3 The textile industry requires both thermal and electrical energy for its operation. About 80% of the energy requirement is met in the form of heat. Thermal energy used in textiles sector is in the form of coal and gas. Wet processing includes Bleaching & finishing , dyeing & printing, humidification and boiler plant losses.The above graph shows that in the process of wet processing maximum thermal energy is used i.e 82% of the total energy consumed. In the stage of weaving and spinning 15% and 18% energy is used respectively.The three major factors for energy conservation in the textile industry are high capacity utilization, fine tuning of equipment and technology upgradation.

Since greater percentage of thermal energy is used in wet processing sector, it can be interpreted that maximum pollution is generated in this stage of textile production because of larger consumption of coal.

4.5 Environmental Issues in Textiles Industry

4.5.1 The textiles 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 discharges of hazardous wastes. The wastewater general standard for textiles sector is given in the table below:

Table: 4.4

Textile Industry	**Quantum**
Man- Made Fibre	
1. Nylon and Polyester	120m^3/tonne of fibre produced
2. Voscose Staple Fibre	150m^3/tonne of product
3. Viscose Filament Yarn	500m^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

Hazardous materials management	
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

- **Wastewater**

  4.5.2 Water is highly polluted in the textiles processing. For example in Tirupur the textile manufacturing activities alone utilize around 2880 crore litres of ground water, which is around 1% of present water demand of Tamil Nadu[44].This has led to the depletion of the ground water. Around 30 litres of water is used for processing 1 kg of textile product. This shows per day requirement of about 1 to 1.5 lakhs cubic metre of fresh water, which after

[44] Ministry of Textiles

process, is to be discharged to the drainage and hence to surface water bodies and on land. It is estimated that around 80 thousand to 1 lakhs cubic metre water is discharged daily.
Annual wastewater generated at Tirupur 2.8 crore to 3.5 crores cubic meters. Tirupur alone constitutes 3950 units out of total 8183 wet processing units in India. Therefore total discharge of wastewater in all clusters is 5.8 - 7.25 crores cubic meters per annum.

Table: 4.6

Wastewater	
S No	**Pollutants**
1.	*Industrial Process Wastewater:* Industry-specific wastewater effluents are related to wet operations, which are conducted during different parts of the textile manufacturing process. Process wastewater from textile manufacturing is typically alkaline and has high BOD (from 700 to 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 contains significant 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).

- **Air Pollution**

Table: 4.7

Air Pollution	
S NO	**Pollutants**
1.	Air Pollution in 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 activities such as printing processes, fabric cleaning,

	wool scouring and heat treatment. Another source of emissions is the evaporation or thermal degradation of chemicals used on the textile materials. The main sources are often the stenter frames, which are used in drying. Other substances with significant air emission potential are used in printing processes, including ammonia, formaldehyde, methanols and other alcohols, esters, aliphatic hydrocarbons, and several monomers. *Exhaust Gases:* Gases are exhausted during process heating which 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.

- **Wastes**

Table: 4.8

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.

4.6 Social Issues

The social issues pertaining to textile sector includes the occupational health and safety hazards during the operational phase of textile manufacturing projects. They 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:* The exposure of workers to dusts from material 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, the lifting, holding, putting down, pushing, pulling, carrying or movement of a load, is the largest cause of injury in the textiles sector. Manual handling causes either cumulative disorder from the gradual deterioration of the musculoskeletal system, such as lower pack pain, or acute trauma such as cuts or fractures due to accidents.

- *Volatile Organic Compounds (VOC):* Workers exposure to VOC emissions during 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 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 exposes 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. texturizing, twisting and doubling ;and woven fabric production. This may affect the hearing capacity of the workers.

- *Colour in Effluent*: The human eye can readily detect less than 1 ppm of most dyes. Hence, colour from textile wastes causes significant aesthetic problem.

- *Accidents in the textiles sector:* The textiles sector has many hazards that cause injury to workers, from transport in the workplace (lift truck), dangerous large work equipment and plant, to the risk of slips from a wet working environment. Workers being struck by objects, such as moving machinery parts and vehicles are a significant cause of injury in the sector. There also exist the risks of fire and explosions.

- In wet processing coal and firewood is used which effects the heath of the workers.

4.7 Institution /Associations

The various institutions and associations associated with the textile sector are:

Table: 4.9

	Knowledge Institutions	Financial Institution	Govt. Support Institution	BDS Providers	Associations
1	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)
2	National Institute of Fashion Technology (NIFT)	RFC (Rajasthan Financial Corporation)	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)
3	Ahmedabad Textiles Industry Research Association (ATIRA)	Union Bank of India	All India Handicrafts Board	National Handlooms Development Corporation Ltd. (NHDC)	Carpet Export Promotion Council (CEPC), New Delhi
4	Bombay Textiles Research Association (BTRA)	State Bank of India	All India Powerlooms Board	The Cotton Corporation of India Ltd,(CCI)	Apparel Export Promotion Council (AEPC), New Delhi
5	Coordination Council for Textiles Research Associations	Central Bank of India	The Cotton Advisory Board		Handloom Export Promotion Council (HEPC)
6	Man – made Textiles Research Association (MANTRA), Surat	Bank of India	Development Council for the Textiles Industry		Powerloom Development & Export Promotion Council (PEDEXCIL)
7	Northern India Textiles Research Association (NITRA), Ghaziabad	Indian Bank	All India Handlooms Board		Export Promotion Council for Handicrafts (EPCH)
8	South Indian Textiles Research Association (SITRA)	Indian overseas bank	The Handicrafts and Handlooms Export Corporation of India (HHEC), New Delhi		Kishangarh Yarn Merchant Association
9	Indian Institutes of Handloom Technology (IIHTs)	Punjab National Bank			Sizers Association (Kishangarh)
10	Weavers Service Institution				Broker's Traders Association, Kishangarh
11	Punjab Institute of Textile Technology				

12	Indian National Institution of Fashion Designing (INIFD)				

4.8 Cluster Initiatives

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

Table: 4.10

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, 4units in Maharashtra, 4 units in Madhya Pradesh, 7 units in Karnataka, 2 unit in West Bengal, 3 in Punjab and 1 unit each in Delhi and Kerala	Textile Workers Rehabilitation Scheme (TWRFS)
Handloom	Office of the Development Commissioner for Handlooms, Ministry of Textiles	To assist the handloom Weavers Groups for becoming self – sustainable, up-grade the skills of handloom weavers/ workers to produce diversified products with improved quality to meet the market requirements, provide suitable workplace to weavers to enable them to produce quality products with improved productivity, holistic and flexible interventions to provide need based inputs specific to each cluster/group	625*	Integrated Handloom Development Scheme
	Office of the Development Commissioner for Handlooms, Ministry of Textiles	Skill up-gradation of the handloom weavers through training, workshops and exhibitions, design development, documentation of traditional designs and providing linkages between various agencies in the handloom sector to enable the weavers to improve productivity and meeting the market requirements		Diversified Handloom Development Scheme
	Ministry of Agriculture and Textiles	To the increase in productivity, improvement of quality and reduction in the cost of production		Technology Mission on Cotton

Powerloom		and thus providing the much-needed competitive advantage to the textile industry along with ensuring attractive returns to the farmers		
	Ministry of Textiles	Setting up of Powerloom Parks with modern weaving machinery to enhance their competitiveness in the Global Market		Group Workshed Scheme
	Ministry of Textiles	• Marketing Development programme for Powerloom Sector • Exposure visit of Powerloom Weavers to other Clusters • Survey of the Powerloom Sector • Powerloom Cluster Development • Development and Upgradation of skills (HRD)		Integrated Scheme for Powerloom Cluster Development
Readymade Garments	Govt. of India, 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 (U.P.), 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 upto 50% of the cost of the CETP is provided by state and Central Government	Pali (Rajashtan), Jetpur (Gujarat), Mathura (Uttar Pradesh)	'Common effluent treatment plant'
	Govt. of India, Ministry of Textiles	To upgrade infrastructure facilities at important textile centers	• 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-	Textiles Centers Infrastructure Development Scheme

			Ahmedabad City, • SEWA Trade Facilitation Centre, Ahemdabad • 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)	

** 625 clusters, each covering about 300 to 500 handlooms*

4.9 Way Forward

4.9.1 Textiles sector is highly energy intensive sector using both electrical and thermal energy. New technology should be introduced to ensure substantial amount of energy is saved. More over this industry generates large amount of solid and well as water pollution. So the units should be persuaded to install necessary pollution control measures. CETPs should be set up in all the textile units.

4.9.2 There are many health and safety hazards in this sector. Work equipments and machineries should be regularly checked and emergency stops them should be accessible and working. Workers should be provided ear- protectors to avoid noise pollution and as far as possible lowest noise and vibrations making machines should be used in the units. Workers should be made aware on the possible dangers posed by the chemicals used by them due to rough handling. They should be provided instruction on the safe usage of chemicals and provided personal protective equipments such as gloves, goggles, face shields or respirators. The oxidizing or flammable substances should be stored in unventilated rooms.

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 one of the important segments of the chemicals industry in India, having forward and backward linkages with a variety of sectors like 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 has emerged as 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 Rs 2436 crore in 2001-02 to Rs 4562 crores in 2006-07[45]. Currently in India all varieties of synthetic dyestuffs and intermediates are produced and have a small presence in the natural dyestuff.

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

Figure: 5.1

Source: Ministry of Chemicals and Petrochemicals

[45] Department of Chemicals and Petrochemicals

The above figure shows the growth trend of exports and imports from 2001-2006. This clearly indicates an increasing market of 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[46]. The small scale units account for majority of dyestuff production while large units dominate manufacturing of dyestuff intermediates.

The following table provides the installed capacity of the dyestuff and intermediates industry

Table: 5.1

	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

The dye industry is also classified based on its application as shown in the table below.

Classification of the Dye Industry Based on Application of Dyes

Table: 5.2

	Type of dye	Main Use
1	Acid	Wool, silk, Nylon, leather
2	Azoic	Cotton
3	Basic	Acrylic, jute , paper
4	Direct	Cotton, Synthetics, paper , leather

[46] http://www.gujexim.com/tradeleads_chem_dyes.htm

5	Disperse	Polyester, Synthetic
6	Food Colours	Colouring food, candies, confections and cosmetics
7	Ingrain	-
8	Metal Complex	Cotton Fabrics
9	Mordant	Wool
10	Optical Brightening, whitening agents	Whitening textiles, plastics, paper, soap
11	Pigment	paint industries , plastics, leather , paper
12	Reactive	Cotton. Wool
13	Solvent dyes	Colour oils, waxes, varnishes, shoe, dressings and gasoline.
14	Sulphur	Cotton, Synthetics
15	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% 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 chemical Clusters

5.2.1 There are few geographical concentrations of small and micro units of dye manufacturers into clusters. The table below provides the list of dye clusters in India. The dye cluster is mainly located in Gujarat.

Table: 5.3

State	Location	No. of units	Type of Dye
Gujarat	Ahmedabad	800	Reactive, direct, vat, sulphur, azo, acid
Gujarat	Ankhleshwar	150	Reactive, direct, vat, sulphur, azo , acid
Gujarat	Vadodra	32	Reactive, direct, vat, sulphur, azo , acid
Gujarat	Himatnagar	4	Reactive, direct, vat, sulphur, azo , acid
Gujarat	Jetpur	20	Reactive, direct, vat, sulphur, azo , acid
Gujarat	Keda	7	Reactive, direct, vat, sulphur, azo , acid
Gujarat	Rajkot	10	Reactive, direct, vat, sulphur, azo , acid

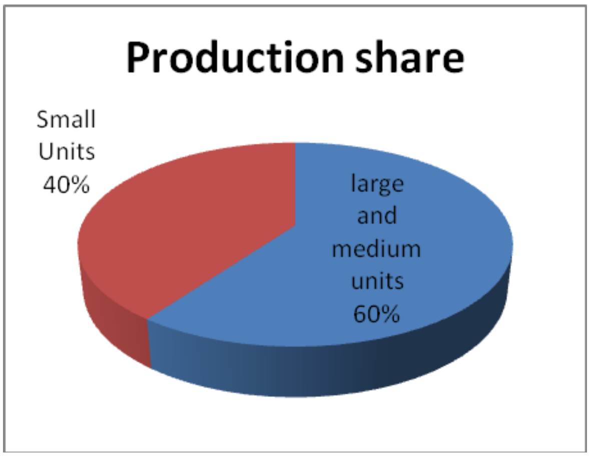
Gujarat	Surat	150	Reactive, direct, vat, sulphur, azo , acid
Gujarat	Vapi	300	Reactive, direct, vat, sulphur, azo , acid
Maharashtra	Tarapur	500	
Maharashtra	Konkan	300	
Maharashtra	Thane/ Belapur	30	
Maharashtra	Dombivali	75	
Maharashtra	Aurangabad	42	
Others		80	
Total		2500	

Source: discussion with the experts

5.2.2 Form the above table it can be seen that the distribution of these units is skewed towards with western region (Maharashtra and Gujarat) accounting for more than 90%. In fact, nearly 70% of the total capacity is in the state of Gujarat.

Out of the total production, 60% is contributed by large and medium units and the remaining 40% by small units.

Figure: 5.2



Dye clusters mainly lead to water pollution. The usage of water is also very high in this sector. The manufacturing process of the dye cluster is provided in the following section.

5.3 Dyes Manufacturing Process

5.3.1 Dyes are synthesized 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, diazotization, and coupling[47], followed by separation processes that may include distillation, precipitation, and crystallization. In the process temperature is controlled by adding ice to the reaction tank. Then a dye mixture is prepared which is filtered and purified. After this the mixture is dried, grinded and standardised to form the final product. Dyeing industry consumes maximum quantity of water.

Figure: 5.3

5.4 Energy intensity

5.4.1 Major energy consuming equipments are Pressure vessel, Dryer, Boiler & mixer. Energy cost is 5 to 8% of the total production cost. The major cost is of the raw material, which is as high as 65 to 70%.

Fuel Usage

Table: 5.4

	Consumption by 1 unit	**Consumption by 2500 units***
Electricity	41227.369	10,30,68,423 units
Firewood / Husk	320.66 tonnes	801655 tonnes
LDO	13625.45 litres	3,40,63,636.3 litres

[47] Sulfonation- The introduction into an organic molecule of the sulfonic acid group (or its salts), —SO_3H, where the sulfur 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 - Reaction between a primary aromatic amine and nitrous acid to give a diazo compound. Also known as diazo process

PNG	31368 kg	7,84,20,000 kg
Coal / Hard Coke	1650 tonnes	4125000 tonnes

Source: Energy efficiency study by Bureau of Energy Efficiency

on the basis of information available for some of the units in Ahmedabad, the above calculations have been done for 2500 dyes and chemical units.

Cumulative Raw Material Usage

Table: 5.5

Raw Material	Quantity
Major Raw material include 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.

5.5 Water consumption

The water usage in the dye industry is mainly for:

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

5.5.1 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 quantity of water. In general, process water consumption is highest, next to it is the cooling and boiler make – up water requirement and the 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 factory (continuous or on shift only)
- Frequency of change of product pattern

Water Consumption and Wastewater generation during production of various types of dye products

Table: 5.6

S No	Type of Product	Range litres/kg. of Product	
		Water Consumption	Wastewater Generation
1	Direct Dyes	2.5 - 667	1.0 – 644
2	Reactive Dyes	2.0 - 186	2.0-157
3	Basic Dyes	60-4200	50-200
4	Azo Dyes	90-400	8.0-213
5	Vat Dyes	1,528-10,345	1,389-7,980
6	Dye Intermediaries	36-230	9.0-74
7	Naphthol Dye	6.0-17	5.0-8.0
8	Pigments	93-923	7.0-785
9	Indigosol Colours	529	429
10	Disperse Dyes	70	12-42.5
11	All Varieties of dyes/ intermediates	13-2,300	11-1,146

Source: Central Pollution Control Board

5.5.2 The generation of wastewater follows the trend of consumption of water. The above table 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 wasted is also during vat dye which is about 90% 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 washing and rinsing operations

5.6 Environmental Issues in Dye Sector

5.6.1 The Dye 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 discharges of hazardous wastes. It is one of the 17 industries identified by them amongst the most polluting ones. For leather sector environmental effluent standards has been set for waste discharges. The minimum national standard for Dye and Dye Intermediary Industry is given in the table below:

Table: 5.7

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
Nickel	2.0
Zinc	5.0
Chromium	Hexavalent - 0.1 Total – 2.0
Bio assay test	90% survival in 96 hours

Source: CPCB

**Except pH, colour and bio assay test*

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

- Wastewater
- Air emissions
- Solid waste
- Hazardous materials

3. 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 being smaller in volume but has 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 is during synthesising when ice is added to control the temperature.
    - Sanitary and other miscellaneous wastewater

Table: 5.9

S No	Pollutants
1	High levels of Biochemical Oxygen Demand and Chemical Oxygen Demand- The wastewater generation rate for vat dyes are of the order of 8,000 l/kg of product. Biochemical oxygen demand (BOD) and chemical oxygen demand (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 the dye synthesis
5	High levels of chlorides and sulphates
6	Presence of phenolic compounds
7	Presence of heavy metals e.g. copper , cadmium, lead, manganese, mercury, nickel and zinc
8	Presence of oil and grease present in the wastewater streams

4. Air emission

Table: 5.10

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 by water *Steam Generation plant:* The other emissions are generated from steam generation plant and captive power plants.

5. Solid Waste

Table: 5.11

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 the process residues from the manufacture of chrome yellow and orange pigments, molybdate orange pigments, iron blue pigments, azo dyes etc.

5.7 Social Issues

- In Gujarat, many big dyes and chemical units were not having proper CETPs and discharged wastewater in the drainage or underground water. Due to this the underground water in the inner and outer regions of Gujarat was totally damaged and the coloured water starting coming in the bore well. This led to closure of some of the most polluting units by the High Court orders.

- Many acids like Sodium hydroxide/hypochlorite, Acetic acid; sulphuric acid is used workers face the problem of skin burns and scalds.
- Many different groups of chemical substances are used which leads to respiratory problems like bronchitis, cancer etc.
- Since the workers are working with different dye colours, it is usually found that their skin colour changes to the colour of dye.
- Women are also employed specially for packaging purposes
- The manpower is not trained on machine handling and other systems
- The working conditions and the infrastructure are not proper.
- As per the study conducted by the nonprofit Blacksmith Institute, Vapi is amongst the top ten of the 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.

5.8 Institutions/Associations

The major knowledge institutions and associations for dyes and chemicals are:

	Institutions	**Associations**
1	ITI Kubernagar	Gujarat Dyestuff Manufacturers' Association (GDMA),
2	Ahmedabad Textile's Industry Research Association (ATIRA)	Gujarat Industrial and Technical Consultancy Organisation Ltd (GITCO)
3	Bombay Textiles Research Association (BTRA)	Gujarat Chemical Association, GCA
4	University Institute of Chemical Technology (UICT)	Gujarat State Plastic Manufacturers' Association (GSPMA)
5	Department of Chemicals and Petrochemicals	Vatva Industries Association (VIA)
6	MSME – Di , Ahmedabad	The Green Environment Service Co op. Soc Ltd. - Vatva Green,
7	MSME – Di Maharashtra	Naroda Industries Association (NIA)
8	Gujarat Chambers of Commerce and Industry	Association of Chemical Technologist India (ACTI)
9	Gujarat State Small Industries Federation	Odhav Industries Association (OIA)
10		Chemical Association of India (CAI)
11		Ahmedabad Management Association
12		Federation of Industries and Associations

5.9 Cluster Initiatives

Major cluster programmes launched so far are:

Funding Agency	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 Dyes cluster	Ahmedabad	
Government of India	GITCO	Setting up of Common Facility Centre. It is estimated at about 10 % dyes and lost during the washing as spray dryers are used during mechanical filtration of water.	Vatva, Odhav, Baroda, Ankhaleshwa r	2009- 2010

5.10 Way Forward

5.10.1 The dyes sector is one of the most polluting sectors in terms of water pollution. There is a need to use modernised and appropriate technology for pollution handling and saving environment. CETPs should be installed for all the existing units in different cluster with appropriate waste water discharge systems. Proper manufacturing systems have to be introduced specially in the unorganised sector. Many social issues exist in the clusters which hamper the health and safety of the workers. Therefore workers should be provided training and education on better practises of machine handling and production systems. They should be made aware of the health and safety measures.

5.10.2 Special initiatives should be taken by the National and local associations. They should play a proactive role to ensure that clean, modernised and appropriate technology is used so that there is waste minimisation and the environment and human life is not affected. There is no dearth of funds and knowhow with the institutions and associations so there is a need to come forward and take responsibility to catalyse this process.

Chapter – B6

Electroplating Sector

6.1Economic Significance

6.1.1 In India, electroplating sector got firmly established in the 1930's when job shops were established in Mumbai and Delhi especially to cater to the automobile and two wheeler sector. Initially most chemicals required by the industry were imported. In the second half of 1950's indigenous manufacture of plating chemicals and accessories had begun and since 1960s the industry saw a phenomenal growth. Today the industry is worth over Rs. 500 Crores and is witnessing an average growth of around 15% per annum. The total employment generated by this sector is 50,000[1] directly.

6.1.2 It is difficult to find out the distribution of production between the organized and small scale/tiny/unorganised sector. However, judging by the consumption of chemicals and additives, it is estimated that about 18,000 tons are consumed by organized sector, while tiny and unorganised sector consumes about 10,000 tons. Therefore, approximately 36 % of the industry is contributed by the unorganised sector.*(Source- COINDS,2008- CPCB)*

6.2Geographical distribution of Electroplating Clusters

Table – 6.1

Electroplating Clusters in India

S.No.	**Place**	**State**
1	Govindgarh, Ludhiana	Punjab
2	Chandigarh	Punjab
3	Parwanoo	Himachal Pradesh
4	Chennai	Tamil Nadu
5	Madurai	Tamil Nadu
6	Coimbatore	Tamil Nadu
7	Bangalore	Karnataka
8	Faridabad, Sector-58	Haryana
9	Mumbai	Maharashtra
10	Nasik	Maharashtra
11	Pune	Maharashtra
12	Surat	Gujrat
13	Ahmedabad	Gujrat
14	Rajkot	Gujrat
15	Wazirpur, Delhi	Delhi
16	Anand parwat	Delhi
17	Okhla Industrial Estate	Delhi

18	Mayapuri	Delhi
19	Secunderabad	Andhra Pradesh
20	Noida, Gautam Budh Nagar	Uttar Pradesh

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

6.3 Electroplating process

6.3.1 In electroplating clusters, work is being done by semi automatic process which was done manually earlier. The main reason for technology up gradation is vendors demand and staying ahead of competitors but government policy and lack of capital are the two hindrances in technology up gradation. These clusters face the problem of increasing cost of raw material and inadequate power supply. The detail of two medium size clusters are:-

6.3.1.1 In Pune cluster, there are over 250 electroplating/ surface coating units with a gross turnover of Rs. 25-30 Crores per annum and providing employment to around 3500 skilled/unskilled workmen. These are located in industrial estates in Bhosari, Pimpri and Chinchwad.

6.3.1.2 In Faridabad cluster, there are 292 electroplating units with a gross turnover of around Rs.22.32 Crores per annum and providing employment to around 2100 skilled/unskilled workmen. This cluster is located in Sector 58 of Faridabad, Haryana. The detail given by metal finishers association of Faridabad is following provided below in Table: 6.2 :-

Table 6: 2

S. No.	**Plot Size (sqm)**	**No. of Plots**	**Employees per Firm**	**Total No. of Employees**	**Total Turnover (lakhs/month)**
1	115	157	6	942	30
2	225	95	7	665	36
3	450	40	12	480	120
Total		292		2087	186

***6.3.2 Definition of Electroplating** - Electroplating is a plating process that uses electrical current to reduce cations 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 the varieties of several techniques of Metal Finishing.* Electroplating products include precious metal processes, non precious metal processes, speciality plating and refining products. It is also used for decorative purposes.

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 volt) 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.

6.3.4 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 mechanized (automatic).

6.4 Environmental Issues at Cluster Level

6.4.1 Electroplating industry generates all kinds of pollution like Air, water and solid waste. The environmental pollution is caused by several ways –

- 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 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 the wastewater, either via 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, and nickel, and in cyanides, fluorides, and oil and grease.

- Solid and Hazardous Wastes -- Solid wastes include, sludges generated from wastewater treatment, sludges from 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 waste. Much of the solid waste contain hazardous and toxic substances.

6.4.3 The exhaust fans, which are installed in the electroplating units, have a capacity of 500cfm to 1000cfm. Therefore 3 lakh cfm is generated by each unit even if we take 500cfm as exhaust and 10hrs per day of operation. Assuming 250 units per cluster the total volume of contaminated air due to 20 clusters is **1530 crore metre cube per year.**

6.4.4 Each unit releases minimum 200 litres(based on an estimate by one unit owner in Faridabad) of waste water per day. 50 Kilo litres per day of waste water (Common ETP capacity is 100 KL per day in Faridabad) is being discharged in every cluster on an average. We are assuming 250 units per cluster. For all the 20 clusters mentioned above, total discharge of the country is minimum **3.6 lakh kilo litres per year.** Industry consumes about 36000 litre of chemicals out of which approx. 50% to 70% comes in our waste water discharged.

6.4.5 Each cluster is generating at least 50 kg of solid waste(Assuming 1 kg sludge from 2000 litre and 100 gram per day from factory) every day.Therefore total waste generated by every cluster is 18.25 tons per year. All the clusters together contribute 365 tons in a year.

6.4.6 The state of Common ETP is generally non functional as per industry opinion There is a lot of scope of minimising the waste and reusing the recovered metal. Since the waste is highly toxic, it is the urgent need of the industry.

6.5 Measures of Pollution Prevention and Control

6.5.1 Plating involves different combinations of a wide variety of processes, and there are many opportunities to improve on traditional practices in the industry. The recommendations for pollution prevention and control measures as suggested by CPCB are:-

- A key parameter is the water use in each process. Systems should be designed to reduce water use. Where electroplating is routinely performed on objects with known surface area in a production unit, water consumption of no more than 1.3 litres per square meter plated (l/m2) for rack plating and 10 l/m2 for drum plating should be achieved.
- Cadmium plating should be avoided.
- At least 90% of the solvent emissions to air must be recovered by the use of an air pollution control system such as a carbon filter.
- Ozone-depleting solvents such as chlorofluorocarbons and trichloroethane are not to be used in the process.
- Segregation of waste streams is essential as it is easier to treat.
- Cyanide destruction, flow equalization and neutralization, and metals removal are required, as a minimum, for electroplating plants.
- If hexavalent chrome (Cr+6) occurs in the wastewater, it should be reduced to chromium of trivalent form using a reducing agent, such as a sulphide.

6.5.2 Electroplating plants should use closed systems of water treatment where feasible to attain the effluent levels.

Table: 6.3

Effluents from the Electroplating Industry as per standards of CPCB (milligrams per litre, except for pH)

S. No.	Parameter	Maximum value
1	pH	6.0 to 9.0
2	Temperature	Shall not exceed 5^{o}C above the ambient temperature of the receiving body
3	Oil & Grease	10
4	Suspended Solids	100
5	Cyanides (as CN)	
6	Ammoniacal Nitrogen	50
7	Total Residual Chlorine (as Cl)	1.0
8	Cadmium (as Cd)	2.0
9	Nickel (as Ni)	3.0
10	Zinc (as Zn)	5.0
11	Hexavalent Chromium (as Cr)	0.1
12	Total Chromium (as Cr)	2.0
13	Copper (as Cu)	3.0
14	Lead	0.1
15	Iron	3.0
16	**Total Metal**	10

Source: EPA Notification {S.O. No.393(E) dated 16th 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.

6.6 Current practices of Effluent treatment

6.6.1 Waste Water Treatment : The main treatment processes are equalization, pH adjustment for precipitation, flocculation, and sedimentation/ filtration . The optimum pH for metal precipitation is usually in the range 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.

6.6.2 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. A 90% recovery of the quantity of VOCs released from the process is required.

6.7 Social Issues at Clusters

6.7.1 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.

6.8 Institutional Linkages

6.8.1 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 established during the period 1979-1994 and have a current annual turnover in the range of Rs.12 – 40 Lakhs, 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 works for a wide range of components. (Source: Waste minimisation Circle news-National Productivity Council, Vol 3, No.2, June, 2002)

6.9 *Electroplating Industrial Park Karaisalkulam, Madurai*

6.9.1 The 80 electroplating industries came together to form an Association with the name of '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 a management and a technological treatment of the hazardous effluents, targeting to avoid metal sludges. The objective is to set up an Eco-Electroplating Park using environmentally clean technology with zero liquid discharges and to introduce enterprises with tools and techniques of cleaner production. The Park is being developed in 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 green belt. The total capital investment for the park is estimated to be Rs. 340 million. The entire cost is being borne by CPCB and state government.

6.9.2 The partners of this project are:-

- German Technical Cooperation Agency (GTZ) under the 'Advisory Services for Environmental Management'(ASEM) – provides the Technical guidance
- IL&FS Ecosmart Ltd., is assisting the SPV in raising the financial support for the project.
- European Union is providing the technology demonstration grants for Waste Water Treatment Plant.
- Central Pollution Control Board (CPCB) is providing 50% of the grant for the Common Effluent Treatment Plant (CETP).
- The State Government is providing 50% of the grant for the Common Effluent Treatment Plant (CETP).
- Electroplating and Metal Finishers Association of Tamil Nadu (EPMFAT).

6.9.3 Metal finishers association of India MFAI is the apex body of industry association for the metal plating industry in India.It is based in Mumbai and it's contact no. Is 022-28769655,91 There are local metal finishers association at the cluster level under the umbrella of MFAI. The programmes of association are partly successful but not very effective. The common ETP's were installed at some clusters like Ludhiana, Faridabad but are not being maintained. Firms in these clusters complains that they are not functional and are bypassed.

6.9.4 **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. The contact address of scientists are:-

a. Electroplating Metal Finishing Tech. Dr. (Mrs).Sobha Jayakrishnan, Scientist-F-email::sobha.jayakrishnan@gmail.com Ph. 04565-228617. Dr.S John Head Industrial metal finishing email johnskkd@yahoo.com Ph 04565 228618

b. **Central pollution control board CPCB: Mr. U N Singh (contact no. Is 011-43102456)** is the Sr. Environ mental Engineer in CPCB Delhi.

6.9.7 The current technoloy providers to the industry are the equipment suppliers. The best plants are supplied by MNC companies through there branch offices/local agents in India. Some of the equipment suppliers are 1) Romuk Industries, Growel, Artek, Autotech, CMF, CMP etc. The small units are mostly run semi automatically. These systems are developed by local technicians as per requirement by the industry.

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4) UNEP (United Nations Environment Programme). 1992. *Environmental Aspects of the Metal Finishing Industry: A Technical Guide*. Paris.

5) World Bank. 1996. "Pollution Prevention and Abatement: Electroplating Industry." Draft Technical Background Document. Environment Department, Washington, D.C.

6) Comprehensive Industry Document, CPCB, 2008.

7) CECRI karaikudy Tamil Nadu.

8) Metal finisher's association of Faridabad.

Chapter – 7B
Brick Industry in India

7.1 Introduction

7.1.1 In India, brick making is a traditional, unorganized industry, generally confined to rural and semi-urban areas. It is one of the largest employment-generating industries, employing around **1Crore workers** (source- All India Brick manufacturer's Association), 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 increase the production cost of bricks. The rich, clayey soil on the banks of rivers is raw material for a whopping 140 billion bricks a year[48]. Produced in over **100 000 brick kilns** in India, these are part of a large but unorganized, brick sector in the country. This industry is the **3rd largest consuming industry of coal** in India after steel and power industry.

7.1.2 These brick making units often exist in clusters spread across the country. The highest number of Brick making units is in UP (33% of national production) followed by Bihar, Bengal, Tamil Nadu, Punjab and Gujarat. Some of the brick making clusters in India are provided in the Table 7.1.

[48] TERI, VSBK Technology, Brick by Brick, FAO study

Table 7.1: Brick making clusters in India

S.No.	Cluster Name	State	S.No	Cluster Name	State
1.	Indore	Madhya Pradesh	2.	Rohtak	Haryana
3.	Sangam Nagar	Madhya Pradesh	4.	Jhajhar	Haryana
5.	Gwalior	Madhya Pradesh	6.	Hissar	Haryana
7.	Bhind	Madhya Pradesh	8.	Amritsar	Punjab
9.	Sehore	Madhya Pradesh	10.	Gurdaspur	Punjab
11.	Datia	Madhya Pradesh	12.	Ludhiana	Punjab
13.	Tirunelveli	Tamil Nadu	14.	Jallandhar	Punjab
15.	Kolar and Malur	Karnataka	16.	Jammu	Jammu and Kashmir
17.	Aligarh	UP	18.	Ahmedabad	Gujrat
19.	Kanpur	UP	20.	Pune	Maharashtra
21.	Varanasi	UP	22.	Agartala	Tripura
23.	Bareili	UP	24.	Gauhati	Assam
25.	Gorakhpur	UP	26.	24-Parganas	West Bengal
27.	Jaunpur	UP	28.	Asansol	West Bengal
29.	Moradabad	UP	30.	Raipur	Chattisgarh
31.	Ghaziabad	UP	32.	Janjgir	Chattisgarh
33.	Meerut	UP	34.	Raigarh	Chattisgarh
35.	Muzaffarnagar	UP	36.	Kota	Rajasthan
37.	Bhiwani	Haryana	38.	Rayagada	Orissa
39.	Faridabad	Haryana	40.	Puri	Orissa

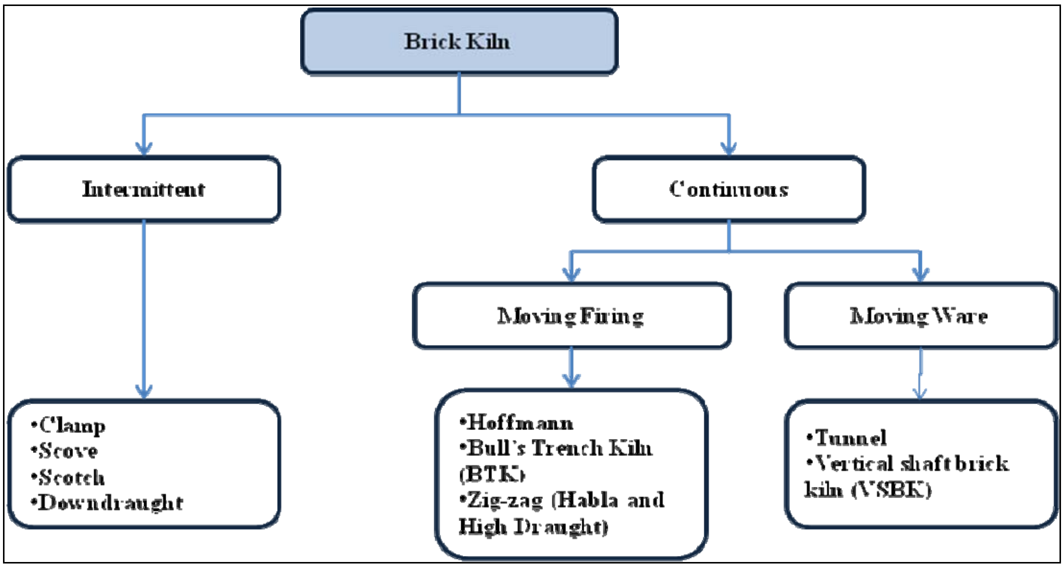
7.2 Energy Intensity of the Brick Sector

7.2.1 Brick manufacturing is highly energy intensive sector and the share of energy in total cost of brick production amounts to 35 to 50 per cent[49]. The coal consumption of the sector is approximately 8 per cent of the total coal consumption in the country. To understand the energy intensity of the sector, let us first understand the brick manufacturing process. The manufacturing process of brick involves transformation of clay from the 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.

[49] The Brick Industry, Central Pollution Control Board.

Brick kilns in general are classified as intermittent kilns and continuous kilns. The production capacity of intermittent kiln is low in comparison to continuous kilns, generally ranges from 5,000 to 5,00,000 bricks per firing. The energy efficiency and quality of brick is also low in intermittent kilns in comparison to the continuous kilns.

Fig 7.1: Different types of kilns



7.2.2 **Coal is the main source of energy used for firing bricks in India.** The next choice of fuel is biomass, including fuelwood. In one of the studies undertaken by the FAO (Year 2000) the use of fuel wood in the entire brick industry in the country is reported to be only 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 tiny fraction (much less than two percent in terms of energy inputs) of the total energy requirement of the brick industry in all of India. The energy consumption of the different kilns is provided in the Table 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	11-16
Fixed Chimney BTK	1.1- 1.5	17.5-24
Moveable Chimney BTK	1.2-1.75	19-28
Tunnel kiln	1.4- 1.6	22-25
Modern tunnel kiln	1.1-2.5	17.5-40
Intermittent kiln		
Clamp and other batch kiln	2.0- 4.5	32-71

Source: Sameer Maithel and Urs Heierli, 2008.

7.2.3 As inferred from the table, 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 the BTKs to VSBKs. To calculate the total amount of coal that can be saved 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 the Table 7.3.

Table 7.3: Brick Kiln in India

Type of Kiln	Annual Production capacity (100,000 bricks/ year)		Approximate number of kilns	Total Annual production capacity (100,000 bricks/year) [50]	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	50	8000	400,000	Coal
Fixed Chimney	30-100	65	25000	16,25,000	Coal
VSBK	5-40	22	30	6600	Coal
High Draft Kiln (HDK)	30-50	40	20	800	Coal
Total				23,32,400	

Source: Development Alternatives

7.2.4 As can be observed from the above table, the estimated annual production capacity of the brick sector is around 233 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.

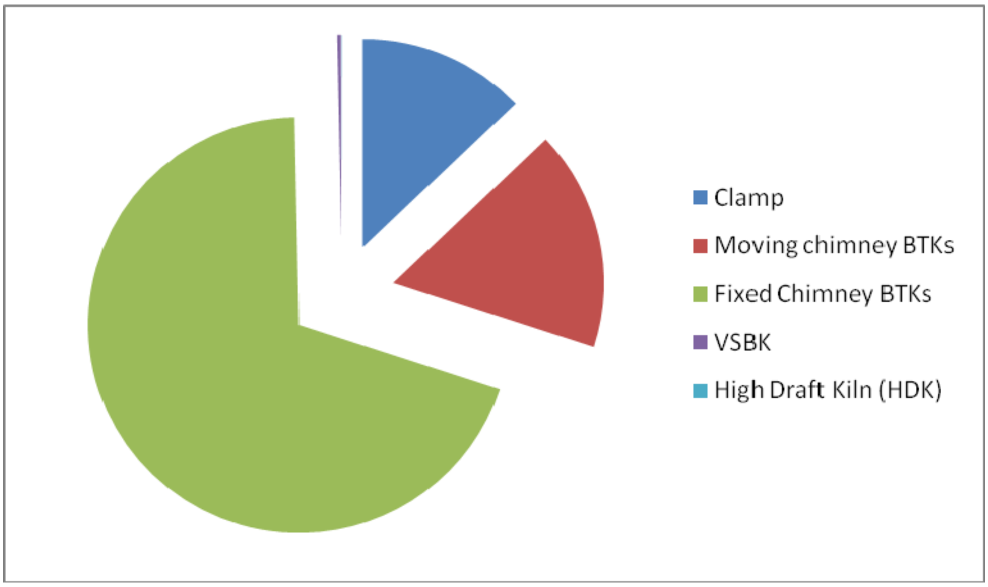
Table 7.4: Production of Bricks

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)

[50] Estimate based on annual production capacity and approximate number of kilns.

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)

Figure 7.2: Production of Bricks from different type of kilns



As can be inferred from the above table and figure, till date the maximum numbers of bricks are manufactured through BTKs both moving and fixed. Therefore the coal consumption for brick making employing these two types of kilns are-

7.2.4i *Annual coal consumption for moving chimney BTKs:* To produce 100,000 bricks total coal requirement is 28 tonnes. Therefore to produce around 24 billion bricks moving chimney BTKs, the total coal consumption is 6.7 million tonnes. Now if the kiln is upgraded to VSBK, total coal consumption to produce 24 billion bricks will be 3.84 million tonnes. Therefore, around 2.9 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.

7.2.4ii *Annual coal consumption for fixed chimney BTKs*: To produce 100,000 bricks total coal requirement is 24 tonnes. Therefore to produce 97.5 billion bricks using fixed chimney BTKs, the total coal consumption is 23.4 million tonnes. Now if the kiln is upgraded to VSBK, total coal consumption to produce 97.5 billion bricks will be 15.6 million tonnes. Therefore, around 7.8 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.

7.2.5 Therefore by upgrading the existing BTKs, both fixed and moving chimney, to VSBKs in India, the total annual coal saving will amount to 107 Lakh tonnes per annum.

7.2.6 The Clamp type kilns, which has 5% share in the total installed capacity of India contributes to 12.86% 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 huge amount of biomass/coal which is being used in clamp type kilns. Since these units are spread in remote areas, exact details are not available on the quantity of coal, cow dung or biomass to produce bricks.

7.3 Environmental Issues in Brick sector

7.3.1 In the 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 effluent and emission. In case of the brick industry the standard is set for emission. The emission standard is given in the Table 7.5.

Table 7.5: Brick kilns: Emission Standards

Size	**Kiln Capacity**	**Maximum limit for the concentration of particulate matter. (mg/Nm3)**
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

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.

7.3.2 Notifications to use Fly ash and stop production by moving BTK Kiln

Existing moving chimney Bull's trench kilns shall be dispensed with by December 31, 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 the safe disposal/utilisation of fly ash, it is provided that from the 1st 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), April 2, 1996]

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

(ii) Existing moving chimney bull's trench kilns shall be dispensed with by June 30, 2000 and no new moving kilns shall be allowed to come up.

Source: EPA Notification [GSR 682(E), October 5, 1999].

7.3.4 The Environmental issues associated with brick manufacturing primarily includes the following:

7.3.4i 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 four Kg of harmful and toxic gases. Therefore the total emission will be around 12.4 crore tons of such gases.** These gases primarily include sulphur dioxide, carbon monoxide, carbon dioxide, oxides of nitrogen and Suspended Particulate Matter (SPM)[51]. **The CO_2 emitted is 5.91 crore tons.**

- 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.

[51] Times of India, February 1, 2009.

- 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.

7.3.4ii Top Soil Erosion: Another environmental issue pertaining to the brick making sector is depletion of good quality agriculture soil leading to reduction in productivity of land. The indiscriminate usage of top soil in brick making remains a serious issue. **Approximately, 22,00,000 crore cubic meter of clay/ silt is utilised every year for brick making**. Taking 2 metre average depth of sand use, this accounts for **1.1 lakh hectares every year.**

7.4 Social Issues in Brick Sector

7.4.1 The brick manufacturing sector mainly comprise 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.

7.4.2 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[52].

7.5 Perspective of Industry

7.5.1 The industry is represented by **All India brick manufacturer's federation** based at IHC,Lodhi Road, New Delhi. However majority of firm owners are not members but they are associated with the federation and are aware of its programmes. 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 has not yielded desired results. Hence Industry has lost faith in new technology initiative of VSBK(As per 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.

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[52] Development Alternatives, Newsletter, September 2006.

7.6 Institutional Linkages

- Central Brick Research Institute, Roorki is a leading institute which is working on the research work in the field of brick making.
- PSDST has developed efficient kiln design and dissemination work in Punjab.
- TERI and Development Alternative have also done projects in the field of technology demonstration and up gradation in Brick Industry.
- Development alternative (NGO) is actively working with brick industry.
- Some NGO's have come forward to intervene to handle social issues in few areas which have improved few hundred labourer's which is a tiny fraction of about a crore labourers. Some examples are listed below :-

(i) IFA (Indian friends Association) and Manavi (Both are NGO's) 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 to 300 workers. The main vehicle for intervention is the non-formal education classes for children that run over 9 months. **Ten teachers**, four female and six male were teaching a total of about **200 children**.

(ii) 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 Vithalvadi brick kiln area, Maharashtra. In a span of 10 years, they were through with their high school and were pursuing higher studies. The corporates like L&T, Infotech, the Tech Mahindra Foundation and the Volkart Foundation supported financially during this project.

Chapter -B8

The Ceramic Sector

8.1 Economic Significance

8.1.1The Ceramic industry is one of the age-old industries 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 sector with wide variation 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 tile, Floor tile, Vitrified tile and Porcelain tile segments.

Four different types of products are identified

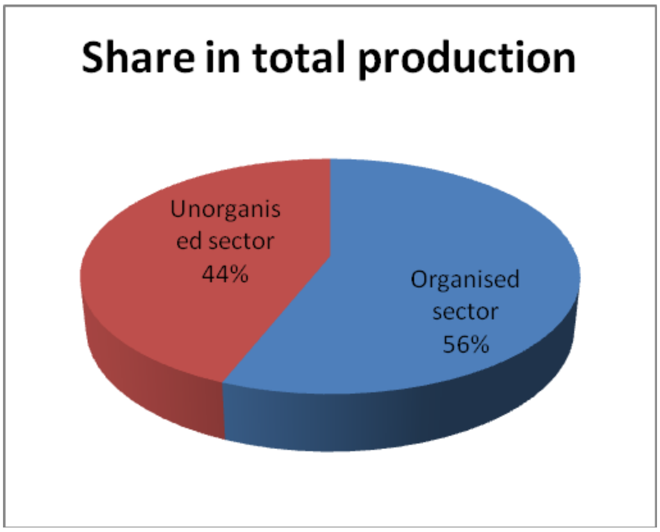
- Unglazed ceramic tiles
- Glazed ceramic tiles
- Ceramic Household articles
- Ornamental ceramic products

8.1.2 India ranks 5th in the world in terms of production of ceramic tiles and is growing at a healthy 15% per annum[53] .It produced 34 crores sq. meters of ceramic tiles, out of a global

[53] Indian Council of Ceramic Tiles and Sanitary ware(ICCTAS)

production of 690 crores sq. meters during 2003-04 and increased to 34 crores sq. meters in 2006-07[54].

Figure: 8.1



8.1.3 Ceramic tiles are produced both in organized and unorganized sector. The current size of the organized sector is about Rs 3000 crores with approximately 16 players having and installed capacity of 12 lakhs MT[55]. The current size of unorganised sector is Rs 3500 crores which constitute 44% of the total industry and accounts for about 2.5% of world ceramic tile production.

Figure: 8.2a

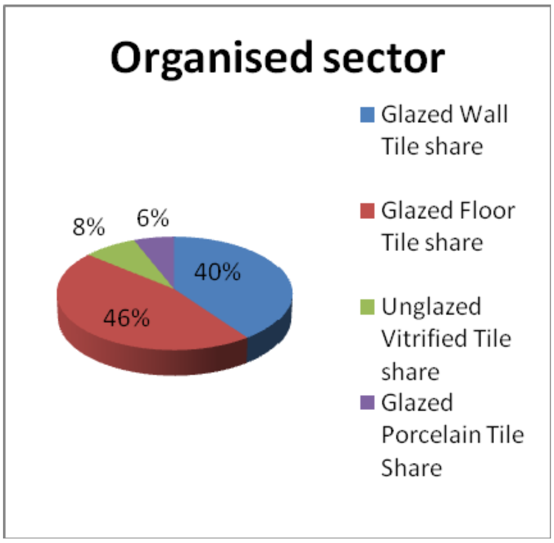
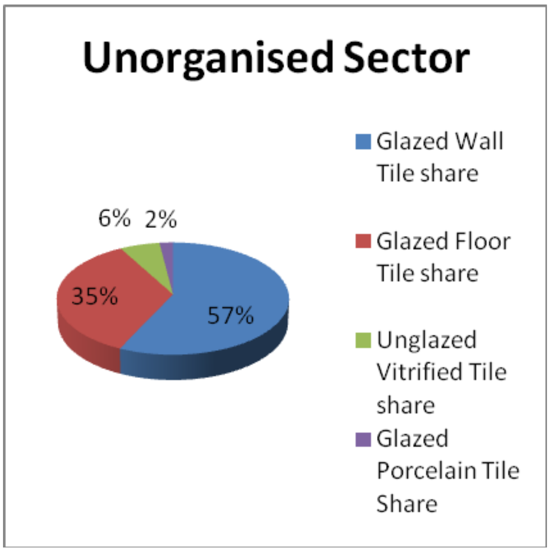


Figure: 8.2b



Source: Indian Council of Ceramic Tiles and Sanitary wares

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[54] ICCTAS

[55] IREDA Report Investors Manual on Energy and efficiency

8.1.4 The above figure shows the share of 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 unorganised sector it is from glazed wall tiles. The minimum turnover is by glazed porcelain in both the sectors.

8.1.5 A total of 5,50,000 people are estimated to be employed in this sector. Out of this, 50,000 people are directly employed and 5,00,000 are indirectly associated. The demand for ceramics is dependent on the growth of housing, retail, IT & BPO sectors sector. In India, per capita consumption of ceramic tile is 0.30 sq. mtr. per annum 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. These are being exported to East and West Asian Countries.

8.1.6 Sanitary ware is manufactured both in the large and small sector. At present there are 7 units with installed capacity of 86,500 tonnes per annum and, there are more than 500[56] plants with a capacity of 50,000[57] tonnes per annum in small scale sector. The industry has a turnover of Rs. 400-500 crore. 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 sector. There are 16 units in the organized sector with a total installed capacity of 43,000 tonnes per annum. Majority of the production of ceramics tableware is of bone china and stoneware. This industry in India is highly labour intensive while in USA, UK, Japan and other countries there is full automation. Quality of finished products, design and shapes in India are still below international standards.

8.2 Geographical concentration of Ceramics Clusters

8.2.1 Most of the small scale ceramic units are located in clusters. These clusters are spread across the country in states like 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% of India’s ceramics production and the Morbi / Thangadh centers alone are responsible for the manufacture of nearly 60% of the country’s ceramic wall and floor tile and sanitary ware. The table below provides the list of significant ceramic clusters in India.

[56] As can be seen from the table below

[57] http://dipp.nic.in/industry/content_industries/CERAMIC%20INDUSTRY.htm#ceramic

Table 8.1
List of significant clusters

State	District	Location	Units	Product Specification	Type of fuel used	Type of kiln
Gujarat	Sabarkantha	Himatnagar	25	Wall tiles	Gas	Tunnel kiln
Gujarat	Ahmedabad	Ahmedabad	32	Cup , soccer, fine porcelain, Sanitary ware, firebricks, insulators	Gas	Tunnel kiln
		Kadi	6	sanitary ware and tiles		
		Kadi Chatral	6	sanitary ware and tiles		
Gujarat	Surendranagar	Thangarh	200	Sanitary-ware, electric porcelain, pottery, refractory	LDO, Gas	Tunnel kiln
Gujarat	Rajkot	Morbi	300	floor tiles, wall tiles , vitrified tiles, porcelain, bone china, refractory, sanitary ware	gas	Roller kiln
			30	roofing tiles		
Gujarat	Surendranagar	Surendranagar	25	Electrical Porcelain, high tension insulators, filter candle	LDO	Tunnel Kiln
Gujarat	Rajkot	Wankaner	20	refractory	LDO	Tunnel Kiln
Andhra Pradesh	Guntur	Piduguralla	275	Calcined lime	Coal	Uptraught kiln
Andhra Pradesh		West Godavari	45	Fire clay Refractories, sanitary ware	Coal	Downdraught kiln
Andhra Pradesh		Vizianagaram	35	Ordinary roofing tiles		Downdraught kiln
Andhra Pradesh	East Godavari	Rajmandry	80	Graphite Crucibles	Firewood	Updraught kilin
Andhra Pradesh	Prasham	Chimakurthy	65	Granite slabs and tiles		
Andhra Pradesh	East Godavari	Jaggampeta	70	-	Firewood	Chamber kiln and Downdraught 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			**1369****			

* *data not available*

***as per discussion with the expert*

8.3 Energy Intensity in Indian Ceramics Sector

8.3.1 The Ceramics sector is highly energy intensive accounting for about Rs 235 crore[58] worth of energy consumed per year and amounts to 35% of the manufacturing cost[59]. 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 motor and fan of the machine and as thermal energy when used to heat the kilns and furnaces. Fuel is converted into thermal energy through combustion reaction. The main fuel used by ceramic industry is LPG and natural gas. The other types of fuel 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 ceramic 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, which includes usage of kilns and dryers. Around 80-90 percent of the total energy is used by kilns and dryers. In case of tile manufacturing the temperature required for firing ranges between 1080

[58] IREDA and CII Report ,2002 Pg 170

[59] Discussion with the expert

to 1100°C. In case of sanitary ware the temperature maintained 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 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 usually shuttle kilns were used. But now with the 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 product is produced fast and the quality of the product produced is better than those produced in intermittent kilns. Since gas is used less pollution is generated as compared to shuttle kilns where oil is used which caused pollution.

8.3.5 In terms of energy consumption, the table below shows the amount of energy required to make different kinds of 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 production in tunnel and roller kilns is high as compared to periodic kilns. Maximum production and usage is of fire bricks. High alumina and basic refractories consume more energy. In small units mostly fire bricks are 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 energy is required. This shows roller kilns are better as compared to periodic or tunnel kilns.

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 discussion with the expert, approximately 20% less energy is consumed in roller kilns as compared to tunnel kilns.*

Source: IREDA – Investor manual for energy efficiency (2002), Pg 171

The energy consumption depends on various factors as listed below.

- Types of kilns and dryers
- Capacity utilisation of kilns and driers
- Combustion control systems
- Type of heat recovery system
- Type of insulation used at kilns and driers
- Types of presses
- Types of spray driers

8.3.6 The energy efficiency measures in any industrial sector starts from the 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 the operation standards in the production line, more effective management, improvement of employees cost consciousness and operation techniques.
Step 2- Equipment improvement: Improve the energy efficiency of the equipment by minor modification of the existing production line.
Step 3- Process improvement: This is intended to reduce energy consumption by substantial modification of the production process itself by technological development. E.g. conversion from tunnel kiln to roller hearth kiln (better technology).

8.37 As Gujarat account 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 used in the production process in Gujarat (as shown in the table above) in mainly tunnel kiln, apart from Morbi and the fuel is used is mainly natural gas. Therefore, the energy consumption is much less compared to other ceramic clusters. The Khurja ceramic cluster is also well known for its ceramic products and there are around 100 small units. The production process involves use of downdraft, shuttle and few tunnel type kilns. Thus there exists a scope of upgrading the downdraft and shuttle type kiln to tunnel type kiln for efficient energy utilization.

8.4 Environmental Issues in Indian Ceramic Sector

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

Table: 8.3
Ceramics – Emission Standards

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

Source: Central Pollution Control Board

*All possible preventive measures should be taken to control pollution as far as practicable

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	
Air Emission	
(i)	*Particulate Matter:* These are generated during the handling of raw materials like screening, mixing, weighing, and transporting / conveying; dry grinding / milling; drying (spray drying); glaze-spraying processes; decorating and firing; and fired ware finishing operations.
(ii)	*Sulphur oxides:* emission in ceramic kiln exhaust gases depends on the sulphur content of the fuel and certain raw materials (e.g. gypsum, pyrite, and other sulphur compounds). The presence of carbonates in raw material prevents the formation of sulphur emissions because of their reaction with SO_2.
(iii)	*Nitrogen oxides:* are generated by high firing temperature in the kiln, nitrogen content in raw materials and oxidation of nitrogen content in fuel used in the process.
(iv)	*Greenhouse Gases*: are emitted when the energy is used in the kiln and during the spraying process for drying.
(v)	*Chlorides and fluorides:* are generated from impurities in clay materials. During the preparation of raw materials the use of additives and water containing chloride generates hydrochloric acid (HCl) emissions. Decomposition of clay flurosilicates generates hydrofluoric acid.
Waste Water	
	Industrial process waste water: It is generated from cleaning water in preparation & 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 (April 30, 2007) and CPCB, New Delhi

8.5 Social Issues

1.5.1 The social issues pertaining to 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:

- 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, and clarification, pressing and granulation processes, cutting, grinding and polishing, fan burners in kilns, and packaging activities generates lot of noise which effects the hearing capacity of the workers.
- The starting and shut down of equipment requires a lot of physical work related to the operation and maintenance of equipment like mills, mill separators, and belt conveyors. 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

The table below shows the list of institutes and associations associated with the ceramics industry

Table: 8.5

SNO	Institutes	Associations
1	Central Glass and Ceramics Research Institute (CGCRI)	Gujarat Ceramics floor tiles Manufacturers Association
2	Indian Council of Ceramic Tiles and Sanitary ware (ICCTAS)	Federation of Ceramics Industry
3	MSME DI – Ahmedabad	Morbi -Dhruva Glaze tiles manufacturers association
4	L.E. Engineering College , Morbi	Terra tiles Consortium (P) Ltd., Trissur
5	Ceramic Centre for Rural Development (CCRD), Bankura District of West Bengal.	Murlu Potters Association
6		Sanitary ware manufacturers Association, Morbi
7		Naroda Industry Association

8.7 Cluster Intervention

The table below shows the intervention done in the sponge iron clusters by some agency, organisations etc.

Table : 8.6

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Implementing Agency	Funding Agency	Type of Intervention	Clusters	Program/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 upgradation 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, and strengthening of institutional structures and policy frameworks; and 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 Program	2002-05

8.8 Way Forward

8.8.1 The ceramic sector is a high energy consuming sector. So initiatives should be taken to modernise the manufacturing process through employment of energy efficient equipments and machines including the latest tunnel & roller kilns. In the sanitary ware industry, roller hearth kilns should be installed, especially if a reduced number of patterns are produced. Heavy fuel oil and solid fuels should be substituted with clean fuels (e.g. natural gas or LPG); To reduce heat loss thermal insulation of kilns has to be improved.

Large amount of ceramics waste is generated is this sector so sanitary ware solid waste grinding unit should be set up in different locations. Solid waste can be reduced by recycling and internal reuse of cuttings, broken ware, used plaster moulds, and other byproducts. Sludge should be reused from fine ceramic and sanitary ware manufacturing as a raw material or additive in the manufacture of bricks or expanded clay aggregates.

8.8.2 To avoid respiratory problems local exhaust ventilation systems with filter units (e.g. fettling hoods) should be installed. Workers should be provided gloves, shoes, air/oxygen supplied respirators especially during maintenance operations. Workers are less trained about the better practises so technical training programs should be conducted to upgrade their knowledge.

Chapter – B9
The Glass and Glassware

9.1 Introduction

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 glass was 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 through 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 the 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. There are various glass items produced in India, like glass bottles, containers of various kinds, sheet, figured and wired glass, safety glass and mirrors, syringes, vacuum flasks, etc, which can be categorised into 4 groups- (i) sheet & float glass, (ii) fibre glass, (iii) Bottles & glass ware (iv) laboratory glassware.

Figure 9.1(a)

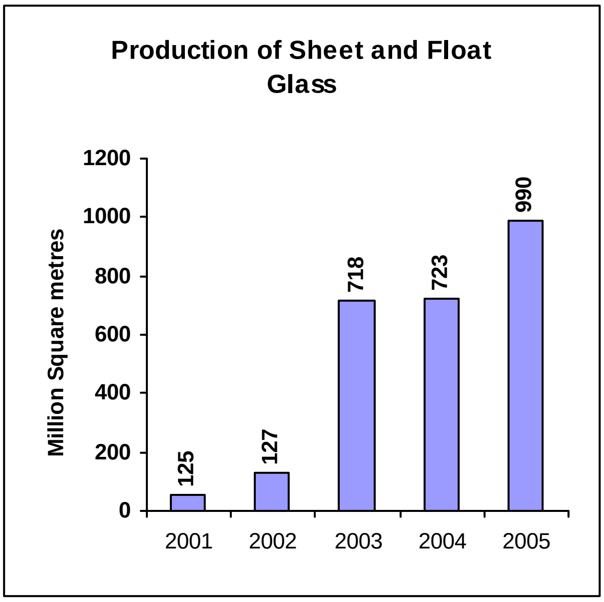


Figure 9.1(b)

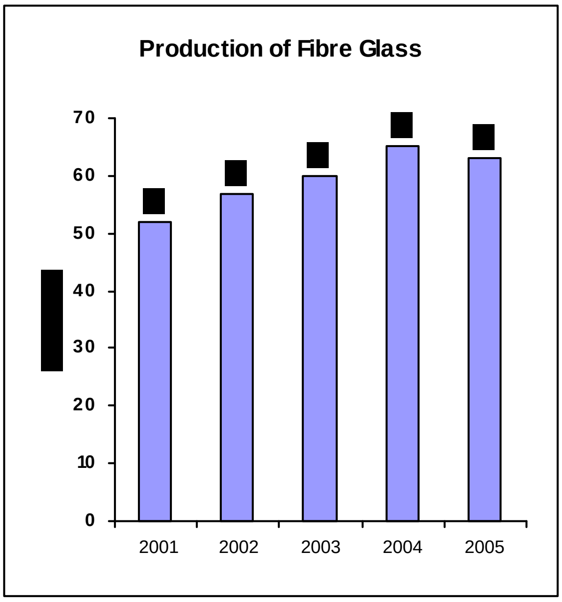


Figure 9.1(c)

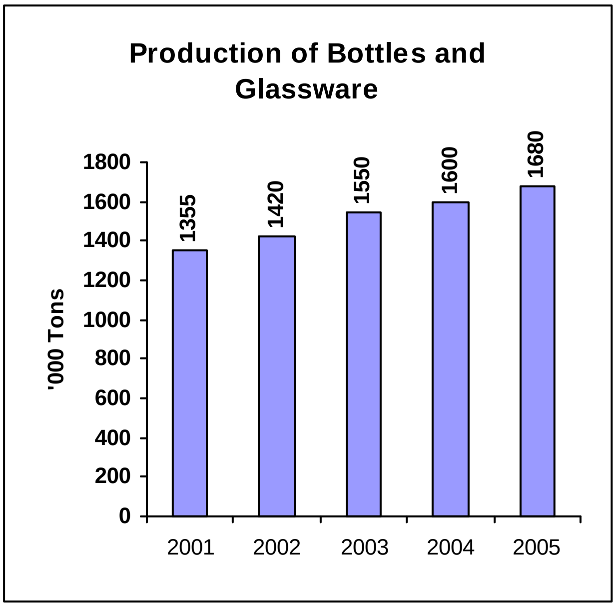
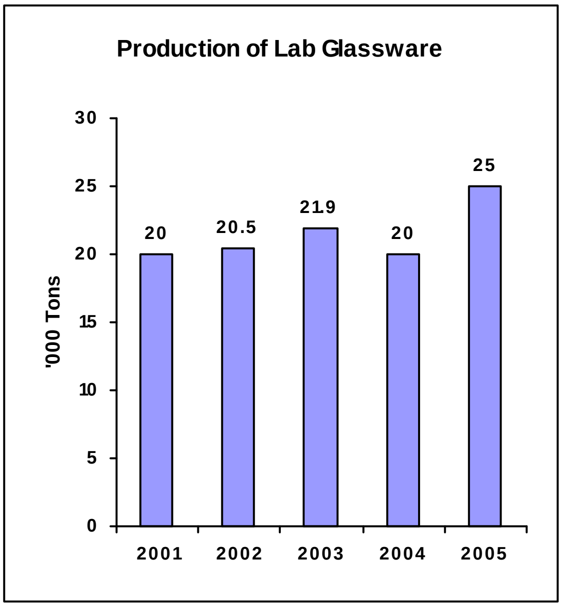


Figure 9.1(d)



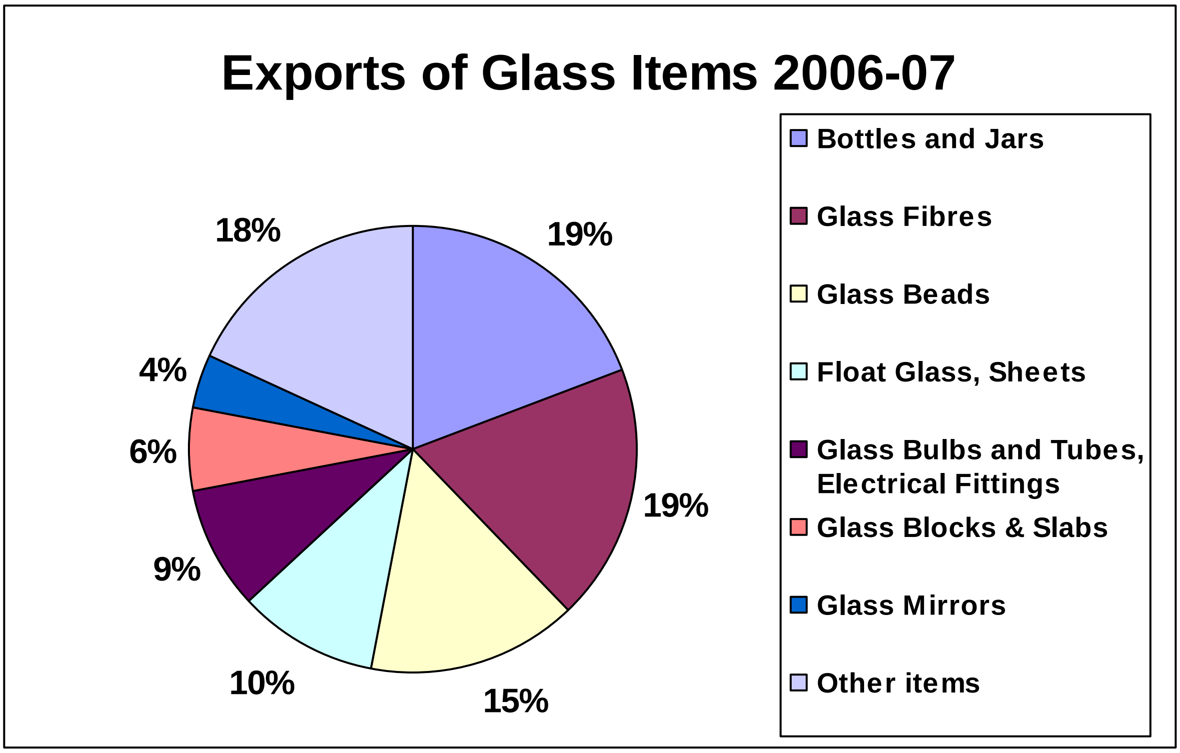
Source- ibef.org

9.1.4 Therefore total production is 138.5 lakh tons of glass out of which sheet glass is 120.78 lakh tons. (Assuming all sheet glass to be 5mm on an average, Density (at 20 °C): 2.44 g/cm^3
Source-http://www.valleydesign.com/sodalime.htm

Table: 9.1 The export of the glass and glassware sector in the past five years is provided in the table below:

Year	Exports (Rs Lakhs)	Percentage Share
2004-05	98,054.62	0.26
2005-06	1,04,367.95	0.23
2006-07	1,39,189.29	0.24
2007-08	1,51,996.31	0.23
2008-09 (April-Dec)	1,47,457.11	0.25

Figure- 9.2: The contribution of various product segments of glass industry in 2006-07



Source- ibef.org

9.1.5 The glass industries are fairly uniformly distributed throughout the country. It has been estimated that there are around 40 glass industries manufacturing different types of products in the western region that are mainly located in the industrial areas, around 20 glass industries in the eastern region (few of them closed down due to labour unrest), about 15 in the southern region comprising Karnataka, Andhra Pradesh, Kerala and Tamil Nadu and about 20 glass industries in the Northern region spread over UP, Haryana and Delhi[60]. However, these units are not clustered in a particular location.

[60] Glass Sector Study, CPCB.

9.1.6 The largest conglomerate of small scale glass manufacturing units is located 40 km from Agra (UP) in Firozabad. We have 3 clusters of glass beads which are located in Purdil nagar,Hathras(UP), Banaras(UP) and Nath dwara (Rajasthan).

9.1.7 The Firozabad cluster accounts for almost the entire glass bangle production and 70 per cent of glass tumbler production of the country. There are around 150 units for glass melting using tank and pot furnace and around 400 muffle furnace units, locally termed as pakai bhattis, for baking bangles. However, there are several unregistered units present in the cluster, which amounts to around 1000 units. The cluster provides livelihood to around **5 lakh people.**

9.1.8 The 3 Glass bead cluster of India together has a turnover of 450 crores and exporting around 150 crores worth of beads. Total employment of these 3 clusters is around 4 lakh people. They use pot furnace and tank furnace for making beads. There are some clusters of value added products of beads in India which depend on these bead making clusters only.

9.1.9 Glass is the most eco-friendly packaging media. 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 cluster was coal, which changed due to landmark judgement by 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 provided in the following section.

9.2 Manufacturing process of Indian Glass Sector

9.2.1 The manufacturing process of glass can be bifurcated into four main phases, which is more or less similar irrespective of the typology of product manufactured.

9.2.1i Phase 1- Preparation of raw material: The common raw material used for the manufacture of glass are glass sand, recycle glass (cullets), feldspar and flux material like soda ash, dolomite etc, which crushed to 20-120 mesh and mixed with other additives to form a batch.

9.2.1ii Phase 2- Melting in a furnace: The batch is introduced into the furnace for melting at about 1500^{o}C.

9.2.1iii 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.

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

9.3 Energy Intensity of Indian Glass Industry

9.3.1 Glass manufacturing is a highly energy-intensive activity. It has been estimated that 40[61] per cent of the manufacturing cost is attributable to the energy cost. It has been estimated that in general the energy required to melt one tonne of glass is approximately 22 Lakh Btu, but in practice twice as much of energy (44 lakh Btu) is required due to variety of losses and inefficiencies in furnace design. **Therefore total coal burnt is 77 lakh tons** (Assuming specific energy 8360 KJ per Kg for Indian coal)

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

(i) Regenerative furnace/ tank furnace: These are large furnaces and the glass from this furnace are used for making a wide range of items, like jars, tumblers, lamp shades, laboratory ware etc. The fuels used in tank furnace are coal, gas and oil.
(ii) Recuperative furnace/ Pot furnaces: These are relatively small furnaces that are used to make small quantities of different colours of glass. There are two kinds of pot furnace- open pot and closed pot. The fuels used are coal, oil and gas.
(iii) Electric furnaces: are commonly small and particularly used for special glass. Electric heating eliminates the formation of combustion by-product with the replacement of fossil fuels and batch carry-over, thus reducing the emission.

9.3.3 Of the listed types of furnaces, coal fired pot furnace and muffle furnace were very low in energy efficiency. These are being used in MSME clusters in India. Apart from melting process, energy is required for baking or annealing. Traditional coal fired muffle furnace (Pakai Bhattis) is used for baking or annealing. The fuel used for baking is mainly coal and generates very high levels of pollution in the form of CO_2, smoke and particulates.

9.3.4 In case of Firozabad cluster, the banning of usage of coal in the Taj Trapezium Zone and making availability of natural gas through Gail (Gas Authority of India Limited), a public sector organisation, resulted in shift from coal fired pot furnace to gas fired pot furnace. This resulted in reduction of energy consumption and low emission of particulate matter. The

2 - Towards Cleaner Technologies, TERI.

Energy and Resources Institute (TERI), an implementing organisation working in the field of energy, environment and sustainable development, has been instrumental is providing the design of a gas fired pot furnace that leads to energy savings of almost 50 per cent compared to the traditional coal-fired pot furnace. Similar attempts have been made by TERI in upgrading the muffle furnace that has the energy saving potential of 30 per cent compared to the traditional coal based muffle furnace. Out of 70-80 Open Pot Recuperative furnace 50 have been upgraded using TERI designed furnace and out of 400 muffle furnace units, around 100 have been installed using TERI design. But at present there are hardly 10-12 gas fired muffle furnace in operation in Firozabad, mainly due to availability of low cost fuel like wood. Considering the unregistered units that are present in the Firozabad cluster, there are huge scope of upgrading the furnace and thereby saving energy by almost 50 per cent.

9.4 Environmental Issues

9.4.1 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 discharges of hazardous wastes. CPCB has set a standard for industry specific emission both for effluent and emission. In case of the glass industry the standard is set for emission. The emission standard is given in the Table 9.2 below:

Table 9.2: Standard for Industry Specific Emissions

Section of the Plant	Parameter	Emission Limit
A. 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) = $14Q^{0.3}$ 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
B. Lead Glass		
All Capacities	Total Particulate Matter	50mg/Nm^3
	lead	20mg/Nm^3
C. Pot Furnace		
	Particulate Matter	1200mg/Nm^3

Source: Central Pollution Control Board

9.4.2 The emission level depends on the type of furnace. In regenerative furnaces, the emission level is quite low under normal conditions with little or no visible smoke. The emissions increase sometime (few minutes) during the reversal of regenerators.

9.4.3 In pot type furnaces the emission level is quite high when 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 little visible smoke.

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

9.4.5 The environmental issues in glass manufacturing sector primarily include:

- Emissions to air
- Wastewater
- Solid Waste

9.4.5.1i *Air Emissions*- Glass manufacturing is a high temperature, energy intensive resulting in the emission of combustion of by-products (sulphur dioxide, carbon dioxide, and nitrogen oxides) and the high-temperature oxidation of atmospheric nitrogen. The main source of air pollution is the dust emission in the manufacture of special glasses like lead glass and Boro silicate glass. In lead glass the level of emission depends on the quantity of lead.

9.4.5.1ii *Particulate Matter*: Particulates are pollutants emitted by glass manufacturing facilities. Dust emissions are an expected result of raw materials transportation, handling, storage, and mixing. 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 dust emitted from handling processes is mostly an occupational health and safety (OHS) issue, **MSME's produce around 648 Tons per annum of PM** (Assuming 2Kg per hour as per CPCB standard, 10 hrs of operation, 54 ton production in Firozabad, 54 ton in all bead clusters and 300 working days in a year).

9.4.5.1iii *Nitrogen oxides*: The main emission sources of nitrogen oxides (NOX) are the generation of thermal NOX caused by high furnace temperatures, the decomposition of nitrogen compounds in the batch materials, and the oxidation of nitrogen contained in fuels. Presence of KNO_3 in the raw material also contributes to NO_x emissions.

9.4.5.1iv *Sulphur oxides*: SO_2 originates from the sulphur content in the fuel oil as well as on sulphite/sulphate/sulphide content in raw materials, particularly the addition of sodium or calcium sulphate for glass oxidation.

9.4.5.1v *Chlorides and Fluorides*: These pollutants arise in glass-melting furnaces waste gases from raw material impurities and volumes are usually limited. The emission of fluorides is observed when fluoride containing compounds like sodium silicon fluoride or fluorspar are used in the raw materials as fine chemicals. Presence of chlorides in the flue gases exists when chloride compounds like sodium chloride are used as refining chemicals.

9.4.5.1vi *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 manufacture may have a lead content of 20–60 percent.

9.4.5.1vii *Green House Gases:* Glass manufacturing is a significant emitter of greenhouse gases (GHG), especially carbon dioxide (CO_2). The total carbon dioxide (CO_2) released in Firozabad cluster is 4.09 lakh tons (PCRA presentation). Almost same amount is being released in all the beads cluster put together. Therefore **total 8 lakh ton CO_2** is released every year by MSME clusters. **The emission done by entire glass industry was 147 lakh tons. (Based on 2006 figures).**

9.4.5.2 ***Waste Water-*** The main source of water pollution in a glass industry is:

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

9.4.5.2i *Cullet washing:* The cullet contains dust, metal caps etc. To clean it, the material is introduced into a rotary drum washer. The through agitation of the dirty cullet with water cleans the cullet which is sent for crushing. The water principally containing mud and also the oil (used for cutting blade for cutting the glass) is the source for water pollution.

9.4.5.2ii *Cooling water:* Water for cooling purpose is used at different areas in the furnace operation. Some amount of bleed/blow down is necessary to keep the solids concentration within limits. This appears as waste water. Some treatment chemicals like dissolved salts and water treatment chemicals used for the cooling-water system also source of pollution.

9.4.5.3 ***Solid Waste-*** There are two sources of solid waste in the glass industry:

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

9.4.5.3i *Sand Screening:* The silica sand /quartz sand which is the main raw material for the 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.

9.4.5.3ii *Waste glass from furnace:* While drawing the molten glass from the furnace, certain amount of glass is wasted and it solidifies.

9.4.5.3iii *Ash and unburnt coal:* The ash and unburnt coal particles results from coal combustion. These are sold to the contractors and ash is used for land filling purposes. This has reduced after natural gas usage in Firozabad The ash generated is **37 lakh tons** for 48% coal.

9.5 Social Issues

9.5.1 The social issues pertaining to Glass sector are mainly related to occupational health and safety issues. Some of them 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 displace fumes and dust away from the work stations.

- *Noise:* Workers are exposed to noise during glass manufacturing. Hearing loss (hypoacusia) is a typical occupational illness in this industry, especially for glass-container manufacturing. The noise level from glass-pressing machines can be as high as100 decibels or more, causing hearing impairment.

- *Respiratory Hazards:* The glass manufacturing contains Particulate Matter in the workplace. This PM may contain silica dust, deriving from silica sands and feldspar, and sometimes toxic compounds like lead oxide, boron, arsenic, tin, nickel, cobalt. Workplaces in container and tableware facilities also typically contain oil fume and smoke arising from hot mould lubrication. These may create respiratory problems for the workers.

- *Physical Hazards:* Many times glass may break and flying glass particles can cause eye injuries. Severe cutting injuries can arise if flat glass breaks during handling. There must be provision of cut-resisting gloves and long aprons to workers who handle the flat glass.

- Baking of bangle is mainly done in homes, where the sitting posture is not scientific and lead to health problems.

- *Labour issues:* Bangle makers are paid piece-rate wages. The wages are very low. The contractors hire the workers, who receive a lump sum amount from the glass factory and pay only a portion to the bangle makers.

9.6 Industry Perspective

9.6.1 The industry is represented by All India Glass manufacturer's association in which Firozabad is represented from MSME clusters but glass beads cluster is not represented. Pollution is a major concern for the entire industry. Child labour and occupational health and safety are also a major issue for MSME clusters apart from pollution. MSME is using outdated technology and is facing threat from modern technology. The survival if beads cluster is specially endangered at present which can lead into loss of livelihood of around 4 lakh people.

9.7 Institutional linkages

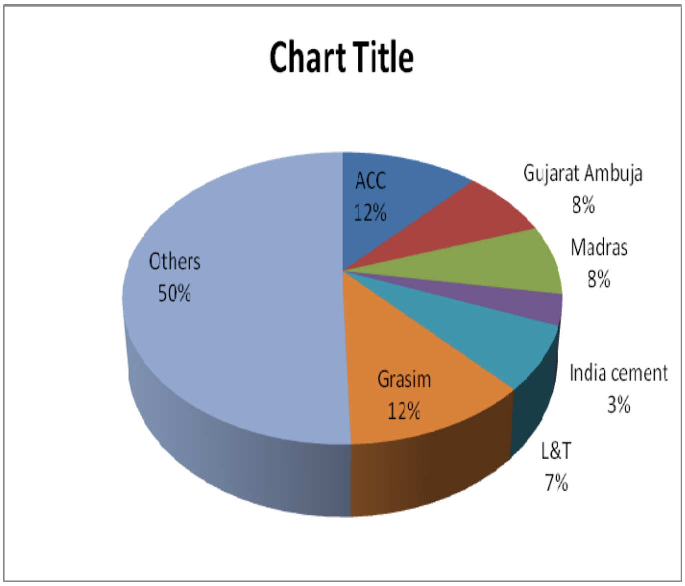
- Centre for Glass and Ceramic Research Institute CGCRI is the leading government institute to develop the glass and ceramic industry and have a special cell located in Firozabad.
- TERI has worked on technological upgradation work in Firozabad cluster along with SDC as funding agency.
- CGCRI has worked on introducing the LPG based community kilns in Purdil nagar Hathras.
- 1.7.4 Goonj, an NGO has worked on social issues in Firozabad clusters along with local NGO's.
- KVIC is a premier funding agency for MSME in such clusters.

Chapter B10
Cement Plant

10.1 Cement is one of the most polluting products of the modern world. It accounts for 5 % of global CO_2 emission, a green house 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 **1.4 lakh people** and has the capability to create huge indirect employment. This sector accounts for **1.3% of GDP**. For the year 2006-07 the total export of cement amounted to 1 Crore MT and a total production was 17.6 Crore MT. During the Tenth Plan, the cement production grew at a CAGR of 8.67 per cent. With the growth of the construction sector, the consumption of cement has grown at a rate, which is 2-3 per cent higher than the growth of GDP. 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 MSME sector, as there plant & machinery cost is more than 10 Crore. The cement industry is dominated by 20 companies which account for almost 70 per cent of the market while top 6 contribute to almost 50% of production.

Figure: 10.1



10.1.2 The Cement Corporation of India, which is a Central Public Sector Undertaking, has 10 units. There are 10 large cement plants owned by various State Governments. 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-5 cement companies in the world entered India through mergers, acquisitions, joint ventures or greenfield projects. These include France's Lafarge, Holcim from Switzerland, Italy's Italcementi and Germany's Heidelberg Cements

10.1.4 The origin of the mini cement plants dates back to 1970s. The acute cement scarcity in mid- seventies, with inadequate investment in this core sector, led to promotion of mini cement plants, by government to meet the local demand. The Government of India came out with the policy for 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. These mini cement plants mainly flocked together in areas close to the vicinity of limestone reserves. Majority of the mini plants are clustered in Andhra Pradesh, Karnataka, Madhya Pradesh and Rajasthan. The table 10.1 below provides the list of mini cement plant clusters in India along with their total number of units and turnover.

Table: 10.1

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	-

10.2 Energy intensity of the mini cement plants

10.2.1 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 Rs 7000 Crore. Energy is consumed at the various stages of cement production. However, the degree of energy consumption is dependent on the typology of the production process undertaken. In India, cement manufacturing process is of three types- wet process, semi- dry and dry process. Wet process of manufacturing of cement is an age old practice and has been replaced by dry process. Till the late 70s a major share of production was through 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-

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 25-75mm.
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 oC: 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 as 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.

10.2.2 The energy is mostly consumed in 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 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 below:

Table: 10.2

S. No.	**Section**	**Electrical Energy in Kwh/tonne of materials**
1	Crushing	1 to 3
2	Raw mill	28 to 35
3	(Including mill auxiliaries)	20 to 25
4	VSK (Vertical shaft Kiln)	12 to 15
5	RK (Rotary Kiln)	25 to 35

10.2.3 As the consumption of energy is less in VSK in comparison to Rotary Kiln (RK), most of the units have changed to VSK. For a modern cement manufacturing unit, the best thermal and electrical energy consumption is as low as 667 kcal per kg of clinker and 68 kWh per mt of cement in India, which is comparable to the global standard of 650 kcal per kg of clinker and 65 kWh per mt of cement.

10.2.4 The consumption of coal and electricity in cement plants is **4 Crore tonnes** and **11440 million units per annum.**

10.3 Issues of Cement Industry

10.3.1 Customs Duty on Coal and Pet Coke

10.3.1i Coal is the main fuel for the manufacture of cement. During the year 2006-07, the industry needed 25 million tonnes of coal, but received 14.43 million tonnes, against linkage of 15.48 million tonnes through FSAs signed between coal companies and cement companies. For the rest of the requirement, the industry had to depend upon the open market, imported coal and alternative fuels like pet coke.

10.3.1ii However, there is an import duty of 5 per cent on coal and pet coke, while on final product cement no import duty is levied.

10.3.1iii To sustain cement production to meet the growing demand, the industry requests the government to abolish customs duty on coal and pet cokes.

10.3.2 Duty on Cement Import

1.3.2i Government chose to permit easy imports, for which in the Budget 2007-08, announced in Feb.2007, **the customs duty has been reduced to zero while excise duty on cement has been increased by almost 50 per cent.**

1.3.2ii these measures have brought distortion in the level-playing field between domestic production and imported cement.

10.4 Environmental Issues in Indian Cement Sector

10.4.1 The cement industry is one of the high polluting industries which creates very high air pollution. The sector contributes significantly to the air pollution level in the vicinity of the plant 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 due to cement plants on environment is local, i.e. limited to a distance of maximum 10 km from its place of installation[62]. The regulation till now issued in various countries are all primarily intended to bring the local air pollution under control, in the vicinity as well as inside the factory. The dominating environmental problem in Indian cement plants is the emission of dust to the atmosphere. The Central Pollution Control Board (CPCB) have categorised cement industry under 'Red Category' in terms of emission. The standards that has been set under CPCB have been given in the table 10.3 below –

Table: 10.3

Plant Capacity	**Pollutants**	**Emission limit (mg/Nm3)**
200 tonnes per day and less (All Sections)	Particulate Matter	400
More than 200 tonnes per day (All Sections)	Particulate Matter	250

10.4.2 The environmental issues in cement manufacturing are-

(i) Air emissions
(ii) Wastewater
(iii) Solid waste generation
(iv) Noise pollution

[62] Central Pollution Control Board.

	Environmental Issues
1.	**Air Emission**
(i)	***Dust and particulate matters:*** are generated at each step of the production process. The major source of dust generation are crusher, raw mill, kiln, clinker cooler, coal mill, cement mill and packaging plant.
(ii)	***Nitrogen Oxide:*** emissions are caused by high kiln temperature and the oxidation of nitrogen.
(iii)	***Sulphur Oxides:*** emissions are emitted from volatile or reactive sulphur in the raw materials and quality of fuels used for power generation.
(iv)	***Greenhouse gas:*** emission is associated with fuel combustion and with the decarbonation of limestone which is 44 per cent CO_2 by weight. CO_2 emission is 7.63 crore Tons by coal and 11.62 Crore Tons by Lime stone.
(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 metal and their compounds if not properly controlled and operated.
2.	**Solid Waste**
	Solid waste in cement manufacturing includes clinker production waste, which are removed from the raw material during the raw mill preparation. Other waste material 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 purpose in different phases of the process. The water is high in pH and suspended solids.
4.	**Noise**
	Noise pollution is generated at different stages of production process. This includes raw material extraction, grinding and storage, raw material, intermediate and final product handling and operation of exhaust fans.

Positive aspect: Cement industry consumes around 25 per cent of fly ash produced in thermal power plants which is a by-product and is a nuisance to deal with.

10.5 Social Issues Indian Cement Sector

10.5.1 Though the dust produced in cement making process is a nuisance within the plant and surrounding. There are several health and safety hazards pertaining to the cement manufacturing. 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 weight and over-exertion in the above polluted environment. Cement dust causes lung function impairment, chronic obstructive lung disease, restrictive lung disease, 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 essentially all the organs of body and affects the different tissues including heart, liver, spleen, bone, muscles and hairs and ultimately affecting their micro-structure and physiological performance.

Chapter B11
Small Pulp and Paper Mill

11.1 Introduction

11.1.1The Indian Paper Industry accounts for about 1.6% of the world's production of paper and paperboard. The estimated turnover of the industry is Rs 30,000 crores, approximately. The industry provides employment to more than 1.2 lakh people directly and 3.4 lakh people indirectly. During 2007-08, the operating capacity of the industry was 93 lakh tons. However, experts in the industry have estimated the total production to be 105 lakh tons during 2008-09 and per capita consumption was pegged at more than 8.3 kg. The major large-scale paper manufacturers are-

- Ballarpur Industries Limited (BILT)
- ITC Bhadrachalam Mill, Sarapaka, Andhra Pradesh
- Tamil Nadu Newsprint and Papers Limited, Kagithapuram, Karur District, Tamil Nadu
- Pudumjee Pulp & Paper Mills Ltd, Pune (Maharashtra, India)
- The West Coast Paper Mills Ltd, Uttar Kannada (Karnataka)
- The Andhra Pradesh Paper Mills Ltd, Rajahmundry, Andhra Pradesh.
- JK Paper Mill, Jaykaypur, Rayagada, Orissa.
- Star Paper, Saharanpur, Uttar Pradesh
- Titagarh Paper Mills Company Ltd, Titagarh and Kakinara
- Sirpur, Kaghaznagar, Adilabad district, Andhra Pradesh
- Sri Krishna Paper Mills and Industries Limited, Bahadurgarh, Haryana
- Vikarabad Pulp and Paper Mills Pvt. Ltd., Vikarabad, Rangareddy, Andhra Pradesh

11.1.2 Paper mills with the capacity of producing upto 10,000 tons per annum (TPA) of paper, boards, etc. are classified under small paper mills[63]. They do not come under MSME as the plant and equipment cost is more than 10 crore even for the smallest unit. The paper shortage in early 1970s led to setting up of small and medium size paper mills. The government supported import of cheap second hand technologies that assisted setting up of

[63] Comprehensive Industry Document, CPCB.

small paper mills in any parts of the country. By 1992, there were around 300 small and medium sized paper mills in the country, which accounted for almost 50 % of installed capacity and production. The capacity of the small paper mills ranges from 3 to 30 tons per day (TPD). Few of these small paper mills exist in clusters. The cluster list is given as follows.

Table: 11.1

State	Location	No of units	Cluster Production Capacity (tonnes/day)
Gujarat	Vapi	30-40	400-600
Uttar Pradesh	Muzaffarnagar	30-40	400-600
Uttaranchal	Udhamsingh Nagar	12-15	800-850
Tamil Nadu	Coimbatore	9	1000-1100

However, these small units suffer from high production cost, uneconomic operations, low quality and negative impact on the environment. The high production cost is also attributable to the rising energy prices, which accounts for almost 25% of the total production cost.

11.2 Production Process of Paper Industry

The pulp and paper sector is highly energy intensive with 75-85% of the energy requirement being used as process heat and 15-25% as electrical power. The energy is consumed at the 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. They are wood, agriculture residue and waste paper. In general, the production process consists of five stages-

11.2.1 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 little energy.

11.2.2 Stage 2- *Pulping:* Pulping can be performed using chemical, mechanical (hydro-pulping) or combined chemical-mechanical techniques. The chemical process involves digestion of raw material 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^{o}C and around 1.2-1.5 tonne of steam is required for each tonne of raw material digested. 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 presence of steam. Chemical-mechanical techniques make use of both chemical and mechanical process. The raw material is soaked in 3-5% caustic soda solution at 90^{o}C for 15 to 30 minutes. Large mills that are based on wood as raw material use the Kraft process.

11.2.3 Stage 3- ***Bleaching:*** Bleaching is adopted where bleached paper is produced for writing, printing and decorative papers. The chemicals required to bleach are mainly, chlorine, alkali solution, hydrogen peroxide, sodium hydrosulphite etc., which varies according to the type of raw material used for paper manufacturing. In small units, only calcium hypochlorite or bleaching powder is used and the conventional steps are not followed.

11.2.4 Stage 4- ***Chemical Recovery*****:** Chemical recovery regenerates the spent chemicals used in Kraft chemical pulping. It produces a waste stream of inorganic chemicals and wood residues 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. The 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.

11.2.5 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 papermaking 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.

11.3 Energy Intensity in Small Paper Mills

11.3.1 Given the production process, most of the energy is used in the form of heat within the pulping process when 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 consumption also varies with the typology of raw material used in the production process. In case of waste paper, the energy requirement is almost 2.5 times lesser than the wood chip or agricultural residue due to requirement of less intensive pulping need 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 mill is provided in the table below.

Table 11.2: Energy Consumption in Indian Paper Mills

Section/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	2.5-4.0	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 and Others			248-252	0.89-0.91
Total	**10-16**	**46.2-73.8**	**1500-1700**	**51.6-80.0**
Source: Srivastava (1998); TERI (1996), and Mohanty (1997).				

Energy content of the Indian Coal is expressed in "Useful Heating Value" (UHV) basis. Indian coal (non-coking) is classified by grades (A-G) defined on the basis of Useful Heat Value (UHV). UHV is an expression derived from ash and moisture contents for non-coking coals as per the Government of India notification. UHV is defined by the formula:

UHV kcal/kg = (8900-138 x [percentage of ash content +percentage of moisture content]) The ash content in Indian coal ranges from 35% to 50%. Average value is 42.5 and moisture is 6%

Source: http://www.indopedia.org/Calorific_Value_of_Coal.html

Hence, the total consumption of electricity is 1680 crore units and that of coal is 840 lakh tons approximately per annum. The generation of carbon dioxide out of this comes out to be approximately 161 crore tons.

11.3.1 Since the second grade technology plants were imported, the cost of up gradation is very high and the payback is 6 to 10 years. The huge investment in the old technology has given very less returns due to inefficiencies in the plant. Imported machines of latest technology are exorbitantly high. Fluctuation in the raw material cost has reduced the margin to a very low level and has also impacted the production volume. Economy of scale can be achieved if raw material supply is increased and indigenous technology is developed which is affordable. The payback should not be more than 3 to 4 years.

11.3.2 Several methods have been undertaken by the paper manufacturing industry and government research bodies to reduce cost. They have mainly done some process improvements and technology for indigenous raw material like bagasse, bamboo grass etc developed by scientists of IARI, and CPPRI.

11.4 Environmental Issues in Paper and Pulp making

11.4.1 Global studies have raised very high concern on the effect of paper industry on energy and environment like:

- Making a tonne of paper requires 98 tonnes of other resources.
- Making a tonne of paper uses as much energy as making a tonne of steel (according to USA Environmental Protection Agency).
- Deforestation causes more climate change emissions than global transport. It causes 17.4% of global climate change emissions, transport causes 13%.
- In industrial countries, the paper industry is the biggest user of water.
  Source: http://www.shrinkpaper.com

11.4.2 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. The Central Pollution Control Board (CPCB) has set a standard for industry specific emission both for effluent and emission. In case of the paper making the standard is set for effluents.

Table 11. 3: The effluent standard is given in the table below.

Effluent

SMALL PULP & PAPER INDUSTRY : STANDARDS FOR LIQUID EFFLUENTS

Mode of Disposal	Parameter	Concentration not to exceed, mg/l (except for pH and sodium absorption ratio)
Inland Surface Water	pH	5.5 to 9.0
	Suspended solids	100
	BOD at 27°C, 3 days	30
Land	pH	5.5 to 9.0
	Suspended solids	100
	BOD at 27°C, 3 days	100
	Sodium absorption ratio	26
c) Raw meat from other sources	disposal via screen and septic tank	

Source : EPA Notification S.O. 64(E), dt. 18th Jan, 1998]

Small Pulp & Paper Industry : Waste Water Discharge Standards*

CATEGORY	
A: Agrobased	200 cum/tonne of paper produced
B: Waste Paper Based	75 cum/tonne of paper produced

* The agrobased mill to be established from January, 1992 will meet the standards of 150 cum/tonne of paper produced.

** The waste paper mills to be established from January, 1992 will meet the standards of 50 cum/tonne of paper produced.

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

- Wastewater
- Air emissions
- Solid waste

11.4.4.1 Wastewater

11.4.4.1i Paper industry's existence depends on the water supply. All the processes in paper making require water and accordingly release wastewater. Small mills using chemical process do not recover chemicals leading to intense pollution problem in comparison to the size of the mill. Chemical recovery is not done mainly due to the cost involved in the treatment.

11.4.4.1ii The composition of waste water from mills employing both agricultural residue and waste papers varies and depends on 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.

11.4.4.1iii In case of agriculture residue, wastewater is generated as Black liquor from cooking section, Pulp wash water from poucher, and from Beater section, Bleaching section, thicker, and Paper machine. Black liquor is the most polluting among the different streams. Black liquor is generally not segregated and ends up in pulp washing wastewater. Pulp washing section accounts for 80 % of the total pollution load and contributes appreciable amount of suspended solids.

11.4.4.1iv In case of waste paper based mills, wastewater is generated from bleaching section, thickener and paper machine.

Table 11.4

Taking the total production figures of 105 lakh ton production of paper in India in the year 2008-09, the following figures can be arrived for waste generation:

Type	Production (%)	Actual production (lakh tons)	Average waste water generated (cu m/ton)	Waste water generated (lakh cu m)
Agriculture residue/wood	82	86.1	250	21525
Waste paper based	18	18.9	107	2022

Source: Waste water per ton calculated from CPCB COINDS

The amount of waste water generated was **235.47 Crore cu m** in the year 2008-09.

11.4.4.2 Air Emission

1.4.4.2i Air pollution problems in small paper mills are limited to gases escaping during digester blow-off which cause aesthetic pollution 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 large sources of standard air pollutants, such as carbon dioxide, nitrous oxides, carbon monoxides and particulates. These contribute to ozone warnings, acid rain, global warming and respiratory problems.

1.4.4.2ii Green House Gas: The generation of carbon dioxide out of coal used comes out to be approximately 161 crore tons per year.

11.4.4.3 Solid Waste

11.4.4.3i Waste paper mill sludges 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 different purposes as such or after appropriate pre treatment. Paper fibers 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 out 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 magazine-type paper is produced using a fine kaolin clay coating, which also becomes solid waste during recycling.

11.4.4.3ii Approximately, 6.09 lakh ton per annum (58 kg per ton of paper produced) of solid waste is being generated approximately by the Paper industry. (Small and Medium paper mills had 35% share in total production and hence share almost 35 % in solid waste and ash.) This waste is excluding the boiler Ash which is being generated at the rate of 1.3 tonne per tonne of paper produced i.e. 136 lakhs ton Ash per annum. These are dumped in low lying areas.

11.5 Industry perspective

11.5.1 The main issues bothering the pulp and paper industry is lack of raw material. Import of waste paper has now become difficult after it's categorisation as hazardous waste by Indian Government. There is an extreme shortage of qualified manpower. Pollution has become a burning issue as the industry has been categorised in Red category by CPCB. Industry is keen to adopt new technologies in paper making and treatment of waste but could not do because of tight margins. The scarcity of raw material is a hindrance for mass production to achieve economy of scale. Moreover inefficiency in operation due to unqualified manpower adds to the problem.

11.5.2 Indian Agro & Recycled Paper Mills **A**ssociation is keen to start the training institute and explore the installation of common ETP if it gets proper funds which can be shared partially by industry and Government of India. According to the association, huge scope lies in using the fibre content of Bagasse for paper industry. Bagasse has 2 components, pith and fibre. Pith is required for energy generation but fibre is also being burnt along with it. This fibre if separated and made available can solve the raw material problem of our industry to a large extent. Similarly the black liquor can be used for agriculture after teating it by using the technology developed by scientists of IARI. This reduces the requirement of manure and helps the farmer in it's cost while benefiting the industry by getting relieved from a major pollutant.

11.6 Institutional Linkages

11.6.1 The following two associations represent this industry:

- *The Indian Paper Manufacturers Association*, PHD House, 4th Floor, 4/2 Siri Institutional Area (Opp Asian Games Village), New Delhi - 11016, Tel: 91-11-2651 8379, fax: 91-11-2651 3415, e-mail: sg@ipma.co.in, website: www.ipma.co.in
- *Indian Agro & Recycled Paper Mills **A**ssociation*, 404, Vikrant Tower Rajendra Place, New Delhi, Delhi – 110008, Tel: 011 25862301

11.6.2 Institutes and organizations working in the field of Pulp & Paper are:

- Central Pulp and Paper Research Institute (CPPRI) — a premier institute working in the field of research activities for pulp and paper industry.
- Department of Paper Technology, IIT, Roorkee.
- Shreeram Institute of Industrial research — doing research work in paper technology.
- Forest Research Institute — has a paper division to train manpower of the paper industry.
- Indian Agriculture Resarch Institute, PUSA. New Delhi.
- Development Council for Pulp Paper & Allied Industry — working on projects with CPPRI and National council of Biomechanics (NCBM).
- NGOs, like Development Alternative (DA), CSE, Chintan and waiste2wealth — contributed in generating awareness for best practices.
- Technology provider are suppliers like Metso, Voithe, ABB, Siemens
- Indian consultants - 1) Chem project consultants pvt ltd, Okhla, New Delhi., 2) Chellam marketing and consultant , Chennai. 3) Kadam Enviro Consultant, Baroda.