Global Solutions Meeting Local Needs
Climate Change instruments for diffusion of cleaner technologies
in the small-scale industries in India

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Global Solutions Meeting Local Needs
Climate Change policy instruments for diffusion of cleaner technologies in the small-scale industries in India

Dedicated to
My Father Kewal Krishan Soni
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<th>Full Form</th>
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<tbody>
<tr>
<td>AAU</td>
<td>Assigned Amount Unit</td>
</tr>
<tr>
<td>ADB</td>
<td>Asian Development Bank</td>
</tr>
<tr>
<td>AIBMF</td>
<td>All India Bricks and Tiles Manufacturers Federation</td>
</tr>
<tr>
<td>AIJ</td>
<td>Pilot Phase for Activities Implemented Jointly</td>
</tr>
<tr>
<td>A</td>
<td>Argument</td>
</tr>
<tr>
<td>ASI</td>
<td>Annual Survey of Industries</td>
</tr>
<tr>
<td>BEE</td>
<td>Bureau of Energy Efficiency</td>
</tr>
<tr>
<td>BTK</td>
<td>Bull Trench Kiln</td>
</tr>
<tr>
<td>CA</td>
<td>counter argument</td>
</tr>
<tr>
<td>CBA</td>
<td>Chandigarh Brick Association</td>
</tr>
<tr>
<td>CBRI</td>
<td>Central Building and Research Institute</td>
</tr>
<tr>
<td>CCI</td>
<td>climate change instrument</td>
</tr>
<tr>
<td>CDCF</td>
<td>Community Development Carbon Fund</td>
</tr>
<tr>
<td>CDGI</td>
<td>Centre for Development of the Glass Industry</td>
</tr>
<tr>
<td>CDM</td>
<td>Clean Development Mechanism</td>
</tr>
<tr>
<td>CEF</td>
<td>common effluent facility/plant</td>
</tr>
<tr>
<td>CER</td>
<td>Certified Emission Reduction</td>
</tr>
<tr>
<td>CERUPT</td>
<td>Certified Emissions Reduction Unit Procurement Tender</td>
</tr>
<tr>
<td>CII</td>
<td>Confederation of Indian Industry</td>
</tr>
<tr>
<td>CO₂</td>
<td>carbon dioxide</td>
</tr>
<tr>
<td>COP</td>
<td>Conference of Parties to the Framework Convention on Climate Change</td>
</tr>
<tr>
<td>CPCB</td>
<td>Central Pollution Control Board</td>
</tr>
<tr>
<td>CSE</td>
<td>Centre for Science and Environment</td>
</tr>
<tr>
<td>CSO</td>
<td>Central Statistical Organization</td>
</tr>
<tr>
<td>DBC</td>
<td>double blast cupola</td>
</tr>
<tr>
<td>DIC</td>
<td>District Industries Center</td>
</tr>
<tr>
<td>DNA</td>
<td>Designated National Authority</td>
</tr>
<tr>
<td>DoI</td>
<td>Directorate of Industries</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>---------</td>
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<tr>
<td>MoSSI</td>
<td>Ministry of Small Scale Industry</td>
</tr>
<tr>
<td>NABARD</td>
<td>National Bank for Agriculture and Rural Development Corporation</td>
</tr>
<tr>
<td>NATCOM</td>
<td>National Communication</td>
</tr>
<tr>
<td>NGO</td>
<td>non-governmental organization</td>
</tr>
<tr>
<td>NML</td>
<td>National Metallurgical Laboratory</td>
</tr>
<tr>
<td>NOX</td>
<td>oxides of nitrogen</td>
</tr>
<tr>
<td>NSIC</td>
<td>National Small Industries Corporation Limited</td>
</tr>
<tr>
<td>ODA</td>
<td>Official Development Assistance</td>
</tr>
<tr>
<td>ODS</td>
<td>ozone depleting substances</td>
</tr>
<tr>
<td>OP</td>
<td>Operational Programme (of the Global Environment Facility)</td>
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<tr>
<td>PBMA</td>
<td>Punjab Brick Manufacturers’ Association</td>
</tr>
<tr>
<td>PCB</td>
<td>Pollution Control Board</td>
</tr>
<tr>
<td>PCB</td>
<td>(State) Pollution Control Board</td>
</tr>
<tr>
<td>PCD</td>
<td>pollution control device</td>
</tr>
<tr>
<td>PCF</td>
<td>Prototype Carbon Fund</td>
</tr>
<tr>
<td>PDF</td>
<td>Project Preparation and Development Facility (of the Global Environment Facility)</td>
</tr>
<tr>
<td>PIL</td>
<td>public interest litigation</td>
</tr>
<tr>
<td>PLS</td>
<td>priority lending support</td>
</tr>
<tr>
<td>PPDC</td>
<td>Process and Product Development Centers</td>
</tr>
<tr>
<td>PSCST</td>
<td>Punjab State Council for Science and Technology</td>
</tr>
<tr>
<td>RQ</td>
<td>research question</td>
</tr>
<tr>
<td>SA</td>
<td>sub-argument</td>
</tr>
<tr>
<td>SBC</td>
<td>Single Blast Cupola</td>
</tr>
<tr>
<td>SBI</td>
<td>State Bank of India</td>
</tr>
<tr>
<td>SC</td>
<td>sub counter-argument</td>
</tr>
<tr>
<td>SDC</td>
<td>Swiss Agency for Development and Cooperation</td>
</tr>
<tr>
<td>SFC</td>
<td>State Financial Corporation</td>
</tr>
<tr>
<td>SIDBI</td>
<td>Small Industry Development Bank of India</td>
</tr>
<tr>
<td>SIDC</td>
<td>(State) Small Industries Development Corporation</td>
</tr>
<tr>
<td>SIDO</td>
<td>Small Industry Development Organization</td>
</tr>
<tr>
<td>SISI</td>
<td>Small Industry Service Institute</td>
</tr>
</tbody>
</table>
SME  small and medium enterprise  
SOX  oxides of sulphur  
SPM  suspended particulate matter  
SSI  small-scale industry  
TDMF  Technology Development and Modernization Fund  
TERI  Tata Energy Research Institute (The Energy and Resources Institute)  
TTZ  Taj Trapezium Zone  
U.P.  Uttar Pradesh  
UNDP  United Nations Development Programme  
UNIDO  United Nations Industries Development Organization  
UPTECH  Integrated Technology Upgradation and Management Programme  
VA  voluntary agreement  
VSBK  Vertical Shaft Brick Kiln  
WASME  World Association for Small and Medium Enterprises  
WCED  World Commission on Environment and Development  

**Conversion used:** 1 Indian Rupee approximately = 45 US$ or 56 Euros.
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Preeti Soni.
1. Introduction

“The effectiveness of climate change mitigation can be enhanced when integrated with the non-climate objectives of national and sectorial policy development and can be turned into broad strategies to achieve the long-term social and technological changes required by both sustainable development and climate change mitigation” (IPCC 2001: 303)

Human activity, such as energy use and industrial production, contributes to the rising concentrations of greenhouse gases (GHGs) in the atmosphere normally associated with global warming and climate change. A significant institutional challenge in this regard is to equitably meet the increasing energy needs across different sectors and countries, while lowering the rate of growth of their GHG emissions. Options include policy instruments developed or debated at the international climate change negotiations that offer incentives for undertaking climate relevant actions and facilitating sustainable development. While these climate change instruments (CCIs) are negotiated internationally, their impact lies in their ability to influence human activities at all levels of social organization. From the developing countries’ perspective, these may be more effective when embedded within their broader national development strategies and policies.

Small-scale industries (SSIs), in particular, are significant contributors to the socioeconomic growth in developing countries. Use of inefficient production and management processes in energy intensive SSIs contribute to GHG emissions and offer potential for saving energy and reducing GHGs. Cleaner technologies can reduce GHG emissions and help SSIs in facing emerging challenges due to environmental policies and increasing competition in a liberalised global scenario. The CCIs, however, have so far largely ignored the SSIs which are characterised by small sizes, dispersed nature and informal structures. They tend to focus more on organized and large sectors which bring in direct and cost-effective means of reducing GHGs. Given their large numbers in the developing countries, leaving out the SSIs would lead to not addressing an important segment of the climate change problem.

This thesis examines the link between the CCIs and the SSIs; that is, the role of CCIs in facilitating cleaner technology diffusion in SSIs, and of SSIs in assisting in global GHG reduction efforts. Taking the case of India, it analyses the potential role and effectiveness of international policies and policy instruments in directing the local-level human activities towards more environmentally sustainable paths.
1.1 Context

1.1.1 Sustainable development and climate change

Sustainable development is commonly defined as a process of change in which “the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are in harmony and enhance both the current and future human needs and aspirations” (WCED 1987: 47). This entails addressing environmental problems and conserving natural resources without compromising socio-economic aspirations of the present and future generations.

Strategies to address climate change become extremely relevant in the context of sustainable development, as the problems and possible solutions involve economic and social activities across all countries with inter-generational and inter-temporal consequences. Developing and implementing institutional and technological approaches is especially challenging given that they impact the atmosphere which is a global common good. For over a decade, the signatories of the United Nations’ Framework Convention on Climate Change (FCCC) have been formulating policies and have introduced policy instruments, in line with the principle of common but differentiated responsibilities, with the objective:

“...to achieve stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system... within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner”(FCCC 1992).

1.1.2 Climate change instruments and diffusion of cleaner technologies

The policy instruments for addressing climate change are largely based on the economic theories for environmental protection and may be referred to as climate change instruments (CCIs).

**Climate change instruments (CCIs)** are policy instruments for climate protection that are developed and introduced under the global regime for addressing climate change.

The CCIs that are relevant for developing countries aim at facilitating sustainable development on two levels, that is, the global (GHG mitigation) and the national (economic, social and local environmental benefits). They tend to focus on ‘additional’ host-country driven approaches. However, CCIs have to be considered in a

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1 Sustainable development is a context related concept, and there is no universally accepted definition. It is more commonly defined as “development that meets the needs of the present without compromising the ability of the future generation to meet their own needs” (WCED 1987: 8). Even this definition has shortcomings (e.g. ambiguity regarding the concept of needs). The three dimensions (or pillars) of sustainable development include economic, social and environmental sustainability (Munasinghe 2000).
political setting wherein several stakeholders are involved and their motivations have a bearing on the design and effectiveness of the policy instruments. While CCIs are designed at the international or national levels, their implementation is dependent on the national policies and policy instruments, as well as human actions (and decision making) at the local levels. Thus, it is important that correct and adequate “CCI signals” and information about their incentives and objectives are transmitted to various stakeholders involved for the desired impact.

Diffusion of cleaner technologies provides an option through which the CCIs may achieve their objectives in the developing countries. Technology, in general, is implicated in climate change as both a source and potential solution to the problem. Cleaner technologies are techniques, processes and products that help diminish or avoid environmental damage (Kemp 1995). For the energy intensive industries in particular, these technologies may improve energy efficiency, and thereby reduce the associated GHG emissions and local environmental impacts. For this thesis therefore, cleaner technologies and their diffusion are defined as follows:

**Cleaner technologies** for energy intensive industries include *energy efficient* technologies, including techniques, processes and products, that help reduce local and global environmental damage.

**Diffusion of cleaner technologies** is the process by which cleaner technologies spread (and are transferred) across potential markets and sectors.

### 1.1.3 Climate change instruments and developing countries

Although the developed countries have contributed to the major share of anthropogenic GHG emissions, the developing countries’ share is rapidly increasing. India, for instance, is among the ten largest GHG emitting countries. It also ranks high on the vulnerability to impacts of climate change (MoEF 2004a). In most developing countries, climate protection is an important issue but not a priority in light of the more pressing development priorities such as economic development and poverty alleviation. Diffusion of cleaner technologies, however, could help them meet their development priorities while decreasing the rate of growth of GHG emissions (DIFD 1999; Goldemberg and Reid 1998). The CCIs can facilitate diffusion of cleaner technologies by: leveraging low-cost finance and state-of-the-art technologies; creating incentives for cleaner technology adoption; promoting international co-operative initiatives; and fostering capacity building (Parikh 2000; TERI 1998a).

The challenge faced by developing countries is the adaptability of the CCIs by analysing the risks and opportunities they encompass, in order to safeguard their own interests during the negotiation process and adoption of the policy instruments. Many developing countries, including India, had initially adopted a cautious approach towards the CCIs during the negotiations (Gupta 2001; Gupta et al. 2001); their con-

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2 The GHG emissions may also be reduced through use cleaner fuels and renewable energy technologies. The focus of the thesis is however on improving energy efficiency.
cerns included additionally, ethics, equity, project eligibility, transparency, simplicity of procedures and sustainability (FCCC 2000). It was also argued that the CCIs may be restricted in their coverage, focusing on a few sectors and technologies (Gupta 2000). However, the interest in CCIs, particularly the market-based CCIs, has increased rapidly and quite significantly over the last few years. Several projects have been developed or are being considered that lend themselves to the CCI criteria. India, in fact, is a leading host country for such projects (MoEF 2004a). Many of the projects, however, are still considered to be driven by investors or consultants, and thereby are motivated more by their interests and less by national development priorities. Given that the CCIs are integral to the climate change policy regime, the developing countries need to strategize to utilize the CCIs effectively given their own national institutional structures and development priorities while ensuring adherence to the overall global environmental objectives.

1.1.4 Small-scale industries in India

SSIs are directly relevant for socio-economic development in developing countries as they generate significant employment opportunities, build local capacity and contribute to economic growth. There is no uniformly accepted definition of SSIs, and literature defines them in several ways (for example, based on employment, capacity and investment). In fact, a more commonly used term for SSIs is small and medium enterprises (SMEs). In this thesis – as the focus is on India – the official definition of SSIs in India is used:

**Small-scale industries (SSIs)** include all industrial units in which the investment in plant and machinery does not exceed Rs 10 million\(^3\).

The SSIs in India are often referred to as the *engine of growth*. Their relevance is aptly described in the words of Mahatma Gandhi: *“I believe in the production by the masses and not mass production”*, who had emphasised the role of SSIs to usher economic development in post-independence India. At present, the SSIs account for around 95% of industrial units (3.2 million registered units), 80% of manufacturing employment (second largest employer directly employing 18 million people), 40% of manufacturing output, and 36% of exports (MoSSI 2001, 2004).

SSIs in India, as in several other developing countries, are often associated with the use of inefficient production and management processes leading to adverse environmental impacts, especially at the local level (Beckerman 1995; Bhalla 1995; CSE 2002). There are no accurate estimates for the environmental impacts of SSIs. However, studies have considered environment impacts of SSIs as quite significant (Bala Subrahmanya and Balachandra 2002), and the estimated contribution of the SSIs to the total *local* industrial pollution in India is 65-70% (Bhalla 1995; CSE 2002; MoEF 2002c). The polluting SSIs, include many energy-intensive SSIs such as metal foun-

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\(^3\) That is, approximately US$ 220,000 or Euro 180,000.
dries and forges, steel re-rolling, brick, glass, pottery, ceramics and mini-cement plants.

1.1.5 Diffusion of cleaner technologies in small-scale industries in India

Diffusion of cleaner technologies in the energy-intensive SSI units can lead to significant energy savings and reductions in associated GHG and local environmental impacts. At the same time, they can bring additional benefits such as improvements in productivity, working conditions and competitiveness of the SSIs along with employment generation and poverty alleviation. This is especially desirable in the present scenario wherein many SSIs face the challenge of increased competition from within the sector, as well as from large industries and imports. Studies indicate an energy-saving potential of 10–15% by improvements in operational and maintenance practices, and an additional 30–35% through upgrading the technology in the SSIs in India (PCRA 2000). However, there are significant barriers to the diffusion of cleaner technologies in the sector (Worrell et al. 2001), which depend not only on micro-level decision-making but are also related to the characteristics of SSIs and their social, economic, political and cultural milieus (Dasgupta 2000; Frijns and Vliet 1999).

There is more than one pathway for facilitating diffusion of cleaner technologies in SSIs, including national policies and community initiatives. For Indian SSIs, there are promotional policies (such as fiscal, credit and institutional support), and those that address local pollution (SIDBI 2000). These policies have resulted to some extent, in the adoption of end-of-pipe solutions (like pollution-control devices, common effluent plants), and relocation and closure with social implications (such as in Delhi and Agra). However, they have had little impact on the actual production processes. Policies for energy conservation and related cleaner technologies in SSIs are largely restricted to awareness creation and demonstration projects, with limited take-up. The demonstration projects in foundry (cokeless cupola), mini-cement (oil-fired vertical shaft kiln), and brick industries (vertical shaft kiln) show considerable energy savings (TIFAC 2001).

An additional pathway to encourage cleaner technology diffusion in the SSIs could be the use of the CCIs.

1.2 Problem definition

The concern of the SSIs at present is their own sustainability linked to increasing global competition. The proponents of cleaner technology diffusion in developing countries argue that the associated barriers can be removed through national, private sector, and community initiatives (IPCC 2000). However, in India, although there are national policies for the promotion of SSIs, those for the diffusion of cleaner technologies in general target the large-scale industrial sectors. There is not much thrust given to the sector, in the business-as-usual scenario, in terms of cleaner technology.
It is also argued that the CCIs can promote cleaner technologies in developing countries by providing economic, technological and capacity-building inputs. But, again, these instruments tend to focus on specific sectors such as power generation and renewable energy technologies. There is still a limited, albeit increasing, focus on energy efficiency improvements in SSIs in climate change policy discussions and the projects developed within the CCIs portfolios. There are also diverging views on the use of CCIs for the SSIs. The GHG impacts of SSIs are often assumed to be limited, and their GHG reduction potential ignored due to their characteristics, for example, small sizes and scattered nature. However, studies show that certain SSIs have adverse environmental impacts and potential for GHG reduction (Scott 1998; TERI 2000a, 2002). Climate relevant projects involving SSIs have also been developed illustrating their GHG relevance, and sustainable development benefits of adopting cleaner technologies. On the other hand, studies also show that SSIs have less access to financing (including national and international), and even small investments in cleaner production are often not made (van Berkel and Bauma 1999). At the same time, the projects under CCIs are likely to have transaction costs, which discourage the involvement of SSI given their limited resources (finance, information, etc.).

In the light of the characteristics of SSIs and their importance in national economies, given the dual objectives of CCIs, what is required is a set of innovative solutions (institutional including policy, and technological) within the CCIs framework. This essentially is the focus of this research. The proposition is that the CCIs will not focus on the SSIs, unless appropriate measures are applied. The issue is how to provide a conducive scenario and effectively utilize the CCIs for the SSIs in developing countries like India such that reductions in GHG emissions and local pollution be achieved alongside other benefits like improvements in SSI cost-effectiveness, competitiveness and working conditions. This entails examining the instruments, and the context and circumstances in which they would operate.

The main objective of this study is:

*To determine whether the climate change instruments can facilitate the diffusion of cleaner technologies in the small-scale industries in developing countries leading to sustainable development benefits, by examining the synergies and conflicts between these instruments and national policies in India.*

The study examines the link between the CCIs and the SSIs. If such a link exists then how can it be strengthened; and if not, then should it and how can it be established? This provides theoretical and policy lessons for the design and implementation of policy instruments under the climate change negotiations. The ultimate scientific aim of the study is to deepen the understanding regarding the effectiveness of global regimes at local levels.
Thus, the central research question is:

*Under what circumstances can climate change instruments induce the small-scale industries sectors in developing countries to contribute towards the global efforts for addressing climate change and at the same time assist the process of sustainable development at the national level?*

1.3 Structure of the thesis

The thesis is structured as follows (Figure 1.1).

**Chapter 1** has presented the background, rationale and the relevance for examining the link between the CCIs and the SSIs. It has defined the main objective and the central research question for the study.

**Chapter 2** discusses the theoretical background and concepts related to the two basic themes, which are (a) the policy instruments for climate protection and (b) diffusion of cleaner technologies in the SSIs.

The theoretical background forms the basis of **Chapter 3**, where the research framework is developed and the research methodology defined. The research methodology used is largely qualitative, including literature survey, primary interviews and multiple case studies (involving primary survey and interviews). The central research question is sub-divided into more focused research questions in Chapter 3.

In line with the research framework, **Chapter 4** examines the climate change policies and policy instruments at the international and national levels. It focuses on their evolution and the implications of CCIs for India and for the SSI sector.

**Chapter 5** deals specifically with the national policies in India, and how they influence diffusion of cleaner technologies in the SSI sector.

**Chapters 6, 7 and 8** present case studies of three SSIs clusters in India, where the national environmental policies have brought about a change in terms of cleaner technology diffusion, and in that sense, have been “diffusion forcing”. This not only helps to draw lessons for drafting international environmental policies, but also to examine the barriers and drivers that exist that may influence these policies. Although it is not imperative to read these chapters in detail in order to understand the conclusions, they are interesting and informative for the full story emerging from the thesis.

The conclusions from the case studies are revisited in Chapter 9. **Chapter 9** draws inferences based on the discussions in these in-depth case studies, for the SSI sector in general, and identifies the gaps in the current paradigm whereby diffusion of cleaner technologies in the sector is constrained.

Finally, the main conclusions are discussed in **Chapter 10**. The chapter brings out the linkages, both synergies and conflicts, between CCIs and SSIs and *vice versa*. 
Figure 1.1: Structure of the thesis

The thesis, therefore, focuses on SSIs which have not been adequately addressed in the climate change literature. It does not limit itself to assessing the generic nature and potential advantages or disadvantages of the CCIs but attempts to examine and provide empirical evidence for the potential interaction between these instruments and national sustainable development goals, with particular emphasis on the SSI sector in India.
2. Theoretical background

2.1 Introduction

This research aims to examine the link between CCIs and SSIs. The rationale for examining this linkage is provided in Chapter 1. This chapter provides the theoretical background. The research essentially deals with two main themes at the theoretical level: (i) policy instruments for environmental protection (specifically for addressing climate change), and (ii) diffusion of technologies (specifically cleaner technologies) in small and medium enterprises in developing countries (specifically agglomerations or clusters of small-scale industries or SSIs). In doing so, it uses and combines theoretical perspectives related to two streams in economics: (i) ecological economics for assessing the climate change policies and instruments for diffusion of cleaner technologies at various levels, and (ii) evolutionary theory of technological change for providing insights into the complexity of factors influencing cleaner technology diffusion in the SSIs.

The chapter deals with the two theoretical themes in Sections 2.2 and 2.3. Though the two themes are important individually, a combination of the two provides a holistic perspective regarding the macro-micro linkages addressed in this research – and is more than just a sum of the parts. The aim is to provide a discussion of the relevant concepts, and draw conclusions in Section 4.

2.2 Policy instruments for addressing climate change

There are several policy instruments for environmental protection in the literature that may also be used for addressing climate change. These may be classified on the basis of the routes they take to influence actions and decisions of the relevant actors (here, entrepreneurs or industrial units is the focus of the thesis), and provide incentives for them to undertake steps for environmental protection. They include regulatory, economic and suasive instruments, and these may be used in isolation or in combination with each other (Opschoor and Turner 1994). The regulatory instruments alter the set of options available to the actors, e.g. standards, limits, norms, bans. They identify the appropriate course of action and make particular forms of ac-

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4 The foundation of policy instruments lies in the theory of externalities (in environmental economics) that the use of natural resources as a factor of production is not internalised sufficiently and is reflected in market prices leading to external costs or externalities (pollution), and, thereby, the socially optimal level of economic activity doesn’t coincide with the private optimum (Baumol and Oates 1971). One way of achieving the social optimum is by the use of policy instruments. See Box 2.1.

5 Incentive here is broadly taken to mean stimulus for change and not only incentive in financial terms.
tion mandatory. In an ideal situation, therefore, the actor (polluter) is left with no choice and has to either comply or pay the penalties. The instruments can range from specification of thresholds or ceilings to location of pollution activities. In most cases, the polluters are required to adhere to standards (which may be technology- or performance-based).

The economic instruments alter the relevant cost–benefit ratios of the options using economic incentives or market stimuli, e.g. in the form of changed relative prices and/or financial transfer. Thereby, they do not provide explicit directives to dictate a particular technology/behaviour, but allow the actors to choose the method “best” in their particular circumstances. This built-in flexibility helps in achieving the environmental goal at a lower cost. These instruments may be market creating (e.g. tradable quotas, permits) and non-market creating (e.g. taxes, subsidies, deposit-refund schemes).

The suasive instruments alter the sensitivity or preference for environmental aspects of the options using moral suasion, e.g. awareness creation, eco-labelling. They aim at full ‘internalization’ within the preference structure of the actor (Opschoor 1995), and can play an important role in influencing the market. In fact, it may be argued that due to public opinion, the trajectories of today’s technological revolutions are inherently less environmentally exploitative than those of the past, and environmental concerns and social values have started gaining wide acceptance in the technology and business strategies of industry (Freeman and Soete 1997).

Another instrument that has emerged is voluntary agreements (VA), or deals (negotiated contracts) between government and industry to undertake measures specifically to achieve an environmental benefit (for example, agreements to phase out chlorofluorocarbons). VAs may be prompted due to unforeseeable social demand or a threat of regulation. In case of non-compliance, government may impose a regulations or coercive measures at the end of the contract period.

2.2.1 Assessment of policy instruments

In traditional environmental economics, economic instruments are preferred over regulatory instruments as they offer a more cost-effective way of achieving environmental goals (Figure 2.1). However, this is only in theory as it ignores issues like uncertainty, feasibility, acceptability and market distortions (Box 2.1 specifies some

6 The standards include: ambient quality, emissions, behavioral, process and product standards.

7 This is observed as several corporations are attempting to appear ‘green’ (especially as the public has started placing a premium on it). Even expensive ‘cleaner’ products (e.g. recycled paper, organic food) make business sense. In the case of climate change, people as well as developmental/environmental NGOs play a role in the negotiations and discussions.

8 The theoretical comparisons of the instruments have been dealt with at length in the literature (e.g. Bohm and Russell 1985). Some others include (Baumol and Oates 1971; IPCC 2001b; OECD 2000; Opschoor 1995; Panayatou 1994; Tietenberg 1985).
restrictive theoretical assumptions). What may be efficient in economic terms and in the first best setting, may not be acceptable or feasible for socio–political reasons (also known as the administrator’s dilemma), or may not be as efficient in a distorted world with market failures (or in the second best setting).

**Box 2.1: Theoretical foundations for economic instruments**

Pigou (1920) suggested that in the face of an externality (such as pollution) in a market economy, a per unit tax (Pigouvian tax) equal to marginal external social damage caused by the last unit of pollution at the efficient allocation on the emissions from a polluting activity may be levied. The tax offers a lower cost method of achieving a given environmental goal as compared to a standard. However, the setting of the “optimal level” is based on the assumption that the costs and benefit functions are known, and will be acceptable (in economic and political terms).

Coase (1960) emphasized the importance of property rights and bargaining between polluters and sufferers – rejecting intervention by the government (e.g. in the case of Pigovian taxes) in favour of market bargaining underpinned by appropriate property right in order to achieve the social optimum. The ‘Coase theorem’ lays down that, regardless of the ownership of the property rights, there is an automatic tendency to approach the social optimum via bargaining. However, this does not hold in case of existence of imperfect markets, high transaction costs, difficulties of polluters and sufferers, identification and threat marking behaviour or differences in negotiating power (a scenario nearer to the climate change negotiations). This theorem brought to the fore the importance of bargaining and transactions costs.

Baumol and Oates (1971) offer the same advantage as a Pigouvian tax or charge but in a more cost-effective manner in a collective sense, by giving the polluters a chance to trade their pollution rights (emissions/discharge permits). They demonstrated formally the general properties of a system as was anticipated Dales (1968) and Crocker (1966) (for water and air respectively). Their paper was about a charge system designed to meet a predetermined environmental target, and was not explicitly about a marketable permit system but it did give a formal basis for it. It illustrated that as long as transactions are beneficial, a market for pollution rights will function.

Both taxes and tradable permits tend to equate the marginal cost of emissions abatement for all affected sources. The difference is that the government sets the tax (administered pricing) and the level of emissions is determined by the responses of the affected sources; whereas in a tradable permit system, the government determines the overall level of emissions, and the market determines permit prices.

References: (Baumol and Oates 1971; Coase 1960; Crocker 1966; Dales 1968; Pigou 1920)

For evaluating (and selecting) the policy instruments, there are a number of criteria provided in the literature. These may be broadly categorised into two 

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9 Select authors (Adar and Griffen 1976; Weitzman 1974b) show that uncertainty (e.g. regarding marginal abatement costs and benefits/damage) may lead to preference of one instrument over another depending on the uncertainty, and elasticity of damage and control functions.

10 For instance, (Goulder et al. 1999) show that the overall costs and cost-effectiveness of instruments may be affected by market distortions like pre-existing taxes; i.e., extending the literature on choice of instruments for a second best setting (relatively a more realistic situation).

11 For an overview, see (Fischer et al. 1998; OECD 1997).
and Turner 1994). Firstly, there are the optimality criteria that are concerned with the issue – whether instruments will do the desired job and at an acceptable performance level. These include environmental effectiveness (in meeting the environmental goals) and economic efficiency (cost-effectiveness – static and dynamic)\(^{12}\). Secondly, there are the concordance criteria that are concerned with the acceptability of the instruments.\(^ {13}\) These may include social and political acceptability (including the motivation, information and resources of various actors – regulators, entrepreneurs and other stakeholders)\(^ {14}\), and administrative feasibility (including implementation requirements and existing policies and institutions, and being supportive of and consistent with broader policy objectives). In this thesis, the relevance of specific policy instruments for a particular sector is analysed and the feasibility and acceptability issues are especially important.

The contention is that the performance of the policy instruments depends not only on their design and characteristics and thereby the potential incentives they may provide, but also on the context and the circumstances in which they are applied, high-

\(^{12}\) Efficiency refers to capability for maximizing net benefits. However, given scientific uncertainty related to costs and benefits as well as their economic consequences, this is usually referred to as cost-effectiveness (minimizing costs of abatement).

\(^{13}\) Environmental economics tends to emphasise the optimality criteria, specifically economic efficiency. It may bring in aspects of concordance in terms of costs (e.g. implementation costs), and dealing with them in optimality terms. Riordan et al (1998) distinguish between three types of costs relevant for neo-classical analysis: production, implementation and public finance (price distortions). Others (e.g. Jaffe et al. 1995) provide a set of associated costs. In general these are treated separately. Also, it is not possible to convert all implementation and acceptability issues into cost terms. However, though the approach is a powerful tool for providing theoretical insights for partial and generic analysis – it is restrictive in terms of its underlying assumptions and applicability to real life situations (esp. related to social context).

Ecological economics, being trans-disciplinary, may consider both sets of criteria within the social context. Though it lets various perspectives be incorporated in order to provide a “realistic” and broader scenario, it does not recommend a superior or “appropriate” perspective or methodological tools for analysis (these may differ based on the behavioural assumptions or questions being researched). It allows for (as in this thesis) using environmental economics tools in combination with other theoretical perspectives, like a political economy approach, addressing both sets of criteria and also issues of scale.

\(^{14}\) This draws from the political economy approach. The approach treats the policy instruments within a "political market" consisting of interest groups with a stake in the policy instruments (demand side) and regulators and administrators involved in design and implementation (supply side) that may favour different instruments based on their interests and motivations (Keohane et al. 1999). Specifically, the “contextual interaction theory” deals with the implementation of policy instruments as separate from their selection (i.e. turning “envisaged” incentives into “real” incentives), and dependent on the behaviour of the target groups (a complex rather than individual actor) – by focusing on the characteristics of the actors involved, particularly their motivation, information, and power/resources, and their interactions (all other factors are external circumstances that influence these core circumstances) (Bressers 2003).
lighting the role of prevailing policies (and institutions)\textsuperscript{15,16} This is especially significant as sustainable development is increasingly being recognized as a context-specific concept, and particularly in the case of climate change policies where political considerations and bargaining processes may play a pivotal role in their selection and performance.\textsuperscript{17}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{Cost-effectiveness (uniform taxes versus uniform standards)}
\end{figure}

Assuming four units with different marginal abatement costs: MAC1<MAC2<MAC3<MAC4.

To bring down pollution, a uniform tax may be fixed at the level $T$, or a uniform standard fixed at level $S$.

With \textit{standard}: Abatement levels are same for all firms ($S$). Thus, the total abatement is $= 4*PS$. And, the total abatement costs $= PAS + PT2S + PCS + PDS$

With \textit{tax}: Abatement levels are different for the four units. The unit with lowest MAC, abates maximum (but pays the lowest tax), and \textit{vice versa}, providing a more cost-effective option. Total abatement $= PP1 + PP2 + PP3 + PP4$. And, the total abatement costs $= PT1P1 + PT2P2 + PT3P3 + PT4P4$.

\textsuperscript{15}Policies (and policy instruments) and institutions are important in influencing and shaping each other. Institutions may be defined as a set of rules, norms that facilitate coordination of human behaviour (section 3.2). Institutions are important for picking up signals, balancing interests and executing agreed decisions; and may be weak when interests are dispersed.

\textsuperscript{16}The context has been treated differently in the literature. The contextual theory in political economy literature describes these in terms of interest groups and their interactions. And, the literature on social institutions and environmental regimes (e.g. IHDP-IDGEC literature) describes these circumstances as \textit{contextual factors} that affect the effectiveness of institutions and policy instruments (chapter 3).

\textsuperscript{17}For example, authors (Fredriksson and Svensson 2002) have examined the influence of political instability and corruption on environmental policy formulation. Political instability in a country may have a negative effect on the stringency of policy instruments if corruption is low, but a positive effect if corruption is high.
2.2.2 Regulatory versus economic instruments

In general, regulatory mechanisms are effective provided they are properly enforced. Their main weaknesses are that they are: (i) **static**: lack incentive for polluters to take action beyond the regulated level, and may also deter them from adopting superior technologies fearing a revision in standards to make them more stringent (Figure 2.2); (ii) **inflexible** and inefficient: they may not encourage most cost-effective options; (iii) **narrow** in terms of expecting uniform behaviour in heterogeneous situations and actors; and (iv) **difficult to enforce** in case of many actors. On the one hand, use of existing regulatory structures and institutions may help reduce administrative costs – in fact, where there are relatively few sources of a pollutant, regulation may be the most administratively feasible option. On the other hand, they may be constrained due to weak enforcement, especially in developing countries, with insufficient monitoring and enforcement mechanisms, and limited technical and financial resources available. Political consensus in these cases is also difficult to achieve, and is often subject to negotiations between government and private sector/independent players.

Economic instruments, on the other hand, while offering **dynamic disadvantages** (encourage diffusion of cleaner technologies) and **flexibility**, also tend to be easier to enforce (especially in case of emission trading where prices are fixed by markets) and have the potential to yield fiscal benefits (e.g. in case of taxes, auctioned permits, reducing subsidies). However, their effectiveness may be reduced due to lack of **information and uncertainty** (e.g. data regarding the marginal costs-and-benefits functions), and at times **macroeconomic impacts** (especially the fiscal instruments – raising issues of distributive equity). In some cases, they may not be feasible as the required governance structure or the political structure where economic agents respond

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18 World Bank 1997 argues that the regulators and polluters are involved in a complex game. The regulators need information to establish “acceptable” pollution levels and polluters want to maximize private benefits without antagonising the inspectors. Thereby, the game is associated with two kinds of decisions – the regulator’s dilemma (choice of optimal solution/ specification) and the polluter’s dilemma (to pay penalties or incur costs of abatement). While the former is dependent on enforcement levels and information, the latter is associated with size, market conditions, worker skills and environmental management in the polluting unit, and together they may alter the effectiveness of the regulations.

19 Using the neo-classical approach and building on the basic model illustrated in Figure 2.2, the **discrete technology choice models** analyse and compare incentives for the firms under different policy instruments (Jung et al. 1996; Milliman and Prince 1989; 1992 - for heterogeneous firms). The main conclusion is the standard one that economic instruments provide better incentives for technology adoption and innovation by firms than direct control (uniform standard). However, they do not consider policy making under uncertainty, and do not distinguish between different technologies. These concerns are addressed to some extent in a model (Kemp 1995), which is based on a political economy model of regulator’s behaviour (Nentjes 1988). In contrast to the earlier results, Nentjes showed that in most circumstances, a tax provides less incentive for innovation, and tradable permit more than direct control or standard. Kemp (1995) extended this model to show that innovation waivers and tradable quotas may be better than direct regulation and taxes in promoting innovation.
sensitively to the changes in incentives may not be available/adequate. For example, this may be the case in countries or sectors with tight government control, socialist regimes, societies with strong business lobbies, or in the case of many developing countries that may not have the required institutional and governance structure and sufficient experience in implementing the economic instruments.

Figure 2.2: Dynamic incentive (tax versus standards)

A uniform tax is fixed at the level $T^*$, while the uniform standard is fixed at $S^*$. In case of technical progress, abatement costs decrease and the marginal abatement curve shifts from MAC1 to MAC2.

With tax: Polluter has to bring down pollution (or increase pollution abatement) – and therefore, pollution abatement increases from PP1 to PP2 (now at a lower cost): implying a dynamic incentive for the polluter. However, he now pays a lower tax. Thus, the cost saving = saving in abatement costs + tax savings. Thereby, polluter has double incentive for technical change.

With standard: The polluter does not have to bring down pollution level more than the specified amount $S^*$, implying no dynamic incentive unless the standard is revised. The pollution abatement remains unchanged at PP1. And, cost saving = only abatement cost saving.

Thus, it seems that that regulatory instruments fare better in terms of effectiveness, while economic instruments score higher in terms of efficiency. In terms of other criteria, however, the theoretical outcomes are not so explicit. All policy instruments require some kind of institutions capable of establishing rules of conduct, monitoring performance and enforcing compliance (Blackman 2000). And, though market-based mechanisms are considered to reduce administrative and enforcement costs, it

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20 Also referred to as “bureaucratic inertia” – that governments may prefer regulatory instruments as they are known and long used.

21 For example, the environmental institutions in developing countries are generally weaker than in developed countries, along with complementary judicial, legislative and data-collection institutions, and fiscal and technical resources are limited – this affects the performance of the instruments adversely.
cannot be categorically stated as such. Acceptability on the other hand, is dependent on the perceptions of various interests groups and the existing socio-political scenarios.

**Table 2.1: Some relative features of the policy instruments**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Regulatory</th>
<th>Economic</th>
<th>Suasive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Route for influencing decisions</strong></td>
<td>Alteration of the set of available options</td>
<td>Alteration of the cost-benefits ratios of available options (direct, indirect by fiscal means, or market creation)</td>
<td>Alteration of actors’ sensitivity or preferences</td>
</tr>
<tr>
<td><strong>Potential incentive (for actors)</strong></td>
<td>Avoid penalty or action (judicial/administrative procedures)</td>
<td>Economic incentive</td>
<td>Avoid social isolation</td>
</tr>
<tr>
<td><strong>Potential advantage (from regulator’s point of view)</strong></td>
<td>Effectiveness</td>
<td>Efficiency</td>
<td>Project “green” image</td>
</tr>
<tr>
<td>May use existing regulatory framework (decreased administrative costs)</td>
<td>Dynamic</td>
<td>Flexibility of choice</td>
<td>Flexibility of choice</td>
</tr>
<tr>
<td><strong>Potential disadvantage (from regulator’s point of view)</strong></td>
<td>Are static</td>
<td>Macro-economic implications</td>
<td>Acceptability</td>
</tr>
<tr>
<td>Enforcement difficult or costly (esp. for many actors)</td>
<td>Distributive and equity considerations</td>
<td>Feasibility (less costs)</td>
<td></td>
</tr>
<tr>
<td><strong>Examples of potential instruments for climate protection (national level)</strong></td>
<td>Behavioural, technology standards (e.g. for emission or energy efficiency)</td>
<td>Taxes (energy, carbon, emission)</td>
<td>Awareness programmes</td>
</tr>
<tr>
<td>Bans</td>
<td>Permits or quotas (national, sectoral)</td>
<td>Eco-labeling</td>
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<td>Mandatory energy audits</td>
<td>Subsides (reduction/ temporary allocation)</td>
<td>Voluntary agreements (VA)</td>
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<td>Non-tradable quotas (quantitative targets)</td>
<td>Financial (grant, loan)</td>
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<td>International standards</td>
<td>Taxes (harmonized or international)</td>
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<tr>
<td><strong>Examples of potential instruments for climate protection (international level)</strong></td>
<td>Emissions trading (e.g. Kyoto mechanisms)</td>
<td>Voluntary commitments</td>
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<td></td>
<td>Financial (e.g. GEF)</td>
<td>Awareness and capacity building</td>
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<td>VA</td>
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Economic instruments are generally considered to be easier to implement as they are “fixed” by the markets. However, there is little evidence of monitoring costs of different instruments, and there is no reason to believe that costs for economic instruments are lower than regulatory instruments (IPCC 2000). Bla ckman (2000) divides the policy instruments into direct: that require the regulator to monitor emissions; and indirect: that do not require emissions to be monitored (e.g. technology and process standards, taxes). He states that it may be fair to say that in general the direct economic instruments (emission permits) are more demanding than direct regulatory instruments (emission standards).
The issue in practice however, is not that of economic versus regulatory instruments, especially since, as noted by Opschoor and Turner (1994), the environmental policy instruments in practice typically come as a combination or mix of the pure elements (whereby economic instruments complement regulations by providing additional incentives for pollution abatement). The issue is to choose, design and implement instruments that may are suitable in the particular circumstances.

2.2.3 National and international policy instruments

Policy instruments for addressing climate change can be set both at the national and the international (bilateral, multilateral or global) levels. While the main focus of this thesis is on instruments provided at the international level, we begin with a discussion of national instruments (that form the basis of the international instruments). The emphasis is on those instruments that provide incentives for relevant actors to undertake GHG mitigation/abatement activities and encourage diffusion of cleaner technologies in industries.

The criteria for evaluating instruments for climate protection are also similar to those for environmental protection. However, in the context of global environmental issues, there is a difference as we are dealing with (i) a global public good (ii) scientific uncertainty, and (iii) a large number of (heterogeneous) actors (there is evidence to show that complexity of policy instruments is positively correlated with the number of the actors involved). Therefore, issues of scale and equity become important especially for international instruments.

2.2.3.1 At the national level: Regulatory instruments

At the national level, there is a significant role for regulatory instruments for addressing climate change. In most developing countries, regulatory instruments form the basis of environmental policy. However, there is evidence that in many cases, they tend to be inadequate, and often there is lack of capacity to enforce them. Some specific examples are regulation in the energy supply sector regarding natural gas flaring and safety controls in coal mines and oil rigs; in the transport sector regarding

### Footnotes

23 Evidence indicates that countries with better institutional capacity developed through regulatory standards are generally more successful in implementing economic instruments (Russel and Powell 1996).

24 Public goods are defined as those which are non-excludable and non-rival. Global public goods are the public goods whose benefits extend to all countries, people and generations (Kaul et al. 1999).

25 This includes a multiplicity of decision-makers, ranging from global decision-making to micro-level firms.

26 See (Dasgupta et al. 2001; O’Connor 1996; Pargal and Wheeler 1995; Scott 2000).

27 In terms of only micro-level decision making, entrepreneurs will comply with regulatory instruments when the marginal cost of compliance is less than marginal cost of non-compliance (may be a function of penalties, probability of prosecution). With weak enforcement, costs of non-compliance decreases and shifts the marginal cost curve, and effectively decreasing the incentive for change for the polluter.
emission norms and banning of older vehicles; in the forestry sector regarding deforestation and usage of forest produce, and in industries – mandatory energy and environmental audits, and energy efficiency standards.

Regulatory instruments can be explicitly designed to be “technology forcing” or technology “diffusion forcing”, and can make technologies materialize much faster (Bohm and Russell 1985). However, they tend to be enforceable to the extent that technological possibilities exist or are likely to be developed (Barde 2000). Performance-based standards are, in general, more flexible and thereby more efficient, than the technology-based standards. On the other hand the technology standards may be easier to monitor and enforce. They are considered especially relevant in the initial stages of environmental policy development (Cole and Grossman 1998).

2.2.3.2 At the national level: Economic instruments

The use of economic instruments though limited is slowly increasing in developing countries. Although theory offers market creating and non-market creating instruments (Panayotou 1994), the focus in practice has been on the latter.

The non-market creating instruments include *taxes* (may be based on energy, carbon or emissions – CO2 or GHG), and *subsidies* or financial incentives such as grants (non-repayable forms of financial assistance), soft loans (loans with interest rates below market rates) and tax allowances (exemptions, rebates and accelerated depreciation). In theory, both taxes and subsidies lead to similar outcomes in case of homogeneous firms (taxes increase and subsidies decrease the costs of abatement). In case of subsidies, incentives may be provided by both reduction of the relevant subsidies (fiscal instrument) as well as deploying subsidies to encourage use of cleaner technologies (financial instrument) – that is, by eliminating permanent subsidies that encourage fossil fuel use, and offering temporary subsidies for activities aimed at limiting GHG emissions.

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28 A carbon tax as a proxy for GHG emissions tax for fossil fuel use is generally considered more efficient than other forms of taxes.

29 However, taxes are considered more efficient especially in the long run. In the short run in case of heterogeneous firms, subsidies may allow firms to continue operating that would not be able to continue in case of a tax, but they do add to the burden on the public resources. Both taxes and subsidies are associated with distributional effects, which play an important part in their feasibility and acceptability, and at times overshadow the efficiency aspects in practice.

30 Reductions in or elimination of subsidies normally results in environmental benefits and monetary savings to the Treasury. Evidence shows tapping even part of the potential saving from reducing subsidies could go a long way to meeting the need for new financial resources to help developing countries achieve sustainable development (World Bank 1997).

31 While the use of targeted subsidies goes against the general trend of reducing government intervention in the market place, their use can be justified, particularly if offered on a temporary basis to encourage use of new technologies during market introduction or development. Thus, though they are not encouraged in pure economic terms but are relevant in terms of development and equity issues.
By the use of market creating instruments, like emissions trading, markets may be developed for tradable permits or quotas (e.g. for GHG emissions) which could be formulated at the national or sectoral levels. Emissions trading provides a more cost-effective option than uniform taxes or subsidies (Figure 2.3). These could be negotiated for a single gas, a group of gases, or as an aggregate of CO₂ equivalent.

However, there are many practical problems associated with trading, such as (i) its complexity regarding trading rules and design such as allocation of initial rights, banking provisions; (ii) dependence on infrastructure or mechanisms required to monitor transactions; and (iii) reliance on market forces.

In theory, permits and taxes also exhibit symmetry. While permits set the level of control, taxes (and subsidies) set marginal costs of control. In practice, however, there are significant differences between taxes and emissions trading. Trading has advantages in terms of: (i) less uncertainty as pollution may be fixed a priori according to the number of permits, (ii) automatic adjustments for external circumstances (like inflationary pressures and technical change) unlike taxes that have to be adjusted, (iii) accommodation to industry change (new entrants can theoretically buy permits from existing firms and state does not have to intervene), (iv) acceptability by polluters/industry (compared to taxes), and (v) cost-effectiveness. On the other hand, taxes have advantages in terms of (i) dynamic incentives (ii) revenue – taxes provide rent to the government, while trading may or may not depending on the trade rules, (iii) less uncertainty – as overall cost is set before hand, unlike trading where it depends on the market (iv) transaction costs and strategic behaviour – trading is associated with higher transaction costs in terms of monitoring (taxes may use existing mechanisms) and is usually more susceptible to strategic behavior and needs competitive market conditions, and (v) acceptability by governments (they retain their control on the industry).

32 The most important example is the US trading of SO₂ and NOₓ emissions, which is being implemented with reasonable success. Another example, is auctionable permits for consumption of ozone-depleting substances in Singapore. The experience with such trading at the international level, however, is limited, e.g., CFC production-consumption quota trade in the EU.

33 Initial allocation may be by auction, lottery or allocation criteria. (Montgomery 1972) shows that the initial allocation does not affect the cost-effectiveness of the trading. However, this holds only when there is one goal that may be satisfied by the initial allocation (Tietenberg 2000). (Zhang 1999) shows that initial allocation can also affect the rules for new entrants.

34 A good summary of these issues is provided by Tietenberg 2000.

35 General – (Stavins and Whitehead 1992), due to uncertainty - (Weitzman 1974a), due to transaction costs – Baumol and Oates 1982 and (Stavins 1995), and political feasibility.

36 There is evidence that, in some cases, the inflationary forces have eroded the effect of emission charges, like in case of select Eastern European countries (Bluffstone and Larson 1997).
Assuming 2 units or countries with different marginal abatement costs \( \text{MAC}_1 < \text{MAC}_2 \). The policy requirement is to reduce the total pollution level to \( 0Q^* \). This may be done using a uniform tax or trading.

With tax: Unit/country with lower marginal cost abates more but pays lower tax, and vice versa.

With permits: total number of permits is \( 0Q^* \). Demand for permits is less for unit/country with lower costs = \( 0Q_1 \) and more for country with higher costs \( 0Q_2 \). The unit/country with higher abatement costs may buy it from the country with lower demand, thereby, bringing in cost-effectiveness.

For emissions trading to work efficiently, the “right” market conditions are required (Tietenberg 1998, 2000). Some major issues (concerns) related to emissions trading are also relevant for international trading. These include, firstly, the transaction costs – three potential sources have been identified by Stavins (1995): search and information, bargaining and decisions, and monitoring and enforcement, that add to the cost of implementation of the instruments\(^{37}\). Secondly, market power – the potential for some economic agents to influence permit price and market power in output market can lead to market distortions (Hahn 1984, 1989; Malik 2002). Thereby, smaller players are likely to have less information (about market conditions, abatement costs, etc.) and negotiating power, and thus may have a disadvantage. However, there are possibilities of formation of cartels and groups to exercise market power. And, thirdly, compliance – implementation, monitoring and enforcement, including free riding and leakages is an area of concern (Barrett 1994).

\(^{37}\) Other costs may be included. For example, some (Dudek and Wiener 1996) also include insurance and approval costs.
2.2.3.3 At the international level: Regulatory instruments

At the international level, there is little scope for using direct regulation over and above non-tradable emission quotas (country- or sector-wise). However, adoption of a fixed and non-tradable quota may lead to inefficiency as marginal abatement costs differ among countries (IPCC 1996a). This is in line with the theoretical indications regarding implementation in case many players are involved.

Another potential option for the use of regulatory instruments is setting international technology standards for GHG emissions across sectors or industries, or specific GHG-mitigation technology. Combined with suasive instruments and increasing awareness, these could lead to a change in actor preferences towards cleaner technologies. Developing effective regulatory standards, however, requires national and international leadership to balance different interests while creating sufficient societal support and incentives for implementation (IPCC 2001b: 412). And, establishing uniform standards will be hard, as it will be difficult to achieve consensus on appropriate standards as they may limit domestic policy choices of individual countries. These standards, on the other hand, for example, could be included within the International Standards Organisation (ISO) environmental series of standards.

At the international level, GHG abatement targets (discussed further in Chapter 4) have been set for the developed countries (at least a proportion of which have to be complied with by domestic action – and therefore, is non tradable). However, they are not really based on scientific reasoning but rather mainly on a political consensus. Without a proper compliance mechanism, these commitments may not be met, in light of problems such as leakages and free riding. This is so as costs and benefits of abatement are not uniform across nations (in fact, it is the developing countries which are likely to be more vulnerable, given their lower economic and technological capabilities).

2.2.3.4 At the international level: Economic instruments

Literature narrows down the discussion of the international policy instruments for addressing climate change to three main economic instruments, namely (i) subsidies (financial), (ii) tax, and (iii) trading (IPCC 2001b). They may bring in incentives for diffusion of cleaner technologies by way of financial, technological and capacity-building benefits (IPCC 2000).

International subsidies: These include international financial transfers (and technology transfer) in the form of grants, loans, etc. The main contention for providing fi-

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38 Internationally, the ISO 14000 series of environmental management standards of the International Organization for Standardization (ISO) can foster a greater ecological conscience in industrial sectors.
39 There have been discussions at the climate change negotiations and literature about entitlements, sharing of the “carbon space” and “convergence and contraction” to an agreed emission limit based on scientific principles (such as per capita emissions, energy intensity, GDP or a mix), but little progress has been achieved.
nancial incentives at the international level is based on the principle of “common but differentiated responsibilities”. Climate change is a global concern and needs to be addressed by all countries. However, as the developing countries may be constrained in terms of financial resources and other limitations (like technology), it is recognized that in order to address climate change issues (also given their other development needs) they may require financial assistance.

**International taxes:** At the international level, a tax can be implemented in two ways: (i) a **harmonized tax** whereby an international agency would impose a tax on participating countries (and a formula for redistributing the revenues), and (ii) **uniform taxes** wherein the countries could agree that each would levy comparable taxes domestically (and a formula specifying share of total revenues for various countries). However, the main weakness with this instrument pertains to its acceptability and feasibility (along with adjustments for external changes). To achieve political consensus at an international level is difficult – a tax imposed by an international agency would impinge upon national sovereignty, and, given the differences in resource endowments, consumption patterns, climatic situations and other factors like the existing tax regimes among countries, a uniform tax rate would be complex and difficult to implement.

**International tradable permits or quotas:** In case of international trading, countries negotiate national limits on emissions of GHGs as either voluntary or legally binding targets/quotas. The exchange could be based on “emissions permits”, or alternatively on emission reduction units or ‘abatement credits’. Trading may use other instruments – e.g. carbon trading is actually a combination of a regulatory measure (i.e. the total volume accepted) and an economic one (trading quota within that minimum). Together with the issues listed above (Section 2.3.2), there remain several design issues such as sovereignty, equity, eligibility, procedural issues, monitoring and verification, compliance, endorsement and certification body, banking, liability. In addition, trading with countries without property rights or abatement targets or permits may raise issues regarding environmental effectiveness. Some of these issues will be touched upon in Chapter 4 while dealing with the CCIs under the UNFCCC and the Kyoto Protocol.

Emissions trading can take various forms; for instance, (i) international trading and (ii) bilateral trading. The latter is based on an innovative system of “Joint Implementation (JI)”, which facilitates co-operative abatement projects in countries where the abatement costs are lower, with sharing of credits. (This has also led to the establishment of the Clean Development Mechanism or the CDM on similar lines, which is discussed in Chapter 4). It deals with a particular form of emissions trading, based on bilateral or multilateral negotiated deals between companies or governments of countries wherein the credits/permits of abatement of one country may be used by another country to meet its quantified emissions abatement targets. Based on these

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40 See (Bohm 1998; IPCC 2001b; Tietenberg 2000; Yamin 1998).
the price of credits/permits may be an international price set by the market or a price negotiated by the involved parties.\(^{41}\)

2.2.4 Assessment of international policy instruments

Evaluations of the three international policy instruments in the literature suggest that if only economic efficiency criteria are considered, the most cost-effective international economic instruments are tradable quotas or permits, and international carbon taxes (IPCC 1996c, 2001b). On the other hand, however, if acceptability (and feasibility) issues are also considered then the most feasible options may be the subsidies and emissions trading (and not taxes). Thus, it seems that emissions trading will be the most preferable option, provided of course the transactions costs are not very high and there are no significant prevailing market imperfections (both very restrictive assumptions when there are numerous heterogeneous players involved).

As mentioned before, the effectiveness of the instruments in practice would depend not only on how they are designed (and the kind of incentives they offer – directly or indirectly), but also on the context and the circumstances when and where they are used (contextual factors). A government may apply different weights to the criteria when it evaluates or implements different GHG mitigation potentials, depending on national and sector level circumstances (such as socio-economic settings, governance structure, vulnerability to climate change impacts). Moreover, it may apply different weights when it evaluates national and international level instruments (depending on the pollution abatement costs, political considerations, etc). Developing countries form a large and heterogeneous group with numerous options for GHG abatement and in many cases they possess less economic and information resources (to assist in negotiations and meet the compliance requirements of the international instruments).

These circumstances present quite a complex scenario for the international policy instrument, particularly since they are negotiated internationally in a political setting (i.e. affected by perspectives of member parties, national representatives and different interest groups), and their implementation is dependent on the national levels (that are different in terms of the socio-economic, institutional and political structures).\(^{42}\) And, implementation is at the local levels where the mitigation activity is actually undertaken (the impact on the target group will depend on the situation on the ground). A major issue here is compliance and implementation – to what extent can

\(^{41}\) Normally these may be higher than the incremental costs provided by GEF (Ghosh et al 1998)

\(^{42}\) IPCC (1996) points out that to some extent the choice of the instruments will be dictated by existing institutional infrastructure and experience, and domestic policies. Enforcement also varies between the countries depending on their political will and institutional capability.
the countries adhere to provisions of the international instruments within their national contexts.\textsuperscript{43}

The instruments that are selected and designed at the international levels should ultimately provide incentives for change at the local levels. This brings in the issues of interplay between different scales and levels. Thus, the design and implementation (including their acceptability and relevance) of the international instruments may be at three levels: the international, national and local. The implementation of the international instruments would have to be through the national level instruments and policies, and will be dependent on the willingness and ability of the national governments (their interaction between different interest groups) and their particular circumstances. It is possible that international instruments may be accepted at the international level, but their use is restricted at the national level, or the design of the instrument at the domestic level may be different from that at the international level; for example, there may be several options for designing domestic systems to complement international instruments.

Therefore, using a broad perspective, it may be fair to say that the performance of policy instruments is affected by the policies (within the overall contexts) at different relevant levels of social organization and decision-making, together with their design and characteristics. There is a possibility of design changes for each category of instruments as well as using a combination of instruments to improve the incentive structure that they represent.

\section*{2.3 Small-scale industries and diffusion of cleaner technologies}

This section deals with how SSIs are treated in theoretical literature, particularly in relation to the diffusion of cleaner technologies and the relevance of policy instruments in this regard. But first, \textit{what are SSIs?}

\subsection*{2.3.1 SSIs in developing countries}

There is no uniform definition of SSIs across different countries, and how they are handled in the literature. The more commonly used term in the literature is small and medium scale enterprises (SME). They are defined in various ways: on the basis of their size, number of workers employed, turnover, etc. As pointed out in Chapter 1, in India, SSIs are defined on the basis of investment in plant and machinery, and this is the definition used in this thesis. This thesis essentially deals with those SMEs or SSIs in developing countries engaged in industrial activities (manufacturing) that are energy intensive and are therefore important from an environmental (particularly climate change) point of view.

\textsuperscript{43} For instance, it is pointed out (Evans 2003) that the manner in which international emissions trading is implemented at the national level – including its international credibility and feasibility to launch the system politically and manage it administratively – will be critical to its effectiveness.
Studies have shown that SSIs can play a key role in socio-economic development and objectives in developing (Schumacher 1989, UNIDO 1999). As per the estimates of the Asian Development Bank (ADB 1997), they account for over 90 percent of industrial establishments, generate between 20–40 per cent of industrial value added, and employ over 50 per cent of the industrial labour force (this can be as high as 80 per cent in the less industrialized countries).

2.3.2 SSIs and the environment

Often the environmental impact of SSIs (or the SSI–environment interaction) is assumed to be limited given their small size, and their GHG reduction potential tends to be ignored in literature and in practice. However, studies show that certain SSIs lead to adverse environmental impacts and are inefficient with respect to resource use (Beckerman 1995; Bhalla 1995; Blackman 2000; Kent 1991; Mani and Wheeler 1998). There have been some attempts to quantify the impacts but the most commonly quoted (but not validated) figure is that they may collectively be responsible for 70% of all (local and global) industrial pollution (Hillary 2000). However, there are no concrete estimates available for their collective influence on GHG emissions. Studies also provide evidence that certain SSIs have GHG reduction potentials (Dasgupta 1999; Scott 1998; TERI 2000a), and indicate significant potential for cleaner technologies (UNIDO 1995). However, the literature on environmental aspects, especially from the global environmental point of view, remains limited.

2.3.3 Clustering of SSIs

SSIs, although they have common characteristics, form a heterogeneous group of production units of diverse size, managerial and technical skills, levels of sophistication and growth potentials (Bhalla 1992; Mead and Leidholm 1998). The sector-specific characteristics include (Dasgupta 2000; Frijns and Vliet 1999): (a) dependence on traditional processes (path dependency), (b) resistance to change and short-term perspective, (c) unorganized and dispersed nature, (d) high transaction costs and low negotiating power; and (e) fixed markets.

Often SSI units tend to be located close to each other in what is known as ‘clusters’ – that is, the spatial or sectoral agglomerations of SSIs (Schmitz 1993). SSI clusters seem to be a common feature in developing countries (however, the related research was popularized only after late 1980s)\(^4^\). Clusters usually develop and derive a clear competitive advantage from (UNIDO 1995): (i) proximity to sources of raw inputs, (ii) availability of suitably customized business development services, (iii) abun-

\(^4^\) The research on “clusters” in developing countries is inspired by work on “industrial districts” in developed countries, but evolve own concepts and framework. A special issue of the World Development (1995) was dedicated to comparing the potential of clusters in developing countries, and the “industrial districts”. The difference is largely in terms of their organization and inter-firm relations. Knorringa 2001 also discusses the differences between their growth trajectories.
dance of clients attracted by the cluster tradition in that industry, and/or (iv) presence of a skilled labour force. Clustering induces various inter-firm relations ranging from casual exchanges of information and tools to highly collaborative forms of production relations, usually depending on local socio-cultural factors (Schmitz and Musyck 1993).

Thereby, clustering in general opens up what is called the “collective efficiency” over the individual gains (positive externality) – it compensates for diseconomies of scale and scope through vertical specialization and horizontal cooperation (Schmitz 1995). That is, it raises possibilities of external economies as well as joint action gains. On the other hand, the geographical clusters also lead to collective or concentrated adverse impact on the environment (negative externality) – which is more evident in terms of local environmental problems. GHG reduction potentials also become more pronounced when SSI clusters are examined. Thus, clusters are important for this study not only due to their collective environmental impact, but also as a target for policies and policy instruments.

2.3.4 SSIs and diffusion of cleaner technologies

This section deals with diffusion of cleaner technologies in SSIs within the broader perspective of technological change. Technological change comprises of improvements in the products, production processes, material and intermediate inputs and management methods in the economic system. It can be divided into: invention (generation of new ideas), innovation (development of new ideas into marketable products) and diffusion (new products and processes spread across potential markets) (Schumpeter 1942; Stoneman 1983). For SSIs in developing countries, invention is more often imitation of technologies that have been adopted elsewhere (Romijn 2000). Typically, diffusion of a technology over time is represented by an “S-shaped” curve – rising slowly at first with the introduction of new technology (or imitation by proactive units), then

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45 This concept dates back to Marshall (1890) who argued that economic gains could be had when small firms within a specific industrial activity are clustered in close proximity to each other with a specific knowledge poll available to all. So far, however, the collective efficiency studies have concentrated mainly on the economic benefits, while the technological factors that supposedly underpin these benefits have been given rather cursory treatment (Caniels and Romijn 2001).

46 Although the individual environmental impact of the SSIs (e.g. wastes, emissions) may be small given their small sizes and production capacities, the aggregated impact of all the SSIs clustered together in the geographical region may be quite significant. This is illustrated in the three cases (Chapters 6–8) in this thesis.

47 SSI clusters in general constitute ideal targets for a support agency – they may facilitate intervention because of the similarity of needs and support requirements, and diffusion of technologies may be faster because of demonstration effect and potential to share tools and equipment (Kennedy 1999; Mead and Leidholm 1998).
experiencing a period of rapid growth followed by a slowdown (as most units have switched to it).  

The theoretical work on technology innovation and diffusion in SSIs is closely linked to the evolutionary theory on technological change. The evolutionary approach treats technological change as a complex (part of a broader socio-economic system), non-linear and path-dependent process (Dosi et al. 1988; Nelson and Winter 1982; Sahal 1985). It is especially relevant for the SSIs, which are often driven primarily by short-term benefits and characterized by path-dependent development based on traditional methods of production (sector-specific characteristics).

Diffusion of cleaner technologies is dependent on technical as well as socio-economic, environmental, political and cultural factors (Heaton et al. 1991). The literature identifies several factors that influence diffusion of cleaner technologies (barriers – factors that constrain; and drivers – factors that encourage reaching the diffusion potential). Two related streams within the SSI literature that focus on the micro-level technological capabilities of and technology mastery by the enterprise, and the (already introduced) regional or meso-level concept of “collective efficiency”, are also especially relevant within the diffusion literature and are discussed below.

2.3.4.1 Technology capabilities

This approach is concerned with the long-term development of the diffusion processes. The main focus is on the micro level – the SSI unit, which interacts with the socio-economic environment. The process of change is seen as an interplay of factors that emanate from within and outside the firm in framing what is known as the “technological capability” of the units. Technical capabilities are defined as the technical skills, knowledge and organizational capacity to make the right investment choices, run a given technology efficiently, and engage in continuous upgrading of quality and design (Lall 1992). These are usually divided into three: (i) production capabilities.

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48 The main theoretical explanations are provided in terms of information and learning (epidemic models that link diffusion with spread of disease – infective and contagious (Griliches 1957)), characteristics of potential adopters (rank models (David 1969), characteristics of technology and scarcity of critical inputs (order models) and sensitivity of output prices to technological change (stock models).

49 Within the stream of evolutionary theory of technological change, environmentally saving technological change, in particular, addresses the issue of how to induce and sustain a shift towards cleaner technologies. Also linked to this approach, new frameworks are being developed which may be useful in examining the link between industrial activities and environmental perspectives. These include: (i) ecological modernisation – suggesting that economic and environmental goals can be integrated within a framework of industrial modernization (Gouldson and Murphy 1998; Mol 1995); and (ii) industrial ecology – systems view of the interactions between industrial and ecological systems (Fischer and Scott 1995; Garner and Keoleian 1995). Though these studies focus on policy instruments and technological change in industrial processes, they are limited more often to the micro-processes (such as investment and technology decisions of firms) than macro-processes or especially the macro–micro linkages (Vellinga and Herb 1999).
capabilities – skills and knowledge to operate established plants and use existing technology efficiently, (ii) innovative capabilities – skills and knowledge to make changes to improve and modify existing technology, and (iii) investment capabilities – skills and knowledge to help in choosing, acquiring or installing new technologies. Technological capabilities is close to the evolutionary theory concept of “dynamic core capabilities” whereby the selection routines define a set of things that the firm can do in a confident manner (Nelson 1991; Romijn 1996). Firms follow selection routines (often irrespective of prices) that produce new findings or blueprints (variation as in biological mutations), which may or may not succeed in the selection environment comprising of market and institutional structures (Nelson and Winter 1977).

This approach highlights the aspect of heterogeneity within an industry or cluster, and their organizational aspects. A distinction can be made, however, between technological capability at the unit level (as described above) and at the cluster level. This is because it may be possible that due to heterogeneity within the cluster although some individual firms do not enhance technological capabilities, the cluster in which they are located as a whole may be growth-oriented with rising capacities. The latter is more relevant for cluster-oriented studies.

2.3.4.2 Collective efficiency

Collective efficiency, as introduced before, implies the potential to facilitate growth in a cluster, and may be planned (active) or unplanned (passive) (Nadvi 1996; Schmitz 1995). Passive efficiency may accrue to the cluster-based units in the form of externalities just by virtue of their location (unintended or incidental by products of economic action like labour market pooling, technological spillovers, market access). On the other hand, the former require active and deliberate cooperation or joint action. This may be in the form of horizontal or vertical cooperation (bilateral or multilateral), and underscores the importance of inter-firm linkages and networks. For instance, joint action may facilitate adoption of a technology that may not be feasible for individual SSI units by sharing costs (e.g. technological know-how, hiring consultants etc) or technologies (like common waste treatment plants or monitoring and testing equipment).

However, the potential for collective efficiency is not always realizable. The literature shows that the growth patterns of clusters vary widely – while there are artisan and survival clusters with little dynamism (McCormick 1999), there are others which have broken into the international markets (Knorrinda 2001, Tenberg and Stamer 1999). The former are characterized by fragmented knowledge and limited information flow, latent conflicts and absence of discussion forums, and thereby have poor perceptions regarding joint action. Thereby, clustering may bring out collective efficiency provided there exist

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50 The special issue of the World Development (Schmitz and Nadvi 1999) is devoted to the topic of industrial clusters in developing countries with a focus on collective efficiency and aimed to “specify circumstances in which clustering boosts industrial growth and competitiveness”.

trade networks connecting them to sizable markets, and trust that sustains inter-firm relations\textsuperscript{51} (Schmitz and Nadvi 1999).

2.3.4.3 Innovation and diffusion in SSIs

Both the technological capabilities and the collective efficiency approaches focus on the dynamics of the firms or clusters, but they are limited in their treatment to external factors. However, they emphasise the external context in shaping the unit and cluster characteristics.\textsuperscript{52} As in the evolutionary approach, the search possesses of firms or clusters are informed by technological paradigms (Dosi 1982) or technical guideposts (Sahal 1981), which are available at the level of the sector or technological communities (Rip and Kemp 1998).

The recent literature also emphasizes the challenges of liberalization and globalization for the SSIs, and that technological upgrading is necessary to respond to these challenges.\textsuperscript{53} The question is how this technological upgrading is achieved? On the one hand, it calls for individual initiative or joint action by the industrial units. There is evidence that many clusters in developing countries (most of which are survival clusters) have limited potential for endogenous upgrading due to the complexity of factors that affect it (Knorringa 2002). Although it is argued that clustering facilitates collective efficiency (including mobilization of financial and human resources), reliance on joint action may not be enough to improve efficiency. There is evidence that responses to the challenges have been highly differentiated between the clusters. In general, there is a positive correlation between growth and cooperation and joint action in view of the challenges (joint action has also led to addressing environmental issues – such as setting up common waste management facilities – which may not be possible on an individual basis). However, they have also led to increased differentiation and heterogeneity within the clusters (mainly due to bifurcation of firms surviving in a domestic market and a few large ones (Rabellotti 1992)).

On the other hand, the SSI clusters may require external impetus that would enable a transition towards more efficient and sustainable (cleaner) technological paths. However, SSIs at different technological levels and organizational structures (internal factors) may react differently to external stimuli (van Dijk and Sandee 2001). Also, diffusion may not necessarily lead to upgrading of technological capabilities (which as

\textsuperscript{51} Lack of trust (may be due to socio-cultural factors) brings in discount on the learning (Knorringa 1996).

\textsuperscript{52} As in evolutionary theoretical approaches, even within firms, search processes are informed by technological paradigms (Dosi 1982) or technical guideposts (Sahal 1981), which are available at the level of the sector or technological communities (Rip and Kemp 1998). A technological paradigm is both an exemplar – an artefact that is to be developed and improved – and a set of heuristics (Dosi 1988).

\textsuperscript{53} A related concept – “global value chains” – is addressed in the literature and is essentially concerned with understanding the dynamics of how firms are globally interconnected given the globalization paradigm (e.g. see Bair and Gereffi 2001).
defined before is the ability of SSIs to choose, adopt, adapt and improve technologies endogenously.

Sandee 1995 distinguishes between producer-driven (where the entrepreneur is the main driver, and focus is on learning by doing for individual firms or on social learning for clusters), supplier- or buyer-driven (driven by traders and other intermediaries, especially relevant where there are vertical linkages), and institution driven (driven by government agencies, NGOs etc. – institutions here function more like support agencies) diffusion for SSIs (Sandee 1995). The institution-driven diffusion may then be regarded as that directly motivated by external factors such as an environment policy specification, or may be aimed at increasing the technological capacities or facilitating or stimulating joint action within the clusters. \(^{54}\) IPCC 2000, on the other hand, distinguishes between government, private sector and community-driven pathways for technology diffusion (and transfer) at a more general level (and not only for SSIs). Combining the two, the levers for change for diffusion of cleaner technologies in SSIs are divided into (i) private (entrepreneurs), (ii) community (other stakeholders like buyer/supplier, trade networks) or (iii) policy-driven change. This focus is categorically on the issue of policy-driven change. However, in analyzing this, it also becomes necessary to look within as well as beyond the clusters to their socio-economic settings and contexts.

2.3.5 SSIs and policy instruments

The predicament faced by many developing countries is how to address environmental issues related to SSIs without comprising their competitiveness and economic ability to survive. One of the issues is how can environmental policy instruments be used to provide incentives so as to induce towards greater diffusion of cleaner technologies (policy driven change) and meeting the “needs” of the sector. \(^{55}\)

SSIs, in general, do not have enough political clout to influence design of state policies, and their needs are not completely understood by the policy makers (Schmitz 1993). This implies that challenges may exist in terms of not only environmental but also support policies for the SSIs. Support policy at best focus on creating favorable

\(^{54}\) Supplier- or consumer-driven change can also be considered to be external to the cluster as the suppliers or consumer may lie outside the cluster. However, we do not consider them as “external” but as other stakeholders directly associated with the process within a cluster. The only external factor here is the government agencies, etc. who do not have direct stake in the production process as such.

\(^{55}\) IPCC (2001a) provides a framework for achieving climate change mitigation potential of technological options – which includes market, economic, socio-economic, technological and physical potentials – by addressing the barriers that prevent the full exploitation of the cleaner technologies. In principle, policy instruments can be designed to provide incentives to influence these factors; that is, removing the barriers and building on the drivers (or opportunities as in IPCC framework). This implies that identification of the factors specific to the target sector will be necessary, and different sectors may require different levels of policy intervention depending on their “needs”.

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conditions on the supply and demand side of SSIs (though policies in developing countries have focused on the supply side like provision of training, credit and infrastructure). The literature also reveals that there is no right way to promote SSI development (there are several wrong ways though, like providing assistance that does not help or is expensive), and the design of effective policies and policy instruments must be built on the understanding of the complexity and the diversity (and different needs) of the SSIs (Mead and Leidholm 1998).

For clusters, in general the “triple C” approach is advocated by researchers (Humphrey and Schmitz 1996) for cluster development, arguing that policy approaches (both towards general development and for cleaner technologies) may be effective if they are: (i) customer oriented; (ii) collective (lowers transaction costs and helps generate relationships between enterprises); and (iii) cumulative (generate capacity to upgrade and be less dependent on outside support). Thus, the objective of policy intervention at the micro level may be geared to develop the capability of groups of firms to generate processes of improvement deriving from inter-firm linkages and contact with the market. However, these principles need to be applied differently to different categories of clusters (Schmitz and Nadvi 1999). This reinforces the earlier arguments regarding the importance of contexts and circumstances for any policy implications.

The focus in terms of environmental policies in developing countries has been on the regulatory instruments (may be focused on local pollution and not CO₂ emissions, but may have indirect implications for GHGs as well). They normally emphasize use of end-of-pipe technology, rather than cleaner technologies. However, the enforcement of regulatory instruments amongst the SSIs is, in general quite difficult (feasibility) as they are small, numerous and geographically dispersed, and also include informal units that may have few pre-existing ties with the government (Blackman and Harrington 2000). This is the case even for technology standards that are considered easier to enforce than emission standards. Empirical studies show that in most developing countries, enforcement has been ad hoc and ineffective (and in many cases ignored), and typically does not achieve the desired results. Extreme cases of enforcement of regulation have been relocation or closure of units in some countries which in turn has social implications. In addition, relocation just means “relocating” the environmental problems, which is not useful especially for GHG emissions reductions unless accompanied by use of cleaner technologies.

On the other hand, the issue for many SSIs is survival (as opposed to profit-making as predicted by “rationality” based neo-classical theorists – building our case for an evolutionary approach), and thereby they tend to ignore or rather at times cannot afford to address environment concerns. Regulatory instruments generally assume that industry has the ability and willingness to respond to the environmental standards and regulations. However, SSIs face several constraints; for instance, lack of knowledge and skill about environmental problems and no access to appropriate and affordable technologies (Blackman 2000; Frijns and Vliet 1999). As many of them work on small profit margins even small investments in cleaner technologies may be
difficult to undertake. Even in case of economic incentives (economic instruments) they may not be able to use them owing to several factors, which may be organizational (related to the unit) or external (related to outside the unit), or may just be lack of information or motivation to bring about the change or even resistance faced from workers. Many countries rely on subsidies as an option for encouraging cleaner technologies, or even enforcement of standards; as well as on suasive instruments such as awareness creation, and capacity building. However, only a small number of SSIs are effectively reached (Tezler 1993).

Thus, addressing environmental problems with respect to SSIs is rather complex and multi-dimensional, as it is constrained by low reactive, adaptive, and adsorptive capacities, limited technological and financial strengths, as well as low awareness not only about technological options to comply with existing regulations but also about the regulations themselves. Dasgupta (2000) argues that with reference to SSIs, a sanction-based enforcement strategy is only a uni-dimensional conceptualization of what is fundamentally a multidimensional problem. The relation between SSIs and technology are more influenced by the socio-economic and cultural context than by the efficiency needs of the production process. Thereby, using a blanket approach (like uniform standards) fails to address the problem of intra-sectoral diversity, and ignores the question of affordability (and, thereby, their acceptability). SSIs cannot be considered as a unified category and expectations regarding policies should vary among different types, locations and industrial sectors (Frijns and Vliet 1999).

2.4 Discussion and conclusions

This thesis aims to examine the link between CCIs set at the international level and SSIs at the local level (Chapter 1). The analysis of such macro-micro linkages in the literature remains limited. While discussing the policy instruments, the literature specifically on CCIs has been mainly of a generic nature or has tended to focus on a few sectors (like large-scale industries such as power generation, iron and steel, cement; and renewable energy technologies or RETs). There is a growing emphasis on small-scale projects. These too, however, deal with small projects in large industries or RETs, and do not specifically address the special needs of the SSIs. The literature on technology diffusion in SSIs again has tended to focus on policy-driven diffusion – but only in general terms, and does not really address their relevance from the perspective of the international climate change policies and policy instruments (other than some financial instruments). This study is a modest attempt to try and bridge this gap in order to draw lessons for the performance of international policy instruments at the local levels.

She argues that to be effective, enforcement strategies would need to acknowledge the implications of the technology at the firm level; and address the tensions between the environmental imperatives and the socio-economic exigencies of maintaining sustainable livelihood opportunities for the workers.
For this, basically two distinct theoretical themes are used. The first theme is the policy instruments: to assess the relevance of the international policy instruments for the micro level. CCIs are based on economic theories of policy instruments for environmental protection. They may provide specific incentives for influencing the actions and decisions of relevant actors (policy implications). There are also associated issues such as uncertainty, transaction costs, market power (bias towards certain sectors), which may weaken these incentives. Thereby, the performance of the policy instruments is dependent not only on their economic efficiency (optimality criteria) but also factors such as feasibility and acceptability (concordance criteria) – that is, not only on their performance characteristics but also the circumstances in which they are used (contextual factors). An ecological economics approach allows for a multidisciplinary analysis of the policy instruments within the overall contexts comprising of prevailing policies (and institutions) and interest groups, which is especially relevant for international instruments at the international and national levels.

Most top-down assessments of policy instruments, however, are rooted mainly in static analyses. They do not accurately present the implications of a dynamic policy regime (for example, how the policy regime evolved and the policy instruments developed over time) and cannot adequately capture the sectoral details and dynamic complexities of human actions. The international policy instruments are relevant at several levels of social organization from global through national policy making scenarios and at the micro-level. A multiplicity of actors and scales implies limits to collective actions and diversity of responses of the actors to particular policy instruments (IPCC 2001b: 607), which may be generalized in top-down approaches (and this is where bottom-up or micro approaches are useful).

The second theme used is diffusion of cleaner technologies in SSIs: for analysing the factors that influence technological diffusion at the micro level that are relevant from the point of view of policy instruments. There is evidence that clustering of SSIs in developing countries brings in “collective efficiency” advantages, and may provide a better target for policy instruments than the individual units. The evolutionary approach is especially relevant for the SSIs as it focuses (in line with ecological economics) on diffusion of technologies within an overall context and specifies the importance of selection routines and path dependency (and technological capabilities), and technological trajectories and paradigms (including external factors). Cleaner technologies, which may make economic sense theoretically, may not diffuse easily because of several factors that influence the diffusion process. Policy instruments can be used to influence the decisions of relevant actors to bring about technological change within the clusters (policy-driven change). These could include the CCIs as one of the levers.

This kind of analysis can provide useful insight into human actions and decisions, and the circumstances or contexts within which the policy instruments would operate at the local level. While focusing on the details, however, the wider picture regarding the macro-context (like that provided by the top-down approaches), and the complexities related to implementation of the policy instruments at higher levels of social
organization (which are taken as given) may be left out. Using evolutionary approaches also allows for including the dynamic aspects of the analysis in terms of contextuality, path dependency, networking and externalities, and learning processes (for example, it will help in understanding issues such as why the country or sector adopted a particular policy instrument when it did).

The two themes essentially form the theoretical basis of this study, as a combination to provide a holistic assessment. On the one hand, it deals with analysing the policy instruments in terms of the incentives they may provide for the SSIs (using the ecological economics approach). On the other hand, it also deals with addressing the needs of the SSIs by inducing policy-driven technology diffusion (using the evolutionary approach). Both these are linked and are dependent on the national policies and institutions (for different reasons of course). Thereby, the macro approach (with a focus on policy implications) is reinforced by the feedback from conditions and actions of actors at the micro level, and *visa versa*. It is felt that the co-evolution of the two approaches – ecological and evolutionary, and levels – broad macro and the micro level (fundamental level for change), may provide a better understanding of the issues in each in order to acquire insights regarding their linkages (especially in terms of how micro level can respond to macro level policies, and in turn how these policies may be built to have the desired impact on the micro level) (also see Opschoor 2002). It thus, also becomes imperative to base our analysis within the global, national, sectoral and local contexts. These theoretical perspectives are used to build the research framework in the next chapter.
3. Research framework and methodology

3.1 Introduction

Given the theoretical background in Chapter 2, this chapter develops the research framework, and describes the methodology used in the study. The research framework has been developed on the basis of the framework provided by a core group of IHDP–IDGEC (International Human Dimensions Programme on Global Environmental Change–Institutional Dimensions of Global Environmental Change). It deals with examining the “macro–micro link” between the climate change policy instruments and diffusion of cleaner technologies in the SSIs (Chapters 1 and 2). The research design is multi-disciplinary, qualitative and analytical.

This chapter is organized as follows. Section 3.2 presents the research framework and examines the elements included in it. Based on these, the research questions that are addressed in this study are defined. Section 3.3 discusses the research methodology giving information about the research methods, techniques and tools used. Lastly, a brief recapitulation of the discussions is provided in Section 3.4.

3.2 Research framework

The research framework for the study is illustrated in Figure 3.1. It is based on the IHDP–IDGEC framework, modified to suit the objectives of this study.

The IHDP–IDGEC framework focuses on the role that social institutions play as determinants of the course of human–environment interactions (Young et al. 1999). It defines institutions as a system of rules (formal and informal), decision-making procedures and programmes that give rise to social practices, assign roles to the participants in these practices, and guide interactions among the occupants of the relevant roles. Institutions figure both as sources of environmental problems and as elements in the responses humans make to actual or anticipated environmental problems.

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57 IHDP is an international, interdisciplinary and non-governmental research programme, aimed at integration of research on human dimensions of global environmental change.

58 It also uses related themes from the IHDP-Industrial Transformation Research (governance and transformation processes), which seeks to understand the complex society–environment interactions, identify driving forces for change, and explore development trajectories that have a smaller burden on the environment on a global scale (Vellinga and Herb 1999).

59 In common language, the term ‘institutions’ has a different meaning and is generally understood to mean organizations. However, it is important here to distinguish between organizations as ‘actors or players’, and institutions as the ‘rules of the game’ (where the world is a game). Although some authors (World Bank 2003b) do consider organizations as part of institutions; in the economic literature, in general, institutions are treated as distinct from organizations. Thus, institutions are not actors or players in their own right, but the rules that influence their behaviour and actions.
(institutional causes or implications, and institutional responses), and operate within socio-economic and political settings that can and often do affect the outcomes they produce (other causes or contextual factors).

The focus of the research framework for this study, however, is on the policies within the international institutions for addressing climate change. The aim is to analyse the role that international policy instruments as features of the international institutions for addressing the environmental impacts of human activities on the climate, may play in shaping the SSI–environment interactions (basically by fostering diffusion of cleaner technologies in the SSIs). This link between the climate change policies at the international level and the SSIs at the local level is developed by looking into the national-level policies (explained in 3.2.1). The research framework, thus, focuses on a specific human activity that is productive activity in the SSIs, and on policies as a specific part of institutions (as in the broader IHDP-IDGEC framework).

The research framework shows that the role of international policy instruments in shaping the SSI–environment interactions is dependent on: (a) the policy implications of the international policies and policy instruments, i.e. in terms of the incentives they provide; (b) the relevant national policies and their policy implications, and (c) the contextual factors, i.e. the factors – both barriers and drivers – for diffusion of cleaner technologies at the local levels. Based on these, the policies may be structured or altered, i.e. undertaking (d) policy responses in order to provide increased incentives for change in the SSIs.

This is in line with the arguments in Chapter 2 that the performance of international policy instruments is dependent on their characteristics in terms of the incentives they may provide and the circumstances in which they operate. The circumstances here include both the national policies and the local contextual factors. The research framework provides a way of examining these interrelations.

3.2.1 Main elements of the research framework

Basically, the research framework comprises of the following main elements: human activity, environmental impacts, international policies, national policies, policy

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60 The international policies can influence the SSIs directly or through the national policies. In both cases, national policies play an important role. On the one hand, they form an essential part of the context within which the SSIs operate, and thereby influence the implementation of the international policies and their role in shaping SSI-environment interactions. On the other hand, they themselves provide incentives for the SSIs, which may complement the international climate change policy objectives. In addition, they also influence how the international climate change policies and policy instruments are formulated and developed. It becomes important therefore to study the implications of the national policies when looking at the international policies. Due to their significance in the entire scheme, the national policies are included as a distinct element in our framework unlike the IHDP-IDGEC framework.
implications, contextual factors, and policy responses. The central tenet is the SSI–
environment interaction, a combination of two elements human activity and envi-
ronmental impacts, which is linked with the other elements. These elements are ex-
amined in detail below. The foundation for the framework has already been outlined.

**Figure 3.1:** Research framework

*Source:* Modified from Young et al. (1999)
in Chapter 2, which discussed the concepts and theory related to the CCIs and diffusion of cleaner technologies in the SSIs.

### 3.2.1.1 Human activity and environmental impacts

SSIs, on the one hand, contribute to socio-economic development, and on the other hand, are associated with inefficient energy use that leads to environmental impacts (Section 1.2.2). SSI–environment interaction (in terms of the SSI-related impacts, environmental and social and economic development) is dependent on the internal characteristics of SSIs (such as energy intensity, technical capability) and external factors (such as socio-economic, technical, including policy-related factors).

The element “human activity” deals with the descriptive characteristics of SSIs in India (technology used, management practices, level of activity, etc.). With emphasis on their energy consumption, the element “environmental impacts” deals with the impacts of the SSIs on the local (pollution, particularly air pollution) and global environment (CO$_2$ emissions), and their potential to reduce the adverse impacts through adoption of cleaner technologies. The SSIs are examined with respect to their contribution towards economic development in terms of value added and export potential; and to social development in terms of employment potential (taken as a proxy for income generation, livelihoods and thereby poverty eradication) and working conditions. These elements have already been addressed at some length in Chapter 1 while discussing the significance of SSIs in developing countries and in India.

### 3.2.1.2 International policies

This element identifies the provisions of the international policies and policy instruments for addressing climate change that may be relevant for the SSIs. CCIs are important features of the emerging climate change regime. They are aimed at facilitating the parties (member countries) undertake steps towards meeting its objectives and targets (Chapter 4).

CCIs that are relevant for developing countries (Chapters 1 and 4) aim at incentives for reduction of GHG emissions (sustainable development at the global level). In addition, they may facilitate sustainable development at the national level. These instruments are negotiated at the international level, and their design and modalities are influenced by the negotiating stances and policies of the parties involved as well as different interest groups (including industry associations, multilateral organizations and NGOs).$^{61}$ Their implementation, however, will be based more at a national (and local) context. They may in turn also influence the national policies of various coun-

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$^{61}$ For example, perspectives of developed and developing countries differ on issues of quantitative commitments for developing countries, and inclusion of sinks in the carbon trading mechanisms (most developed countries support inclusion as they can provide cost-effective options; developing countries within Latin America also support it due to their vast sink reserves and opportunity for getting external funds; while, other countries with limited sink options do not support it). Similarly, oil companies and environmental groups support a different approach for addressing climate change. These issues are discussed further in Chapter 4.
tries. Thus, there are synergies between the CCIs and national policies. To under-
stand these, it is necessary to examine the underlying structures and values at the na-
tional levels (IPCC 2001b).

3.2.1.3 National policies

This element identifies the features of the national policies that may influence the link between CCIs and SSIs. The term ‘national policies’ is used broadly to include state and sectoral policies as well. The national policies that are relevant here include (i) national climate change policies, and (ii) national SSI policies (promotional and environmental). These too will be influenced by the perceptions of various interest groups at different levels of social organization, as well as the related policies and development goals.

National policies can influence SSIs and their environmental impacts directly (Chapter 5). They are also important in terms of implementation of international policy instruments. For instance, in terms of the willingness and the capability for implementation of the key provisions of the climate change regime in the national contexts (Section 2.4). The horizontal and vertical integration of the policies at different levels of social organization is therefore important in shaping human actions at the local levels.

3.2.1.4 Policy implications

International policies and policy instruments may influence the SSIs through policy implications, guided by the set of incentives (including direct incentives, disincentives and penalties) provided by these instruments based on their characteristics. These are determined by material (characteristics of the policy instruments) as well as the cognitive conditions (interests and values of the actors involved) that may strengthen or weaken the incentives (Young 1999). Weak or non-existent incentives to control GHG emissions or induce cleaner technologies will be unable to make a significant influence on SSI–environment interaction.

This element identifies the incentives provided by international and national policies for SSIs, by examining the main features (objectives, criteria, motivations and interests) of the instruments, past experience and current status. It also identifies the issues that may weaken these incentives, such as associated uncertainties, transactions costs and market power or bias. The emphasis is on optimality as well as on concordance criteria. First, climate change policies (at international and national levels) are examined to identify the incentives provided in general, and their relevance in rela-

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62 In India, the policies of the Central Government provide the basic framework within which the state- and sectoral-level policies are based and designed.

63 For example, technology upgradation schemes for SSIs can help bring in cleaner technologies.

64 This includes taking steps through the national policies providing incentives for reducing emissions of GHGs, or adhering to provisions of the UNFCCC. For example, submitting national communications, ratifying the Kyoto Protocol, etc.
tion specifically for the SSI sector. Second, the national policies are examined to identify the incentives they may provide specifically for SSI–environment interactions. These include both the direct and indirect implications (direct effects arise from the operation of environmental policy, that is, policy explicitly created to deal with human/environment relations; and indirect effects are unintended effects of promotional policies for SSIs and other national policies).

3.2.1.5 Contextual factors

Energy use in SSIs and the related environmental impact are influenced by policies as well as the contextual factors. These are related to the characteristics of SSIs (including internal dynamics and decision-making processes) and their social, economic, and cultural milieus (including market conditions and influence of stakeholders). The contextual factors determine the local context for implementation of the policies and policy instruments and thereby affect the outcomes they produce.

For the purpose of analysis, this section integrates the range of contextual factors into two categories, (a) barriers (obstacles or constraints) and (b) drivers (which assist or facilitate) (Gillisen et al. 1995; IPCC 2000; van Dijk and Sandee 2002; Vellinga and Herb 1999). It then subdivides them as organizational (e.g. technological capabilities, management structures), economic (e.g. access to finance, market conditions), technological (e.g. access to technology, know-how, infrastructure), environmental (e.g. local emissions, safety considerations), and social (e.g. attitudes, culture, collective efficiency, influence of interest groups).

3.2.1.6 Policy responses

The policy responses deal with the weakness of the existing policies in leading to desired policy implications for the SSI–environment interaction (for instance, due to weak incentives). This element picks up signals of the problems and needs (World Bank 2003b) in order to design the responses to correct these weaknesses (at the international, national and/or local levels). This may include altering the policies and policy instruments by modifying the set of incentives they represent (directly or by influencing the contextual factors) or introducing new instruments.

Thus, the framework provides a “macro–micro link” between the CCIs and the SSIs. The framework examines at different levels – global, national (including state and sectoral), and micro levels (units or clusters), by focusing on the policy implications, contextual factors and making some recommendations for policy responses. In doing so, it deals with examining the issue of causality (link between the SSIs and their environmental impacts, and responses for addressing them by the national policies and CCIs), and makes recommendations for their design.

3.2.2 Research questions

Based on the above elements, specific research questions are defined in this section. The first aspect is related to the international climate change policies and the incen-
tives they provide for the diffusion of cleaner technologies in the SSIs. To understand these, it is important to study how these policies are formulated, which policy instruments are used, how have the policy instruments developed over time and to what extent do they address human activities in developing countries in general and SSIs in particular. The strength of the incentives that may be created by these policy instruments in bringing about a change in SSIs will depend on their characteristics (objectives, modalities) and motivations (like actor interests, biases), specifically with respect to the sector.

The research framework shows that the relevance of the international climate change policy instruments, particularly for the SSI sector in India, will be greatly influenced by the national policy related to climate change in the country. It is, therefore, important to examine the national policies as well. That is, what is the national policy on climate change in India, how has it evolved and how does it view the international climate change policies and policy instruments (especially their acceptability, applicability and translating the provisions in the national context). In addition, what incentives does the national climate change policy provide for the diffusion of cleaner technologies across different sectors and for SSIs in particular; and how do they influence or complement the incentives provided by the international instruments. This includes both direct and indirect incentives, and implies not only examining the climate change policy per se and perspectives of various stakeholders in the country regarding these issues, but also understanding their implications for the SSIs (i.e. to examine climate change policies vis-à-vis the SSI sector).

**Research question 1:**

How do climate change instruments create incentives for diffusion of cleaner technologies in the small-scale sector in developing countries? How do the national policies address climate change in India? What are the policy implications of climate change policies and policy instruments for the small-scale industries in India?

It is not just climate change policies that are relevant for looking into SSI–environment interactions and the potential of CCIs to influence these interactions. National SSI policies, promotional (or support) and environmental policies (other than climate-related) are relevant as well. This means focusing not only on policies specifically designed for SSIs but also macro policies and development goals that have had implications for the sector, such as liberalization and globalization aspects and poverty alleviation and social objectives.

As the next research question, we look into the main provisions of the national SSI policies that may create incentives for the diffusion of cleaner technologies, and study whether these are strong enough to shape SSI–environment interactions and whether they complement or conflict with the climate change policies.

**Research question 2:**

Which national policies address the small-scale industrial sector in India? What are the implications of the national policies for the diffusion of cleaner technologies in the small-scale industries in India?
The potential of the policies to influence the SSI–environment interactions depends on the interplay of the incentives they provide and the context or the circumstances within which they are used. It then becomes necessary to identify the driving or constraining forces, or in other words, the contextual factors that influence diffusion of cleaner technologies in the SSIs and thereby the performance of the various policy instruments? It implies not only understanding the internal dynamics of the industrial units and perceptions of the micro-level decision makers, but also the external factors, such as cooperative networks, local initiatives, influence of civil society, and socio-economic and technological considerations. Analysing these factors and how they have influenced the prevailing policies can help draw some lessons for the international policies as well. This then helps formulate research question 3.

**Research question 3:**

*What are the main drivers and barriers related to diffusion of cleaner technologies in the small-scale industries in India?*

While research question 1 addresses how CCIs may be able to benefit the SSI sector in India, questions 2 and 3 look into the Indian conditions and local circumstances within which these instruments would have to operate. Research question 4 examines these two aspects together, categorically for SSIs in India – what are the conflicts and synergies between CCIs and SSIs? Where are the gaps *vis-à-vis* the national policies? Can climate change policy instruments address these gaps and under what circumstances? It also helps to identify the possible policy responses that could help influence the SSI-environment interactions positively. These are based on quasi- or condition-scenario making (for example, if the government is to undertake a specific action as a particular policy response, then will the incentive for diffusion of cleaner technologies in the SSI become stronger or not?). The scenario building is not the major part or focus of the thesis; however, the element concerning policy responses is built up by making assumptions regarding possible policy responses wherever needed.

**Research question 4:**

*How can small-scale industries benefit from climate change instruments and contribute towards a reduction in greenhouse gas emissions? How can climate change instruments affect small-scale industries–environment interactions?*

Based on the empirical responses, practical and theoretical lessons may be derived. The empirical data and analysis helps in drawing conclusions, and contributes to the present understanding (in particular, what lessons can be drawn for the development of policy instruments under ecological economics? What is the importance of an ecological approach while looking at diffusion of cleaner technology in the SSIs). It also helps in addressing the issue of design of policy instruments and making recommendations for structuring policies and policy instruments to maximize their performance in ensuring sustainability at the local levels. This is our last research question.
Research question 5:

What lessons can be drawn from the Indian small-scale industries sector for the design and implementation of policy instruments under the international climate change negotiations?

It should be pointed out here that though the research questions do follow a sequence in the way they are presented, it is difficult to separate them explicitly. The questions are linked to each other, and considerable degree of overlap exists between them. \(^{65}\) The research questions cover all the elements of the research framework, and together help address the central research question of this study (Chapter 1).

3.3 Research methodology

This section describes the methodology used in this study based on the research framework developed in the previous section. The research framework helps to examine the linkages between the policy scenario (international, national, state and sector), and industry-level activity (decisions and processes). It basically provides the overall boundary of the research, which needs to be supported by empirical evidence. An empirical approach becomes especially relevant as we are dealing with real-life situations and trying to understand the complexities of human behaviour (including perceptions, motivations and reactions). We basically work inductively towards enriching the knowledge base supporting policy development. \(^{66}\)

3.3.1 Research techniques

The research methodology uses qualitative techniques including literature survey and multiple case studies, with use of some quantitative data and techniques as well (e.g.

\(^{65}\) For example, it will not be possible to analyse the implications of the national SSI policies without really looking into how the sector operates and vice versa (questions 2 and 3), or look into national climate change policies and environmental policies separately (questions 1 and 2).

\(^{66}\) We are taking an inductive approach by focusing on real-life situations and using empirical case studies. Inductive reasoning involves proceeding from specific to general by observing and developing explanations of regularities or drawing conclusions regarding the patterns. This approach is often criticized using the argument that the dependence on observable facts makes reaching a degree of finality in economic thinking difficult (Fellner 1960). On the other hand, however, it is generally preferred to describe fully and identify the mutually shaping influences in the research context (Tacconi 1998). If policies are to be effective then they have to be examined and be applicable in the real world context. Thus, we feel this approach is suited to this study rather than taking a deductive approach generally followed in neoclassical economics (Johnson 1986; van den Bergh 2000), where formal models are developed for deriving well-defined propositions. Overemphasis on deduction results based on fixed assumptions (van den Bergh 1996; van den Bergh and Gowdy 2000) may prove to be at variance with reality and unable to effectively deal with evolving social and economic conditions (Fellner 1960), as is the case with the climate change policy arena. Thereby, we use induction, and focus more on descriptive, exploratory and interpretive procedures.
use of energy, estimation of potential emissions). It uses multiple sources of information combined with observations from the field in order to present the outcomes and answering the research questions (Table 3.1). The research is divided into two components. The research techniques used in the components are different.

The first component is the review and analysis of the CCIs and the national policies vis-à-vis the SSI sector (Chapters 4 and 5). It examines the material and cognitive conditions related to the CCIs and the national policies in India, to draw inferences regarding their policy implications for the SSI sector. It thus addresses the research questions 1 and 2 of this research.

This component is largely descriptive and analytical. It involves (i) literature review using secondary information, including reports and records (such as government policy and plan documents, legislative acts), research studies and submissions to the UN FCCC Secretariat, and (ii) interviews (semi-structured) with actors associated with the climate change negotiations and policy instruments, and the national SSI policy (government, multilateral organizations, industrial organizations, NGOs, journalists and researchers). The latter assists in understanding the perspectives of the actors regarding the climate change policies and involvement of SSIs. These are analysed to determine the set of potential incentives, and thereby the policy implications of the CCIs for the SSI sector.

<table>
<thead>
<tr>
<th>Research question (RQ)</th>
<th>Focus</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ 1 (Chapter 4)</td>
<td>International climate change policies</td>
<td>1. Literature review</td>
</tr>
<tr>
<td></td>
<td>National policies (climate change)</td>
<td>2. Interviews</td>
</tr>
<tr>
<td></td>
<td>Policy implications</td>
<td></td>
</tr>
<tr>
<td>RQ 2 (Chapter 5)</td>
<td>National policies (SSI)</td>
<td>1. Literature review</td>
</tr>
<tr>
<td></td>
<td>Policy implications</td>
<td>2. Interviews</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Case study approach</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. Survey</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Interviews</td>
</tr>
<tr>
<td>RQ 3 (Chapters 6–9)</td>
<td>Contextual factors</td>
<td>1. Case study approach</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. Survey</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Interviews</td>
</tr>
<tr>
<td>RQ 4 (Chapters 9–10)</td>
<td>Synergies between SSIs and CCIs</td>
<td>Analysis and interpretation of RQ 1–3</td>
</tr>
<tr>
<td></td>
<td>Policy responses</td>
<td></td>
</tr>
<tr>
<td>RQ 5 (Chapter 10)</td>
<td>Policy design and theoretical lessons</td>
<td>Analysis and interpretation of RQ 1–4</td>
</tr>
</tbody>
</table>

Ecological economics is issue-driven, trans-disciplinary and does not restrict the use of one kind of methodology (Costanza et al. 1991; Klaassen and Opschoor 1991; Norgaard 1989) (also see chapter 2). Qualitative methods are considered (Tacconi 1998) suited to deal with multiple realities and are adaptable to various influences and value patterns (e.g. in dealing with perceptions, motivations, interests) encountered in the field.
The second component involves case studies in the Indian SSI sector (Chapters 6, 7 and 8). Each case study has two main objectives: (a) to analyze the role of the existing national policies, and (b) to identify the main factors influencing diffusion of cleaner technologies at the local level. These determine and provide empirical evidence for the potential use of CCIs in this sector. Thus, this component also helps in understanding the local context within which the instruments will have to operate (contextual factors). It, in combination with the first component, addresses research question 3 (and supplements research question 2).

The data collection techniques for this component are twofold. Firstly, a primary survey of the SSI units was undertaken for each case study cluster. For the surveys, structured questionnaires for the entrepreneurs were used. The information thus collected was also supplemented with discussions (individual or groups) with entrepreneurs. Secondly, semi-structured, in-depth interviews with other stakeholders/actors (representatives of government departments, industrial associations, NGOs, and financial institutions, consultants, technology suppliers, workers and researchers) were conducted. Using the information, the set of contextual factors influencing cleaner technology diffusion in that SSI was obtained. In addition, findings regarding performance of national policies were also realised (what were the common features of, and main reasons behind successful or unsuccessful policy interventions?).

The two components were then combined and correlated to examine whether the potential benefits of the CCIs can address diffusion of cleaner technologies (and needs) in the SSIs. Therefore, they in effect complement and supplement each other. In broad terms, the first deals with the supply aspects (top-down), while the second deals with the demand aspects (bottom-up) related to CCIs (Chapter 2). Together, they help in answering research question 4 (Chapter 9) and drawing theoretical and policy-related lessons for addressing research question 5 (dealt with in Chapter 10).

3.3.1.1 Case study selection

This section deals with the rationale for the choice of suitable case studies. Case studies are empirical inquiries that investigate a phenomenon within its real-life context (Yin 1994). They are especially appropriate when the research focuses on contemporary issues, aims at understanding complex relationships and uses multiple sources of evidence (Yin 1994), and thus are suitable here as well. In particular, they may be used as the basis for drawing inferences and framing (at least tentative) generalizations about the role of institutions and policies in global environmental change processes (Young et al. 1999).

68 A brief questionnaire for workers was also prepared and attempts were made to get their insights as well. However, in most cases, the owners or managers would allow the workers to be interviewed in their presence only, which restricted the insights got from the workers. The survey therefore has focused on understanding the perspectives of the entrepreneurs.

69 These stakeholders were also asked to fill a questionnaire (again semi-structured) if they agreed to do so. However, in general, the main research tool here was the interviews.
The **multiple case study approach** is used for this study for analysing multidisciplinary and complex (macro–micro) linkages. A case study in this context refers to an energy-intensive SSI cluster (a number of units located in close proximity). The case studies help to examine the implications of the national policies and the contextual factors for the SSIs. The approach assumes that the similarities (common SSI characteristics) and differences (cluster size, market orientation and production patterns) between the three case studies will reflect the different circumstances across SSIs, in which policy instruments may be used. The main criteria adopted for the selection of case studies were the following:

a) Relevance for energy and environment: The SSI cluster is energy intensive, consuming significant quantities of fossil fuels especially coal. Thus, it is associated with adverse environmental impacts (both global and local) and possesses potential for diffusion of cleaner technology.

b) Relevance for socio-economic development: The SSI cluster is important from a socio-economic perspective, particularly in terms of the amount of value added, i.e. production and employment generation.

c) Relevance for national policies: In the SSI cluster, environmental policies have been introduced, which will or are playing a role in bringing about a change in the processes of the industrial units.

Based on these criteria, three energy-intensive SSI clusters were selected as case studies. These include iron casting or foundry industry in Howrah, West Bengal; the glass industry in Firozabad, Uttar Pradesh; and the brick industry in Chandigarh, Punjab (Figure 3.2). These also indirectly represent other energy-intensive SSIs in India such as pottery, cement, steel, silk reeling, etc. The selection was made after reviewing available official documents and research reports, and consultations with experts on SSIs in India. The selection basically involved a two level/stage selection: one, the choice of industry within the SSI sector, and second, the choice of a cluster within the selected industry.

**Case studies: the choice of industries**

SSIs occupy an important position in the Indian industrial sector. Many of these are energy intensive and have a significant potential for diffusion of cleaner technologies (Chapter 1). However, the circumstances and conditions existing in the SSIs are different from those in large industries. Most SSIs are associated with small size of operations, semi or unorganized structures, traditional practices and flexibility of operations, and high labour intensities (sector-specific characteristics – see Chapter 2.3). Thereby, the problems and needs of SSIs are also different as compared to large industries. With the help of the case studies, these special needs of the sector are highlighted while looking into the relevance of the international policy instruments
In spite of the similarities or sector-specific characteristics, there is also considerable variability within the SSI sector. The sector covers a spectrum of industries comprising of modern SSIs using sophisticated technologies to rural and traditional industries using very simple means of production (see Chapter 5). The “modern SSIs” include units that use power and are situated in close proximity to large industrial sectors or urban areas. The “traditional SSIs”, on the other hand, are generally artisan-based units characterized with very small initial investments (including handicrafts) and are located generally in rural or peri-urban areas (MoSSI 2002). The case studies are chosen to try and bring out these circumstances.

In identification of the SSIs, the main criteria used have been listed above. The primary guiding principle has been that they are energy intensive and therefore are relevant from the environmental point of view (especially GHG and local emissions). They are also relevant for socio-economic development of the region and the country, especially in terms of employment and value added. In other words, they are relevant from the point of view of sustainable development (Table 3.2).

Table 3.2: Selection of case study SSIs

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Iron foundry</th>
<th>Glass</th>
<th>Brick</th>
</tr>
</thead>
</table>
| Energy use and environmental relevance | •Main fuel: coal/coke (0.6 million tonnes/annum)  
•Pollutants – SPM, CO₂, SO₂ | •Main fuels: natural gas (0.6 million standard cubic metre/day) and coal  
•Pollutants – SPM, CO₂, SO₂ | •Main fuel: coal (24.2 million tonnes/annum)  
•3rd largest coal consumer industry in India  
•Pollutants – SPM, CO₂, SO₂  
•soil erosion (top soil depletion) |
| Economic relevance        | •Product – industrial and other castings  
•6th largest producer of castings in the world | •Product – glass bangles (monopoly) and other glass items  
•2nd largest production capacity in the world | •Project – major input for construction industry  
•2nd largest producer of bricks in the world |
| Social relevance          | •0.6 million workers           | •0.5–1 million workers  
•Cultural significance     | •8–10 million workers          |
| Policy relevance (main instrument) | Emission standard             | Ban (on coal use)                          | Emission Standard                         |

Source: (Bhattacharjee and Pal 2001; IIFA 2000; MoSSI 2003; PSCST 2001b; UNDP 2000)

As iron and steel and the construction industry are major contributors of GHG emissions in the industrial sector in India, it was important to choose a case study from each of these industrial sub-sectors. Owing to their energy consumption, the iron

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70 These include khadi and village industries, handlooms, sericulture, handicrafts and coir.
foundry and brick SSIs were chosen. These industries represent completely different situations (see Table 3.3). The SSI iron foundries (90% of all foundry units in the country) produce castings for internal and external markets, including inputs for several other industries (due to which it is known as the ‘mother of all industry’). The brick SSIs provide inputs for the construction industry and cater largely only to local markets. Brick making is a seasonal and predominantly traditional industry, with all its units falling in the SSI sector.

The glass industry is also energy intensive and represents very different conditions. Most of the glass SSI units tend to be located at a single location (about 70% of the SSI glass products come from this single cluster in Firozabad), and maintain a monopoly situation in the production in glass bangles or bracelets, in addition to producing other products for internal markets and exports. It also has a socio-cultural significance (glass bangles have been worn by Indian women since a long time and also have a religious connotation; almost the entire population of Firozabad is directly or indirectly dependent on the industry, and child labour is a major concern).

The case studies were chosen such that they include SSIs that are also relevant from the perspective of national policies as one of the criteria. The environmental aspects related to cleaner technologies are usually not given adequate consideration for the SSIs (see Chapter 5). However, there are some specific SSIs where environmental policies have brought in change, and these included our case study industries. The main policy intervention in these cases has been the introduction of emission standards. The glass industry is especially important as it also faced a ban on coal usage.

### Table 3.3: Key differences in case studies

<table>
<thead>
<tr>
<th>Foundry</th>
<th>Glass</th>
<th>Brick</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Modern SSI</td>
<td>• Modern plus traditional units</td>
<td>• Predominantly traditional</td>
</tr>
<tr>
<td>• Located in large clusters (mainly urban)</td>
<td>• Concentration in single large cluster (urban)</td>
<td>• Scattered but located in small clusters (peri-urban and rural).</td>
</tr>
<tr>
<td>• Cater to internal and export market</td>
<td>• Cater to internal and export markets</td>
<td>• Cater to local market</td>
</tr>
<tr>
<td></td>
<td>• Monopoly cluster for glass bangles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Several interrelated stages of production (vertical and horizontal integration)</td>
<td>• Seasonal – production in dry season (though few technologies enable annual production)</td>
</tr>
</tbody>
</table>

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71 The three highest coal-consuming industries in India are power, iron and steel and brick (PSCST 2001b). Brick, therefore, is anyway important being the third largest coal consuming industry. Foundry too is a major energy consumer, as according to a study (TERI 1998b) foundries and forging SSIs together account for 44% of the total energy consumed by the 41 major energy-intensive SSIs considered in the study.
*Case studies: the choice of clusters*

Each SSI comprises of different SSI clusters – there are 350 urban and 2000 rural clusters in India. After choosing the case study SSIs, the next step was to identify one cluster in each of the cases for detailed study (Table 3.4). For the case study cluster selection, the criteria were the same as for the case study industries – its relevance for sustainable development and impact of the national policies. In addition to these, logistical, resource and time considerations were kept in mind. It was also decided to choose the three clusters in different states so that the importance of state policies may also be highlighted. In all the three states in which the case study clusters are located, the emphasis on SSI development is high.

For the foundry and the glass industries, the choice was fairly obvious. The foundry cluster at Howrah, West Bengal, was chosen because it is the oldest and largest (in terms of number of units, production and exports) foundry cluster in India. Similarly, the glass cluster in Firozabad, Uttar Pradesh, was chosen because it is the largest glass cluster, and is the only glass bangle-making cluster (monopoly position). In fact, Firozabad is also known as the ‘glass city’ or ‘glass capital of India’, with the entire population of the city directly or indirectly dependent on it (Chapter 7).

<table>
<thead>
<tr>
<th>Howrah</th>
<th>Firozabad</th>
<th>Chandigarh</th>
</tr>
</thead>
<tbody>
<tr>
<td>• State: West Bengal</td>
<td>• State: Uttar Pradesh (U.P.)</td>
<td>• State: Punjab</td>
</tr>
<tr>
<td>• Largest and oldest foundry cluster in India</td>
<td>• Largest cluster in India (called glass capital of India)</td>
<td>• In Punjab – the largest brick producing state</td>
</tr>
<tr>
<td>• Largest producer and exporter of castings in India</td>
<td>• Only bangle-making cluster</td>
<td>• Progressive cluster in terms of awareness</td>
</tr>
<tr>
<td></td>
<td>• Whole town dependent on it</td>
<td></td>
</tr>
</tbody>
</table>

The brick clusters are usually smaller and are found all over the country. Chandigarh, Punjab, is especially relevant (here we are referring to units falling in and around Chandigarh). This is because it falls in the largest brick-producing state in India. Secondly, it has been especially relevant in terms of the change brought in through the national policies and the level of awareness that has been generated in terms of energy efficiency (Chapter 8).

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The brick clusters are very small in size, but tend to be located in small clusters around an area. The case study of the brick industry in Chandigarh, in fact represents four mini-clusters around the Chandigarh city, which have been taken together as one cluster. Also, the brick production process and conditions are very different across regions in India. Therefore, the case study was supplemented with observations from a mini-case study that was also undertaken in Pune, Maharashtra, where the technology and conditions as well as the policy interventions are totally different (Chapter 7).
3.3.1.2 Survey techniques

The survey for collecting empirical evidence had to provide a variation in the understanding of the circumstances and the needs of the SSI units. In addition to the variability across different SSIs and SSI clusters, there also exists intra-cluster diversity. The units within clusters differ in most cases on the basis of their sizes, production capacities, technologies, number of employees, market orientation, organizational structure, etc. Therefore, a conscious effort was made to make the sample representative – by classifying the various units within a case study SSI cluster based on information from local sources (as there is no uniform way of classifying the units) and including units from each category in the sample. In the case of foundries, the units were categorized on the basis of size (or production capacities); while for the brick and glass clusters, they were classified on the basis of their location and kind of technology used, respectively.

The primary approach for the collection of the data was kept simple. In each case, the field reviews consisted of multiple field visits and periods of extended stay at the case study areas. The first visit was always to get a feel of the situation, make contacts and hold preliminary discussions, on the basis of which the questionnaires were developed. The information collected through the questionnaires was supplemented with informal discussions with the entrepreneurs regarding their problems, needs, and views pertaining to cleaner technologies and national policies. In addition to this, the information collected was also supplemented by my own observations in the field plus relevant secondary literature (studies, reports, official data) wherever available.

The field data involved three streams of information: (i) data related to the SSI units and status of the cluster (to define the base case and the potential for cleaner technologies); (ii) information related to the impact of national policies; and (iii) data providing insights into the decision-making process at the unit level in order to identify the contextual factors. This included information pertaining to the unit (like unit’s age, association membership, production, market orientation, number of employees, emissions), energy and raw material inputs (type and amounts of fuel used, etc.), technological status and changes (e.g. technology type and specifications, pollution control devices, technological upgradation – if any, and for what reasons), factors affecting technological change (perspectives regarding the main considerations and potential barriers for adoption of cleaner technologies, and the importance of national policies)73, and support (kind of policy or organizational support available and perceptions on what is needed).

73 For this, three sets of factors were identified and listed in the questionnaire: (i) considerations for decision-making regarding adoption of cleaner technologies; (ii) factors constraining adoption of cleaner technologies; and (iii) requirements for adoption of cleaner technologies. The entrepreneurs were requested to rank these factors according to their importance for them (1–5: not important to most important). This was supplemented with discussions with the entrepreneurs, which helped substantially in bringing more insights regarding the factors.
3.3.2 Validation, reliability and objectivity

The research tools used aimed at maintaining validity, reliability and objectivity of the information collected as much as possible (Denzin and Lincoln 1998). To maintain internal validity (for the survey data as well as the interview techniques) multiple sources of data were used, and the observations and information from the surveys and the interviews were constantly reviewed and compared. For views on policy-related issues, the information was systematically crosschecked with policy documents wherever they were available (e.g. time frame and provisions of policy interventions). However, the official statistics related to SSIs (Box 3.1), and documents related specifically to the case study areas are not many or detailed, and reliance was more on checking by asking the same questions in a different way, and cross-checking among different stakeholders, policy implementers and others. Staying at the case study areas and constant interactions within the SSI clusters enhanced observational consistency and understanding of the issues.

In addition to the internal validity, external validity of the information was also kept in mind. External validity involves not only generalization but also the robustness of the empirical findings (Brinberg and McGarth 1985). In the research, an attempt has been made to understand the circumstances that may exist at the local levels across the different case study clusters that influence the performance of the policy instruments. Empirical evidence has been used to see what kind of policy instrument was successful or a failure in the presence of various contextual factors. It is because of this that the three case studies were chosen such that they represented different scenarios and circumstances. The overall results obtained from the three industries operating in different situations and conditions (in terms of state policies, policy instruments used, market orientation, operational practices, etc.) are likely to be more representative of the SSI sector as a whole, as opposed to one case study industry that may have provided concrete conclusions for that particular industry.

For example, information regarding energy consumption in the clusters was tricky to obtain. The official statistics was not accessible through the District Industries Centre (DIC). The associations also either did not have the figures or were reluctant to share it. This data was collected on the basis of the sample survey, by collecting information on production and energy used in the units. It was cross-checked by asking for the same information in different ways – the entrepreneurs were asked directly what their energy consumption per year was, and then indirectly information was sought about their yearly production and coal (and other energy sources) usage as a percentage of the produce. It was however not possible to validate the information by any official record. The next step was to obtain the number of units in the cluster to get the information regarding energy use in the cluster. The official data is available for the number of registered units, but these may or may not be operational and there may exist unregistered units. In order to find out which units were not operational, stakeholders were asked to look at the list of units and mark the operational units (glass and foundry units) and by just asking them to give the number. Similarly, the number of the unregistered units was approximately obtained by asking various stakeholders (especially associations).
Box 3.1: SSI statistical data sources

While there are two main official national level statistical sources available for the SSI sector, the level of detail and coverage with respect to information related to the sector is not considered enough, especially for policy formulation and economic analysis. The data set of the Small Industry Development Organization (SIDO) covers a large share of SSIs (based on basic registration statistics, surveys, and occasional census – three till now), but it does not cover the whole sector (is largely limited to modern registered SSIs), is highly aggregated and associated with sampling problems (Mohan 2001). The Central Statistical Organization (CSO) data set (including the Annual Survey of Industries covering the registered units and the economic census covering both registered and unregistered economic activities, but both these are often not found to be complimentary to provide a complete picture), on the other hand, has a better coverage and is less aggregated, but it is not very easily accessible. The availability, accessibility and coverage of state level data and information on SSI vary in different states depending on the administrative structures at lower levels, and is generally based on the registration data (the SSI units are registered – not compulsorily – with the local District Industries Centre).

Objectivity was maintained as much as possible throughout the course of the study. Interviews and perceptions of different stakeholders could have brought in some degree of bias and subjectivity. However, the methodology allowed deviations in terms of freedom for respondents to interact and listen to views and opinions (for example, in case of group respondents and discussions). Clearly, there was divergence of views between various actors, which was taken as a given since the beginning, and forms the crux of the research. Informal interaction was encouraged to bring forth various perspectives. Being an independent researcher allowed most respondents to hold open and candid discussions.

Assurance of anonymity was given to the interviewees, which is why names of the respondents are not mentioned in this thesis.

3.4 Recapitulation

This chapter has presented the research framework and the methodology used in this study. The research framework assists in analysing the role the international policy instruments may play in shaping SSI–environment interactions by focusing on the interplay between the policy implications and the contextual factors. The research questions are formulated based on this framework and together they address the central research question of the study.

The methodology used for answering these questions follows an empirical approach, basically working inductively towards enriching the knowledge-base supporting policy development. It uses mainly qualitative techniques and includes literature survey

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75 It was clear during the initial visits and discussions that some of the entrepreneurs were suspicious regarding any discussions regarding environmental issues. So, during discussions with them, the subject was approached from the perspective of energy cost savings rather than pollution control or GHG reduction.
and multiple case studies. The research is divided into two complementary components: the first involving review of climate change and the national SSI policies, and the second involving case studies of energy-intensive SSI clusters. The case studies have been selected using three basic criteria: relevance for the environment (and energy intensity), relevance for socio-economic development, and relevance for national policies. At the level of understanding the evolution of the international and national policies, and how they address the SSI sectors, the narrative is based on the review of official and scientific literature, and interviews with representatives of the government, industry, academia and the NGO community. At the field level, a primary survey of the SSI units and interviews were the main tools.
4. Climate change policies

4.1 Introduction

The balance of evidence suggests a discernible human influence on the global climate (IPCC 1996: page 4). The FCCC (1992) and the Kyoto Protocol (1997) form the core of the present and any future international regime for addressing climate change with the CCIs (defined in Section 1.2.1) as important features. The CCIs provide incentives for the signatories to the Convention for undertaking climate-relevant actions for addressing climate change.\(^7\)

This chapter examines the climate change policies at the international level, and in India. It focuses on CCIs that provide incentives for facilitating cleaner technology diffusion for GHG mitigation in developing countries. The analysis is based on literature review complemented with primary interviews with representatives of government department and ministries, NGOs and financial institutions in India. Section 4.2 describes the evolution of the international climate change policies. Section 4.3 discusses the CCIs introduced till now which are relevant for the developing countries. It broadly covers the objectives, incentive structures and policy implications of the CCIs. Section 4.4 deals specifically with the national policy related to climate change in India. Finally, Section 4.5 draws the main conclusions regarding the implications of the climate change policies particularly for SSIs in India. These conclusions will be revisited in Chapter 9 and help in answering research questions 1 and 2.

4.2 International climate change policy

Climate change was recognized as a major environmental concern at the First World Climate Conference in 1979. It emerged on the political agenda in the mid-1980s, in spite of scientific uncertainties related to the phenomenon and its impact on the world. Subsequently, the Inter-governmental Panel on Climate Change (IPCC) was set up in 1988, to assess the seriousness of the problem and recommend appropriate policy measures. The recommendations of the IPCC led to the setting up of the Intergovernmental Negotiating Committee (INC) in 1991, under UN auspices, to draft a global convention on climate change and any other related legal instrument that it considered necessary (FCCC 2002a, 2003).

The timeline of the evolution of the international climate change policy since the adoption of the FCCC, with particular reference to CCIs, is outlined in Figure 4.1.

\(^7\) Climate relevant activities include GHG mitigation, by emissions reduction (reducing their sources) and sequestration (enhancing their sinks), and adaptation (adjustments to actual or expected climatic changes) activities. The emphasis here is on mitigation by reducing GHG emissions from energy use.
Fig. 4.1: Timeline of Climate Change Policy Regime and Transition towards Market Instruments
The FCCC was adopted at United Nations Conference on Environment and Development (UNCED) at Rio de Janeiro (the Rio Earth Summit) in June 1992, and came into force in May 1994. Since then, regular meetings of the Conference of the Parties to the FCCC (COP) and its subsidiary bodies have been held to monitor its implementation and continue talks on how best to tackle climate change. This is a complex task as the causes of the problem and many of the possible options to address it are embedded in the basic economic and social activities across all countries. It is evident, however, that the problem is global and requires collective and concerted action. The climate change process may be analysed in two phases that is pre- and post-Kyoto, with the introduction of the Kyoto Protocol in 1997 dividing the two phases. It may be pointed out that while in the pre-Kyoto phase, climate change concerns were treated almost independently; they are now increasingly being integrated within the broader sustainable development goals.  

4.2.1 Pre-Kyoto phase: Setting the overall framework

The pre-Kyoto phase laid down the overall basic framework for the international regime to address climate change. The objectives and principles were defined in the FCCC, and significant policy instruments and measures were introduced (FCCC 1992). The Parties adopted commitments to make a voluntary effort to curtail their GHG emissions. Commitments for all Parties included preparing national communications, undertaking research and development, technology development and transfer activities, etc. In addition, based on the principle of common but differentiated responsibilities, the developed countries were to take the lead by modifying their long-term emission trends and reduce their GHG emissions

“...with the aim of returning individually or jointly to their 1990 levels ...” (FCCC: Article 4).

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77 The treatment of sustainable development in the international climate change context is also reflected in the IPCC assessment reports. The first IPCC assessment report (IPCC 1990) dealt almost exclusively with the science of climate change, and sustainable development and climate change were considered distinct issues. The second report (IPCC 1996b) recognized the overlap between the issues, but made unsatisfactory attempts to link them. In the third report (IPCC 2001c), there was conscious intent to explore the linkages more systematically. Ultimately, however, a feasible climate change response be integrated with other sustainable development goals is desirable. This task is to be taken up under the fourth assessment report.

78 The developed countries have historically been the largest contributors of GHG emissions. The developing countries are more vulnerable and have low techno-economic capacity to respond to climate change impacts. Thus, the FCCC divides all Parties in terms of their responsibilities. It requires the developed countries (Annex I Parties) to take a lead by modifying their long-term emission trends. It calls on the richest among them (OECD or Annex II Parties) to provide financial and technological resources to help developing countries (non-Annex Parties) tackle climate change and adapt to its effects (FCCC 1992; Pachauri et al. 1997).

79 The language of this article comprising the abatement commitments for developed countries is ‘legally vague’ (Gupta 1997).
The developing countries did not adopt specific quantitative abatement targets, but committed to take climate change considerations into account in their relevant developmental policies and actions. Their efforts towards tackling their GHG emissions are largely contingent on the financial and technical resources made available to them by the developed countries. In this regard, technology transfer was emphasized (FCCC: Articles 4.1h, 4.3, 4.4, 4.5, 4.7). Two specific CCIs were also introduced by: (i) setting up a subsidy-based ‘Financial Mechanism’ (FCCC: Article 11), and (ii) introducing the concept of ‘Joint Implementation (JI)’ for undertaking cooperative GHG relevant projects that led to setting up the prior ‘Pilot Phase of Activities Implemented Jointly (AIJ)’ in 1995. It is fair to say, therefore, that the emphasis was more on ‘suasion’ and capacity building in terms of awareness creation, learning (e.g. GHG inventory preparation, learning AIJ phase), identifying appropriate policies and measures, etc., and also on putting in place the Financial Mechanism – the responsibility of which was entrusted upon the Global Environment Facility (GEF).

With the adoption of the FCCC, several countries and actors (governments, private sector and civil society including NGOs, academics and media) started to get involved in the climate change process, and the related concerns were gradually incorporated within international and national policy levels. The Convention, however, did not provide abatement targets beyond the year 2000, and thus, these were inadequate for achieving the longer-term GHG stabilization objective. Moreover, it was becoming evident in the mid-1990s that many developed countries would not meet their abatement targets in the prescribed time period. Thus, recognizing the need for an agreement aimed at strengthening these commitments, the negotiations were launched by COP-1 at Berlin in 1995. Subsequently, the Kyoto Protocol to the FCCC was adopted after long negotiations in December 1997 at Kyoto, Japan.

### 4.2.2 Post-Kyoto phase: Strengthening the commitments

The post-Kyoto phase has seen efforts to strengthen the commitments under the FCCC with the adoption of the Kyoto Protocol, and creation of an international market for carbon abatement credits as a cost-effective measure (on a global basis) for meeting the objective of the FCCC. The Kyoto Protocol, in order to enter into force, required that at least 55 Parties to the FCCC, including Annex I Parties (developed countries) accounting for at least 55% of the total CO$_2$ emissions in 1990, ratify, ac-

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80 JI is not explicitly mentioned in the text of the FCCC. However, Article 4.2 (a) reads in part: “Each of these parties shall adopt national policies and take corresponding measures on mitigation of climate change,... These Parties may implement such policies and measures jointly with other Parties...” and Article 4.2 (b) mentions: “…the aim of returning individually or jointly to their 1990 levels...”

81 The 1999 data (FCCC 2002) revealed that GHG emissions in the OECD countries had risen by 6.5% since 1990 (excluding sequestration). Emissions in economies in transition, however, had declined by 40% due to economic restructuring. As a result, overall emissions from developed countries had declined by 7.6% since 1990. The emissions of the countries in transition are now increasing.
cept, approve or accede to it (FCCC 1997). The rate of ratification was slowed by po-
itical disagreements over how to implement the Protocol, especially after the deci-
sion of the United States, which accounts for the largest proportion of the global
GHG emissions (36.1% of Annex I 1990 CO\textsubscript{2} emissions), not to ratify. The Proto-
col’s entry into force hinged for a long time upon Russia (which accounts for 17.4% of
Annex I 1990 CO\textsubscript{2} emissions) as Russia decision to ratify became critical to
achieve the required 55% of Annex I emissions mark. Finally, Russia’s ratification in

The Kyoto Protocol introduces ‘legally binding’ quantified emissions limitation and
reduction or abatement commitments for the developed countries to reduce their col-
lective emissions of six key GHGs (through domestic or cooperative efforts)
“…by at least 5 per cent below 1990 levels in the commitment period 2008 to 2012”
(Kyoto Protocol: Article 3). \(^82\)

While this provides a regulatory incentive for abatement, the compliance mechanism
is being finalized. There are no quantitative emission targets for the developing coun-
tries as yet. \(^83\) However, there has been significant debate over introducing voluntary
commitments for them. \(^84\) Other commitments for the Parties include: preparing na-
tional mitigation and adaptation programmes; improving emissions’ data quality; sci-
entific research and capacity-building, etc.

The Protocol reinforces the importance of technology development and transfer
(Kyoto Protocol: Articles 8.3, 8.5, 8.6, and 10c), and stresses private sector involve-
ment and actions in and by developing countries. It introduces three market-based in-
struments, commonly known as the Kyoto Mechanisms (Kyoto Protocol 1997: Arti-
cles 6, 12, 17), to provide flexibility and cost-effectiveness for developed countries in

\(^82\) Compared to emissions projected for the year 2000, the OECD parties needed to reduce their
collective emissions by about 10%, as many of them exceeded their earlier target of reducing
emissions to 1990 levels by the year 2000. While countries with economies in transition have
faced falling emissions since 1990, this trend is now reversing. Thus, for developed countries
as a whole, the 5% target represents an actual cut of around 20% compared to emissions lev-
els that are projected for 2010, if no emissions control measures are adopted.

\(^83\) However, there may be consequences of the developed countries abatement commitments on
the developing countries, especially those highly dependent on fossil fuel (for instance, im-
pact of energy prices, research and development of cleaner technologies, and financial and
 technological transfers to the developing countries). In the future regimes, the developing
countries may even decide or be obliged to take on voluntary or even binding commitments.

\(^84\) Voluntary commitments in terms of abatement targets for the developing countries have been
refuted basically on two accounts: (a) sovereignty – developing countries are on development
paths and require sovereignty to use their ‘environmental space’ (as the developed countries
enjoyed when they were at a similar stage), and (b) differentiated responsibility – the onus is
on developed countries to first show ‘demonstrable’ progress in reducing their emissions and
meeting their commitments. Many developing countries like India (discussed later in the
chapter) have shown initiative and progress in terms of reducing GHG emissions while meet-
ing their development needs, in spite of not having specific abatement commitments.
meeting their commitments. These are: (i) *Joint Implementation (JI)* for facilitating cooperative projects between developed countries and sharing of emission reduction units (ERUs); (ii) *Clean Development Mechanism (CDM)* for facilitating projects in developing countries and sharing of certified emission reductions (CERs); and (iii) *Emissions trading* for international trade in assigned amount units (AAU) or emissions permits over the assigned amounts under the abatement targets. All three envisage some form of trade in carbon credits.

In addition to the efforts related to ratification of the Protocol, there have been significant developments towards strengthening of the climate change policy process especially under the ‘Marrakesh Accords’ at COP-7 in 2001 (FCCC 2002b), and integrating climate change with broader sustainable development issues with the adoption of the ‘Delhi Declaration on Climate Change and Sustainable Development’ at COP-8 in 2002 (FCCC, Decision 1/CP.8). The Marrakesh Accords set the operational rules for the Kyoto Mechanisms and three additional funds under the Financial Mechanism. At the recent COP-11, the Kyoto ‘Rule Book’ was adopted for strengthening the framework for implementing the Kyoto Protocol which includes key elements for a stronger CDM and the launch of a JI process (UNFCCC 2005). Thus, the emphasis post-1997 has been shifting towards economic instruments, especially the market-based instruments as flexible and cost-effective solutions to address climate change, and to some extent a regulatory approach in terms of legally binding commitments (though politically negotiated and not scientifically agreed upon).

There is increased awareness and concern for climate change and interest regarding the CCIs. Several countries are undertaking initiatives to reduce GHG emissions (individually and collectively) and actions for meeting their commitments (such as developing action plans, national communications). Talks are also under way for developing a ‘beyond-Kyoto regime’, i.e. beyond the 2008–2012 commitment period. Although the rate of ratification of the Kyoto Protocol was slow and participation and compliance insufficient, protecting the climate has emerged as an important global concern, especially in the light of (i) increased scientific evidence of human interference with the climate system (IPCC 2001a, d); (ii) climatic changes and oc-

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85 Initially, these mechanisms were called the “flexibility mechanisms”, as they provided flexibility to the developed countries in meeting their commitments. However, since the CDM is projected as a flexibility as well as development mechanism – the term was considered inappropriate, and Kyoto Mechanisms is now the more commonly used term. These mechanisms are discussed in detail in the next section.

86 A GHG or carbon abatement credit broadly is one unit of carbon dioxide equivalent offset. It may take different forms such as a CER, an ERU or an AAU depending on the mechanism that generates them. The process whereby the different forms of credits obtained via the Kyoto Mechanisms can be interchangeably used is known as fungibility of credits.

87 In 2001, the Marrakesh Accords broadened the mandate of the GEF to manage three new funds (in addition to the Trust Fund that covers the climate change focal area): (i) special climate change fund (under FCCC) for countries highly dependent on fossil fuels; (ii) least developed countries fund (under FCCC) for special work programme for least developed countries; (iii) adaptation fund (under Kyoto Protocol) for adaptation activities.
currence of certain natural events over the last few years (FCCC 2004); and (iii) growing public involvement with significant number of Parties, NGOs, private sector, researchers joining in the various aspects of climate change debates. Table 4.1 summarizes the differentiated responsibilities and the key provisions in the pre- and post-Kyoto phases under the UNFCCC and the Kyoto Protocol.

Table 4.1: Differentiated responsibilities and key provisions for Parties

<table>
<thead>
<tr>
<th>Commitments</th>
<th>UNFCCC</th>
<th>Kyoto Protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Parties to prepare national communications; promote scientific research and training, technology development and transfer, etc.</td>
<td>All Parties to prepare national programmes; improve emissions data quality; promote scientific research, technology transfer, capacity-building, etc.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quantified emission reduction targets</th>
<th>Developed countries</th>
<th>Developing countries</th>
<th>Developed countries</th>
<th>Developing countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>To reduce emissions to 1990 levels by year 2000</td>
<td>None (measures contingent on financial/technical resources from developed Parties)</td>
<td>Binding target to reduce emissions to at least 5.2% below 1990 levels by 2008–2012</td>
<td>None (but debate over voluntary commitments)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanisms</th>
<th>Developed countries</th>
<th>Developing countries</th>
<th>Developed countries</th>
<th>Developing countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>For meeting financial obligation (GEF, technology transfer)</td>
<td>For finance, technology (GEF, AIJ, technology transfer)</td>
<td>For flexibility in meeting abatement targets (CDM, JI, ET)</td>
<td>For finance, technology, capacity-building (CDM, GEF, technology transfer)</td>
<td></td>
</tr>
<tr>
<td>For learning, capacity-building for future trade in credits (AIJ)</td>
<td>For learning, capacity-building for future trade in credits (AIJ)</td>
<td>For meeting financial obligations (GEF, technology transfer)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: GEF: Global Environmental Facility; AIJ: Pilot Phase for Activities Implemented Jointly; CDM: Clean Development Mechanism; JI: Joint Implementation; ET: Emissions Trading

4.3 Climate change instruments and policy implications

This section discusses the main CCI s introduced till now, which are directly relevant from a developing country’s perspective. These are (i) the financial mechanism or the GEF, (ii) market instruments, in particular AIJ and CDM, and (iii) direct international transfers of financial and technological resources, including official development assistance (ODA), private transfer and development assistance. The focus is on the specific CCIs, i.e. GEF and AIJ/CDM, and the incentives they offer. In the pre-Kyoto phase, the emphasis was on the financial mechanism for providing financial incentives largely based on public funds and co-financing climate relevant projects,

88 There is a wide range of literature covering different aspects of the CCIs (e.g. IPCC 2001a). The idea here is not to summarize all of it, but to highlight select issues related to their policy implications for developing countries which are relevant for this study. We deal more with the specific instruments, the Financial Mechanism and Kyoto Mechanisms, in order to draw lessons for CCIs in general later in the chapter. The term 'specific CCIs' here, includes those policy instruments introduced specifically under the climate change regime.
but there is now significant interest for strengthening a system for trade in credits whereby both private and public funds may be utilized. For the latter, the AIJ provided an experimental phase, which has given way to an operational CDM and other Kyoto Mechanisms. In addition, there has been a general emphasis on other instruments such as direct international transfers and capacity-building. Clearly, the issue involves complex multi-actor interaction, equity concerns, and decisions at international, national and local levels (Section 3.2). The design and modalities of the instruments are developed based on the negotiating positions of different countries (and influenced by several actors), which put the broad incentive structure in place.

4.3.1 Climate change instruments

4.3.1.1 Global Environment Facility

The GEF is the operating entity entrusted with the responsibility of the Financial Mechanism introduced in the FCCC.\(^{89}\) It creates incentives for the developing countries by providing grants or concessional financing for undertaking climate relevant initiatives, and provides opportunity for developed countries to meet their financial obligations under the FCCC.\(^ {90}\) GEF meets the ‘incremental costs’ of climate change projects in line with its operational programmes and funding platforms (GEF 1996, 2002).\(^ {91}\) The projects need to meet the operational programme criteria, reflect national or regional priorities, and be country-driven, cost-effective and replicable.

GEF has committed grant funding and helped leverage co-financing for climate change projects in more than 140 countries (GEF 2003, 2004). The focus has been on GHG mitigation projects, though expansion in support for vulnerability assessment and adaptation is proposed especially under the new funds introduced by the Kyoto Protocol (FCCC 2002a). Of the operational programmes, renewable energy has the

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\(^{89}\) The GEF, set up in 1991 to cover four focal areas (two more were added later), was assigned the role of the financial mechanism initially on an interim basis (Gerlak 2004). For an overview of initial power politics and how developing countries were induced to accepting GEF as the financial mechanism see (Gupta 1995, 1997). In 1998, it was entrusted with this responsibility on an ongoing basis, with review every four years.

\(^{90}\) The GEF finances those full or incremental costs that are additional and complementary to sources of support that promote national sustainable development. Thus, it is a project co-financier providing ‘new and additional’ funds. Incremental cost separates the cost aimed at achieving national goals (baseline) from those aimed at GHG benefits (alternative).

\(^{91}\) GEF operational programmes for climate change are removing barriers to energy efficiency and conservation, promoting adoption of renewable energy by removing barriers and reducing implementation costs, reducing long-term costs of low GHG emitting energy technologies, and supporting development of sustainable transport. The GEF funding platforms are full-size projects (>US$ 1 million), medium-sized projects (US$ 50,000 to 1 million), small grants (<US$ 50,000), enabling activities (<$350,000), and project preparation and development facility (PDF) including block A (<$25,000), block B (<$350,000) and block C (<$1 million) grants. In addition, the GEF funds small projects under its Small Grants Programme (SGP). GEF portfolio details are found at http://www.gefonline.org/home.cfm.
largest share of investment and number of projects, followed by energy efficiency projects portfolio. The focus is on renewable energy-based electrification and on market development related projects. These have resulted in significant, though small, energy savings and renewable energy-capacity installations (IPCC 2000).

4.3.1.2 Pilot Phase for Activities Implemented Jointly

The pilot phase for AIJ was set up as a demonstration and experimental phase for a future operational JI system. It enabled countries with high marginal GHG abatement costs (investor) to implement projects jointly and cost-effectively in countries where the marginal costs are lower (host), but with no credits accruing to any of them. Thereby, it envisaged incentives for developing countries by providing opportunities for additional funds and cleaner technology. The AIJ projects were intended to be voluntary, bring real and measurable environmental benefits and be compatible with and supportive of national priorities of the countries involved.

AIJ managed to generate interest among parties and by 2002, 157 AIJ projects had been endorsed by the FCCC Secretariat (SBSTA 2002). Almost one-third of these are energy related and very small projects (in size, GHG impact and investment). The portfolio is not quite diverse as many projects are similar and show uneven regional distribution (SBSTA 2002). Through the projects, the AIJ phase achieved, but only limited success in drawing lessons for an operational JI system (Beuermann et al. 2000; Chatterjee 1997; Dixon 1999; Ellis 1999; Michaelowa 2002). This is because several of the projects are not fully implemented, have not undertaken proper monitoring and verification actions, are quasi-AIJ simulations (taking projects from other programmes or simply adding AIJ components to them), and/or are not representative of future projects under a mechanism with credits. Reporting of evidence has also not been uniform (in spite of common guidelines) or detailed enough for convergence on methodologies, and information particularly related to additionality (many projects were profitable in themselves, or used ODA explicitly or implicitly) and sustainability remains inconclusive. The final submission of all reports of the activities undertaken in this phase is underway for synthesis of the information.

92 After the JI concept was introduced in the FCCC, several concerns and viewpoints emerged regarding equity and modalities of developing such a system. Thus, the INC called for a prior pilot phase to demonstrate the viability of JI as an operational and equitable strategy to meet the FCCC objectives, and COP-1 in 1995 established the AIJ phase. The operational JI with credits was introduced only in the Kyoto Protocol as JI for Annex I Parties and CDM for projects in developing countries (Pachauri and Soni 1994).

93 The initial response was lukewarm, but the process picked up in 1997 (mainly in preparation for Kyoto Mechanisms and based on the perception that the AIJ projects may get converted to CDM/JI projects at a later stage). The focus now has shifted to the Kyoto Mechanisms.

94 Of the 157 projects, 56 smaller projects are located in only three Annex I host countries involving energy efficiency, mainly municipal/district heating systems improvement and renewable energy-conversion to bio-fuel boilers. Overall, AIJ involved 54 Parties (42 hosts, 12 investors), of which Latvia and Estonia hosted about 30% of AIJ projects, and Sweden, US, Netherlands and Norway funded most projects (SBSTA 2001, 2002).
4.3.1.3 Clean Development Mechanism (CDM)

Theoretically, CDM is perceived as a formalized project-based AIJ or JI mechanism between developed and developing countries.\(^{95}\) It allows countries with quantified abatement targets to procure abatement credits or CERs from developing countries without these targets. CDM aims at creating dual incentives by assisting the developing countries in achieving sustainable development, and the developed countries in achieving compliance with their emission reduction targets (Kyoto Protocol: Article 12). The credits are to be certified on the basis of voluntary participation approved by the parties involved, and real and measurable emissions reductions that are *addi-tional to* any that would occur in the absence of the certified project activity (known as ‘project additionality’).

CDM can take different forms (Baumert, K A et al. 2000; IPCC 2000). These include: (i) *portfolio* where several projects may be developed at the same time under one banner (may be a carbon fund, bilateral/multilateral agreement or tender); (ii) *competitive* where a competitive market value exists as a CER price for all projects; (iii) *negotiated* where each project is stand alone, developed and negotiated separately; and (iv) *hybrid* arrangement for GHG credits. The form influences the price of credits and thus the financial incentive to the country hosting the project (Babu and Michaelowa 2003; Chander 2003; Ghosh et al. 1994; Gupta, S 2003).\(^{96}\) The programmes for developing CDM projects have more often followed the portfolio approach. First to be set up were the Prototype Carbon Fund (PCF) and the Dutch government’s Certified Emissions Reduction Unit Procurement Tender (CERUPT).\(^{97}\) Subsequently several other programmes have been developed. There are a large

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\(^{95}\) CDM was conceptualized almost overnight at COP-3 (Srivastava and Soni 1998). It is known as the ‘Kyoto Surprise’ (Streck 2004). The term close to CDM was first introduced in the Brazilian submission for adopting a Protocol to the FCCC Secretariat, which suggested setting a ‘Clean Development Fund’ or a non-compliance fund with a development objective. It provided a basis for setting up a fund to enhance development and reduce GHGs in developing countries. The CDM, however, is not similar to the Brazilian submission.

\(^{96}\) The price of credits can be: (i) mark-up price (abatement cost possibly with a mark-up) in a portfolio approach; (ii) market price in a competitive CDM; or (iii) negotiated price based on relative market power *vis-à-vis* investors in a negotiated CDM (Figure 4.2 gives broad comparisons). The funding may be in the form of equity, purchase agreements, loan, grants, etc.

\(^{97}\) PCF was launched by the World Bank in the year 2000 as the first market-based mechanism to address climate change. PCF operates like a mutual fund for promoting transfer and finance of cleaner technologies to developing countries and countries in transition (for CDM and JI). It is scheduled to terminate in the year 2012. PCF gets financial contributions from investors (governments, private companies) who in turn are eligible for GHG credits. CERUPT, on the other hand, is a tender based on purely financial inputs where the buyer does not get involved in the projects (though separate funds may be provided for project development). It was launched by the Dutch government through an agency called SENTER in November 2001 and closed in January 2002. Eighteen projects were accepted for further development as CDM projects aiming to reduce over 16 megatons of CO\(_2\) emissions. Other programmes include national programmes of Finland, Denmark, Austria and Sweden, and the IFC Netherlands Carbon Facility.
number of currently ongoing or planned GHG mitigation activities being developed as CDM projects. There has been a rapid growth in these projects as well as number of participating countries, especially since the first project was registered in 2004. The largest number of these are renewable energy (electricity generation) projects (OECD 2004).\textsuperscript{98} Number of fugitive emission projects, in particular the HFC23 reduction projects, are also increasing due to their large GHG reduction potential.

\textit{Small projects and small-scale CDM}

Since the inception of CDM, a major concern was that the CDM projects would remain limited to a few host countries, sectors and technologies. Such that, in particular the small projects with high transactions costs would get left out (Baumert, K et al. 2000; Dasgupta 2000). Studies have shown that the transactions costs per CO\textsubscript{2} of small projects are higher than of larger projects. There are possible options for inclusion of small projects in the CDM (Samaniego and Figueres 2002; Sutter 2001). The options include: (i) \textit{unilateral} CDM: where the ‘additional’ small project is undertaken independently by the host country and the credits are offered for sale; (ii) ‘\textit{bundling}’ of projects: bringing together a number of small projects such that they represent significant GHG reductions (and reduced transaction costs than individual projects); and (iii) ‘\textit{sectoral focus} or baseline’: when emphasis is on developing projects at the sector or even industry levels (that may therefore include several small projects).\textsuperscript{99} In spite of these, however, it was felt that transactions costs would render small projects unattractive vis-à-vis the large projects as ability of small project to deal with and absorb the transactions costs is relatively lower (World Bank 2003a).

With the importance of small projects realized, and to kick-start the CDM process, ‘\textit{small-scale CDM}’ was introduced. The Marrakesh Accords (2001) established the legal basis for the modalities governing small-scale CDM, which have subsequently been elaborated.\textsuperscript{100} The small-scale CDM aims at reducing transactions costs of small projects by measures through simplified methodologies and procedures (for approval, certification, etc.), and thereby provides increased opportunities for them (FCCC, Decision 21/CP.8). The initial PCF experience also showed that small projects or countries probably lose out, and therefore a separate Community Development Carbon Fund (CDCF) was established for financing small-scale CDM projects.

\textsuperscript{98} The 160 CDM projects being developed comprise 17 energy efficiency projects (till mid-2004) accounting for only 3\% of expected annual credits (OECD 2004). The number of registered projects has increased, and the official status is at http://cdm.unfccc.int/projects.

\textsuperscript{99} While under ‘\textit{bundling}’ the investor interests would still play an important role, the other two options are dependent largely on the hosts (government or private party).

\textsuperscript{100} Activities eligible under small-scale CDM are: (i) renewable energy with maximum output capacity equivalent of up to 15 megawatts; (ii) energy efficiency improvement, which reduce annual energy consumption by up to equivalent of 15 gigawatt-hours; (iii) others that reduce emissions by source and directly emit less than 15 kilo tonnes of CO\textsubscript{2} equivalent annually.
Under a competitive market, the 'market price' or the global price of carbon would be set via the market mechanism, such that the surplus would be the difference between the MCs (including non-market costs) and the global price of carbon, which is given by the shaded portion.

Under the bilateral or negotiated CDM, the project funding would be negotiated by the actors involved ('negotiated price'). It will depend on the difference between the MCs (incl. non-market costs) of the investing and host Party. That is, the rent sharing would depend on the negotiations. This may be equal or lower than global price of carbon in a competitive market.

Figure 4.2: Climate change instruments – forms and financial incentives
highlighting the need for special attention for small projects. Several small-scale CDM projects are being developed and the share of small-scale projects has increased significantly (FCCC 2005).

4.3.1.4 Other instruments

Besides the CDM, the two other Kyoto Mechanisms are Emissions Trading and JI. It is unlikely that developing countries will be able to directly participate in Emissions Trading unless they take on abatement commitments, and JI is only for the developed countries’ participation. However, the two mechanisms impact the mitigation efforts in the developing countries indirectly by influencing the size (and price of CERs) of the CDM market. They may even directly be relevant for the developing countries in the long run depending on how the regime develops. For example, these may be directly relevant if developing countries take on voluntary or binding quantified abatement commitments, through fungibility of credits, or participating in a secondary GHG credits market.

Besides the specific CCIs, climate-relevant activities are and can be undertaken under other pathways such as direct international transfers of finance and technology to the developing countries (IPCC 2000; OECD 2002). Technology development and diffusion (including transfer) has been envisaged as an important mechanism for addressing climate change and is emphasized in the FCCC and the Kyoto Protocol along with the need for suasive efforts and capacity-building. The pathways include Official Development Assistance (ODA), private sector investment and multilateral or bilateral development assistance. While ODA remains an important source, especially for the soft part of technologies (enabling environment and capacity-building), the contribution of private investment has been rising over the last few years. In addition, regulatory instruments such as international technology and emissions standards are also being debated.

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101 CDCF finances small-scale CDM projects to “enable private capital-seeking carbon credits to reach deep down into the poorest areas of the developing world, not just to reduce carbon emissions, but to serve the aims of sustainable development. ...” Another example is the Finnish CDM Pilot Programme launched in 2003 that targets small-scale projects via tenders.

102 The FCCC requires the developed Parties to take all practicable steps to promote, facilitate, and finance, as appropriate, the transfer of, or access to, cleaner technologies to other Parties, particularly to developing countries (FCCC: Article 4.5). However, it lacked on specifics or a strategy and was not really addressed till 1998. Consequently, several steps are taken including setting up a ‘consultative process’ and ‘expert group’ to recommend a framework and enhance meaningful actions, and supporting efforts like assessment of needs, broadening information base and access (e.g. technology clearing house, networks), creating enabling environments and capacity-building. The Kyoto Protocol also emphasizes technology transfer and co-operation between industrialized and developing countries. It formally recognizes the role of the private sector and the need for an “enabling environment” to promote investment.

103 FCCC commits Parties to cooperate in and strengthen national capacity-building (FCCC: Article 10e). This issue is considered separately since 1999, when COP-5 launched a consultative process to discuss it in an integrated manner.
4.3.2 Main policy implications

The above discussion points out that CCIs increase awareness and offer significant incentives in the form of opportunities for additional financing, efficient technologies and capacity-building for undertaking climate-related activities. The present efforts have led to positive trends; however, compared to the magnitude of climate-related technology and financial needs these are only of a modest scale (IPCC 2000). Clearly, there is no preset answer for enhancing the efforts, which are affected by motivations that induce as well as the barriers that impede the process, and depend on human and organizational capacity at every stage of involvement with the CCIs.

4.3.2.1 Policy implications and GEF

The GEF offers direct financial incentive for developing countries by providing additional financing (grants or subsidies) to undertake climate-relevant activities. The strength of GEF lies in its flexibility in terms of different funding options for projects based on their size. This also includes the Small Grants Programme (SGP) for funding small projects, which has been fairly successful in bringing in communities and local-level participation in actions that address climate change though few of them have actually been replicated or up-scaled. The GEF also creates possibilities for new and innovative projects, including SSI activities (for example, in Bangladesh, Vietnam, Kenya and India) and programmes (such as the SME programme)\(^{104}\). The GEF assists in testing and demonstrating different financial and institutional models in several countries (Martinot and McDoom 2000), and helps in catalysing sustainable markets, building capacity and mobilizing the private sector to finance clean technologies (IPCC 2000).

However, there are several concerns associated with GEF as well. Foremost being the transactions costs of developing and implementing GEF projects. The procedures for availing funds and the series of approvals are complicated. The time taken between preparation of projects and their final implementation is long, and relatively higher for full or large projects (FCCC 2002c; GEF 2003). Only a few projects funded in the programmes till 1999 were implemented fully.\(^{105}\) The financial resources available to and disbursed by the GEF are often considered inadequate, and do not always reflect ‘financial additionality’. Though steps have been taken to im-

\(^{104}\) GEF with International Finance Corporation (IFC) initiated the ten-year global ‘small and medium enterprise (SME) programme’ in 1995 for financing SME projects with environmental benefits and financial viability (IFC 2005). Focus was on long-term low interest loans for ‘IFC–GEF SME programme intermediaries’ (private companies, NGOs, financial intermediaries) that may fund such projects. This was the first GEF-funded non-grant SME financing programme. It is now succeeded by the IFC–GEF Environmental Business Finance Programme. GEF is increasingly recognizing the importance of small projects (e.g. under Montreal Protocol ODS-free options for SMEs is still a challenging task).

\(^{105}\) Out of the 72 energy efficiency and renewable energy projects approved between 1991 and 1999, only eight were fully completed by mid-1999 (Martinot and McDoom 2000). GEF (2002) provides an assessment of the GEF-climate change portfolio.
prove the level and pattern of funding and simplifying procedures, and there is provision for Project Preparation and Development Facility (PDF) funds for project development, this remains a major issue. In addition, the GEF faces challenges of strategic development, focus and effectiveness of its portfolio (GEF 2004). Many projects do not result from coherent, integrated approaches to development and environment at the country level, but are conceived on an ad-hoc basis (FCCC 2002a). Thus, while the GEF’s operational strategy recognizes the need to develop ‘country-driven’ projects, they are often ‘consultant-driven’ (or donor-driven) and give more weightage to cost-effectiveness than national priorities (Hassing et al. 2000; Srivastava and Soni 1998). The largest thrust has been on renewable energy projects (GEF 2004).

4.3.2.2 Policy implications and CDM

CDM is an innovative instrument as it provides economic incentives through an emerging carbon market. Herein lies the strength of the mechanism and makes it most relevant in the current scenario. The AIJ phase laid down its foundation by providing the opportunity for all parties to start quickly and gain experience. The absence of credits, while providing a non-risky scenario for building capacity, also weakened the incentive to participate in the AIJ phase. With the developing countries insufficiently prepared, the investors (basically a few developed countries) appeared to dominate the process (Gupta 1997). Most of them, however, did not translate the opportunities into clear incentives for the private sector by setting domestic instruments. This remained a weakness of AIJ suggesting a need for stronger incentives for participation, which is provided by CDM in the form of credits. The small-scale CDM in particular further strengthens the incentive by reducing the transactions costs for small projects. There is substantial interest in CDM, even though there are issues associated with it as well.

Uncertainties. When CDM was introduced, it was associated with high expectations in spite of the concerns and apprehensions. It was expected to bring in low-cost finance including private funds, technology transfer and even develop socially beneficial projects that are unviable in a business-as-usual scenario. A large CDM market

\[\text{106}\] National programmes (USA, Australia, Canada, Japan, Germany) cover some transaction costs (project development, negotiation). Sweden, Switzerland and the Netherlands introduced subsidies. On the other hand, in several states of USA, ‘externality adders’ were a powerful incentive for electric utilities to invest in carbon offsets including AIJ. Externality adders led to the biggest private AIJ projects (Michaelowa 2002). The first utility to invest in AIJ, did so because it feared an externality adder even before the term AIJ was coined.

\[\text{107}\] Other developing countries’ concerns relate to equity (is it a way for developed countries to shift their responsibilities to developing countries?), long-term benefits (are they giving away their cheaper options or low-hanging fruits?), and modalities – particularly, supplementary (CDM activities should be in addition to domestic action), project eligibility (developing methodologies especially for baselines, sustainability and additionality; inclusion of sinks), risk- and benefit-sharing arrangement, credit price and transactions costs. The Marrakech Accords has address some of the issues, but it is often felt that several concessions have been made (e.g. inclusion of sinks) for survival of the Kyoto Protocol after withdrawal of USA.
was envisaged with high credit value, and projects with high GHG abatement costs were identified. However, CDM has developed to project a slightly different picture.

Firstly, the CDM buyers’ market is growing rapidly (it is still smaller than anticipated reasons include US withdrawal from the regime, existence of ‘hot air’, and uncertainty regarding the costs–benefits and future of the regime beyond first commitment period). Its evolution, however, has been quite speculative. The experience till now (Lecocq 2004; Lecocq and Capoor 2003) and projections (Jotzo and Michaelowa 2002) indicate a carbon price much lower than was expected (US$ 0.5–5.5/tonne of CO2 till 2004). Prices have risen since 2004 (as per World Bank’s estimates the average is more than US$7 in 2005), and are expected to rise further as the first commitment period draws nearer. The sellers remain quite heterogeneous.

Secondly, CDM at present is relevant as a financing option and not as an instrument for technology transfer. With economic criteria at the fore, the other criteria have become less important in practice. The emphasis is on carbon credits and minimizing risks than on sustainable development benefits. For instance, a tender which is a preferred practice for CDM programmes, implies obtaining cheap and low-risk credits as the prime motive for investors. This, coupled with evidence from existing portfolios, indicates that the aim of facilitating sustainable development in developing countries remains largely theoretical. The main motivations are different and generally are as indicated in Figure 4.3.

Thirdly, most CDM programmes are set up as multilateral or bilateral funds or tenders by governments drawing on public money, with some incentive for private sector participation (through tenders, subsidies or purchase of carbon credits). Most Parties have hardly translated or complemented the emerging options by domestic emissions trading or other policy instruments. While some private sector trading systems have come up, their involvement has been low. An option for increasing private sector involvement as investors is to decentralize national abatement targets, but this has not really happened.

Transactions costs. Several steps are involved in developing a CDM project including preparation (search, negotiation, baseline determination, approvals, registration, etc.) and implementation (monitoring, verification, certification, etc.). Each stage is associated with transactions costs that may be at international, national or local/project level. Transactions costs are a major cause of concern as they push the abatement costs upwards rendering several projects economically unviable. These

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108 Some reasons may be: delay in ratification of the Protocol; increased supply in the presence of hot air and inclusion of sinks projects; and limited private sector involvement.

109 The risks involved include (Mitchell and Parson 2001): project risks (under-performance, market risk and technical risks, etc.), participant risks (e.g. non-cooperation), and exogenous risks (e.g. political instability; world energy price fluctuation; natural calamities, etc).

110 These costs include: project development costs (project development, preparation, negotiation, consultation), registration and share of proceeds for the adaptation fund (2%) as mentioned in Article 12, and monitoring and verification costs, etc.
include not only monetary but also non-monetary and indirect costs (such as bureaucratic delays, opportunity costs). Studies and evidence show that the transactions costs for CDM is high (Ahonen and Hamekoski 2005; DeGouvello and Coto 2003; Michaelowa et al. 2003; UNDP 2003). In the AIJ phase also the transactions costs were indicated to be large and influenced by economies of scale (Michaelowa et al. 2003). Efforts have been made to simplify procedures and provide support for project development. Especially for small-scale CDM, the transactions costs are reduced substantially and estimates indicate a decline of more than 50% to 67%. Despite these, however, small-scale CDM faces high transactions costs, and the regular CDM even higher.111

![Figure 4.3: Primary interests (perceived) of actors in developing a CDM project](image)

**Notes:** Investor country government is theoretically interested in global sustainable benefits, but the main interest may be just to obtain cheap credits to meet their abatement targets.

Private sector investor’s motivation, in the absence of specific targets for them translated from the national abatement targets, is largely economic (to maximize profits and avail the incentives offered by the governments under their CDM programme).

Host country government is basically interested in national sustainable development benefits, i.e. additional socio-economic and environmental benefits, but more so to get a good price for credits. In the absence of clear incentive for them, they may be just safeguarding their political interests.

The private sector host’s main concern again is economic (investment, technology) benefits.

In addition, the consultants and intermediaries, are the ‘jam in the sandwich’ as they bring the project together. Their main motive is the short-term gains in form of their consultancy fees and/or ‘cut’

111 Though these costs for small-scale CDM projects are estimated to be reduced by 50–67% of regular projects, they are also estimated to be as high as at 23–78,000 USD or 110,000 USD (DeGouvello and Coto 2003; Ecosecurities 2002; World Bank 2003a). For a good summary of transactions costs estimated and experienced, in particular for the Finnish pilot CDM programme, (see Ahonen and Hamekoski 2005: page 26).
Market biases. An examination of the existing CDM portfolios indicates inherent market biases, with a large number of renewable energy projects. Key portfolios including PCF and CERUPT projects, have been at times criticized on the ground that many projects are viable in themselves, have inflated baselines and/or do not adhere to project ‘additionality’ criteria (e.g. see Pearson and Loong 2003). Additionality, both project and financial, as a concept still remains complicated (Jepma 2004) and is prone to interpretation. The open process for approval of methodologies is set up to bring in transparency and credibility (some methodologies submitted to the FCCC Secretariat were even rejected). Lack of clear methodologies such as in case of energy efficiency however adds to the uncertainties associated with the projects.

4.4 Climate change policy in India

While the above sections discussed the climate change policies at the international level, this section specifically deals with the climate change policies in India. India is a party to the FCCC and the Kyoto Protocol. It signed and ratified the Convention in June 1992 and November 1993 respectively, and acceded to the Kyoto Protocol in August 2002 (Figure 4.4). However, there is no formal national policy for addressing climate change. A combination of national policies for different sectors are relevant for addressing climate change, including, in particular, policies for the energy sector promoting energy efficiency and renewable energy and policy for protection of environment and forests.

Figure 4.4: Timeline pertaining to the climate change process in India

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112 By 2003 end, about 24 projects were being developed as CDM projects in a few host countries. By March 2004, the number increased to 35 planned/ongoing CDM projects, mostly in the renewable energy area (JIQ 2004). The analysis of the credit market also indicated a majority of renewable energy projects (Lecocq 2004; Lecocq and Capoor 2003). The current situation in 2006 is also similar with less than 2% energy demand projects (FCCC 2005).
4.4.1 National policies that address climate change

India is among the largest contributors of GHG emissions in the world, accounting for around 3% of the global emissions in 1990. On a per capita basis, however, the emissions are only one-sixth of the global average (ADB 1998).\(^\text{113}\) The rate of growth of the GHG emissions in India is higher than the world average (Gupta, S 2003). The largest GHG contributor is the energy sector, within which the industries are the maximum energy consumers and GHG emitters. The energy sector also possesses significant potential for GHG mitigation.\(^\text{114}\)

India is also vulnerable to climate change (MoEF 2004a). The national economy is reliant on climate-sensitive sectors like agriculture and forestry (Kumar 2003; Kumar and Parikh 2001; Ravindranath and Sukumar 1998). India has a large low-lying coastline threatened by a potential rise in sea level (TERI 1996). Therefore, climate change is a relevant issue for the country. However, in light of more pressing socio-economic and developmental needs, climate change is not a priority area.

4.4.1.1 Organizational structure

The Ministry of Environment and Forests (MoEF) is the nodal agency for addressing climate change-related and other environmental policy issues in India. The MoEF has set up a ‘Working Group on the UNFCCC’, with inter-ministerial and NGO representation, to deliberate upon measures and positions regarding issues emerging out of the climate change negotiations. Other Central Government ministries play a vital role in the process of developing national positions and related initiatives, as well as providing technical advice to MoEF. For instance, the Planning Commission is important for capacity-building, the Ministry of External Affairs (MEA) is represented at the international negotiations, and others especially the energy-related ministries such as Ministry of Power and Ministry of Non-Conventional Energy Sources (MNES) participate in the national discussions. Steps are being undertaken for meeting the FCCC commitments including the national communications (NATCOM) (MoEF 2004a). Efforts are also under way to improve the scientific understanding and increase awareness, and several organizations are getting involved in the process.

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\(^{113}\) Even the top 10% of the urban population emits below the global per capita average (Parikh and Parikh 2002). This issue came up way back in 1991 when a study (Agarwal and Narain 1991) brought to the fore the debate on per capita emissions and entitlements.

\(^{114}\) The energy sector in India accounted for 61% of total GHG emissions in 1994. The rest came from agriculture (28%), industrial processes (8%), and others sectors. In terms of CO\(_2\) emissions, energy contributed 85% of the total emissions, followed by industrial processes (13%) and land use, conversion and forestry (2%). The emissions from the energy sector, which is dominated by coal-based supply and increasing demand, have been growing significantly (by 5.8% between 1990 and 1995) and are projected to increase fivefold by 2020 (ADB 1998). Sector-specific studies have indicated high potential for CDM projects in the power sector and in enhancing energy efficiency in industries (to the tune of about US$1.05 billion each) over the next decade (CRISIL 1999).
4.4.1.2 Participation in climate change negotiations

India has been quite active, though cautious, in the climate change negotiations. The national stance on climate change however has largely stemmed from response or reactions to events outside the country and the international climate change process.

Before 1990, climate change was not an important scientific or policy problem for the country. It reached the domestic policy agenda basically with the INC in 1990. India emerged as one of leading developing countries to put forth their positions at the Rio Summit, and has continued to stress the views of the G77 (Gupta et al. 2001). However, some observers (Gupta 2002) have criticized the government for taking a defensive stance on specific issues, failing to put forth a coherent climate strategy and missing an opportunity to jumpstart the negotiations. The basic essential elements of India’s approach to international efforts at addressing climate change include (a) principle of common but differentiated responsibilities and respective capabilities of different countries; (b) reliance on multilateral approaches; (c) equal per-capita entitlements of global environmental resources to all countries; and (d) priority of the right to development (MoEF 2004b).

India has emphasized the need for financial and technological resources for the developing countries at the climate change negotiations. In this regard, the basic support and approval system for the CCIs is in place. For the GEF, a Global Environment Cell has been set up for examining projects and providing technical and scientific inputs into the process of project formulation including those for GEF assistance. In addition, a national strategy has been formulated and an Empowered Committee has been set up for identification of GEF projects, formulation, implementation and monitoring of GEF activities in the country. With regard to CDM, the Designated National Authority (DNA) has been set up (MoEF 2005), and a national strategy study for implementation of CDM prepared (TERI 2005). India’s initial experience during the Pilot AIJ phase when MoEF had set a Task Group on AIJ for project approval was that there were initial reservations but gradually interest picked up. Though five AIJ projects were approved, only three were officially developed and one officially registered with the FCCC Secretariat. For CDM also, there were concerns voiced by India at the climate change negotiations. Nevertheless several actors are getting involved in the process and a number of projects are in the pipeline.

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115 India has been active especially in putting forth the perspectives of the developing countries, including issues related to equity, adequacy of commitment, financial mechanism, Kyoto Mechanisms, voluntary commitments, inclusion of sinks and technology transfer.

116 DNA was set up by the MoEF (F. No. 4/5/2003-CCC), under the powers conferred on it by sub-section (1) and (3) of section 3 of the Environment Protection Act (EPA), 1986.

117 India has stressed the supplementarity – developed countries may use the Kyoto Mechanisms to meet only a part of their commitments and be supplementary to domestic action – additionality and host country initiative in defining sustainable development. It has advocated against inclusion of sinks and fungibility of credits.
4.4.1.3 National policies relevant for climate change

The climate change issue entered the domestic political arena around the same time when the country was initiating a conscious policy of economic reform with focus on liberalization and globalization. The overall goal of the economic reform policy, triggered largely by the macro-economic crisis of 1991, was to achieve economic efficiency and growth across various sectors of the economy (Srinivasan and Bhagwati 1995). These have had an impact on the GHG emissions of the country, and India’s CO\textsubscript{2} intensity per unit GDP has shown a decline (MoEF 2002b). In addition, efforts and initiatives are being taken within the overall development strategy and economic policy that have clear relevance for climate change (Box 4.1). The efforts towards macro socio-economic priorities as articulated in the Tenth Five Year Plan (GOI 2002) including poverty eradication, employment and literacy, health and population reduction, gender equality and environmental sustainability all have a bearing on the national GHG emissions trajectory.

The energy policy, in particular, plays a crucial role in defining national efforts related to climate change. Significant initiatives have been undertaken in the energy sector, which are relevant from the climate change perspective. While the use of coal resources and installing new thermal capacity to meet the rising energy demand are increasing GHG emissions, significant policy provisions like promoting energy efficiency and renewable energy contribute towards addressing climate change. Over the past decade, the energy policy has seen a marked shift with greater focus on energy reforms, though there is still much reliance on regulatory instruments and subsidies and a lot needs to be done (Box 4.2). In addition, the environment and forests policies are aimed at increased environmental awareness, and providing incentives for conservation of natural resources and reducing local pollution.\textsuperscript{118}

4.4.2 Main policy implications

The national policy provides incentives for reducing the growth of GHG emissions while addressing the national goals and targets. There is increased awareness and environmental consciousness, and GHG reducing initiatives are being undertaken especially in the energy sector. Though the level and depth of climate-related discussions have increased over the years, the climate change issue is still minimal at an overall domestic political level (Gupta 2001). The changes are in accordance with the country’s development strategy and are not driven by global environmental concerns. This is because although climate change \textit{per se} is not a priority, energy policy is an urgent issue in the economic development of the country (Gupta et al. 2001). The energy policy does not directly incorporate addressing environmental degradation or climate change as a primary goal. The environmental and energy policies are still distinct and are developed separately. However, climate change has a mention in the

\textsuperscript{118} The national policy for environmental protection and their implication specially for the SSIs are discussed in Chapter 5.
current national Five Year Plan (for 2002-2007) and the National Environment Policy (GOI 2002; MoEF 2004b).

**Box 4.1: Policies and measures complementing GHG mitigation efforts**

**Electricity generation**
- Renovation and Modernization (R&M) programme for power plants resulting in improved fuel efficiency.
- Increased share of natural gas in the coal-dominant thermal mix (from 2% to 14.5% in the last three decades) and renewable energy (accounts for over 3.4% of grid capacity).

**Energy sector reforms**
- Initiatives aimed at efficiency such as a move towards rational energy pricing and privatization (expected to reduce losses)

**Renewable energy**
- Implementation of the renewable energy programme (largest in the world)
- Policy objective: Adding 10% of additional power capacity from renewables by 2012.

**Transport**
- Initiatives for switch to cleaner fuels (unleaded petrol, CNG), especially for public transport

**Industries**
- Setting up of the BEE (Bureau of Energy Efficiency) under the Energy Conservation Act, 2001, to facilitate and enforce efficient use of energy
- Industry-specific environmental standards under the national environmental policy

**Forestry**
- Implementation of the national forestry action programme (for protection and expansion of forest resources, improvement in forest productivity and expansion of forest area)
- Promotion of people’s participation in forest conservation efforts through joint forest management (about 14.25 million hectares being managed under the programme)
- Policy objective: to increase the forest and tree cover to 25% of the geographical area during the tenth Five Year Plan (2002-07).

For climate change in particular, the interest in India is mainly due to the CCIs. With an economy growing at a high economic growth rate, and a large GHG emissions contribution and mitigation potential, India is one of the leading host countries for CCI projects and investments with several projects are already in place. These include projects related to SSIs being implemented/considered under GEF and CDM such as those for steel re-rolling (for GEF) and foundry and brick industries (for CDM including small scale CDM); however, these are still only a few projects and focus more on capacity-building. The private sector is being gradually involved despite uncertainties regarding the associated costs, benefits and risks. Key national industrial associations are advocating CCIs as an opportunity for the present and future. The interest is not only to be hosts but also investors (e.g. South–South coop-

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119 Liberalization policies are increasing the private sector’s interest to capitalize on available opportunities to modernize their production processes, especially in CDM (Gupta 2001). For example, some key industry associations have set up ‘Green Cells’, and one of them also regularly publishes a journal on emerging opportunities.
Given this, several consultants and intermediaries, including NGOs and financial organizations, have come out to support and advice on developing such projects. A number of workshops and conferences are organized each year on this issue.

**Box 4.2 National policies for the energy sector in India**

Energy is important for industrialization and economic growth in India, and has formed a key component of the development strategy since Independence. However, there is no comprehensive energy policy in India. It comprises policies and plans of five different ministries, MoP, MNES, Ministry of Petroleum and Natural Gas (MoPNG), Ministry of Coal and Mines (MoC), and the Department of Atomic Energy (DAE). There is discussion now on the need to have an integrated energy policy.

The initial focus of the national policy related to the energy sector was on centralized planning for attaining energy security. Emphasis was on public sector investment in power generation and development of oil and gas resources. The period 1970–90 coincided with a growing shift in development policy and the emergence of a pro-poor ideology in the country (and the two oil shocks of 1973 and 1979), and experienced increased energy investments under state control and introduction of populist measures such as price control and subsidies. These measures led to rising fiscal deficit, inefficient quality of energy services, and an inward orientation of the energy economy. At the same time, the need to identify alternative energy sources was highlighted. In this light, and in line with the economic reforms in the country, there was a marked shift in the energy policy in 1991.

As the economic reforms were initiated to restructure the entire economy, reforms in the energy sector were also initiated. The government is giving particular attention to efficiency and private sector participation. Focus on access to energy services and renewable energy sources for electricity generation is also increasing (though coal is expected to continue to dominate the energy supply share). The Rajiv Gandhi Vidhutikaran Yogna is a good example of initiatives in this regard for increasing access to electricity especially in the rural areas. In addition, stress on demand side measures, which had been basically missing before, has been realized and a Bureau of Energy Efficiency has been set up under the Energy Conservation Act, 2001 to facilitate and enforce efficient use of energy.

Sources: (Dubash and Chella Rajan 2003; Sinha 2007; TERI 2003)

Despite this, however, there is no concrete country strategy or a transparent policy regarding CCIs. The CCIs have not been translated to any kind of national policy instruments, nor has a proactive stance been adopted at most times. There are no clear indicators to evaluate the proposed projects, nor has a priority list of the kind of projects to be approved under CDM or GEF been developed.\(^{120}\) The approval process

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\(^{120}\) The MoEF has adopted “guidelines” for approval of CDM projects. These emphasize additionality and sustainable development including social: poverty alleviation by additional employment generation, removal of social disparities, contribution to provision of basic amenities leading to improvement in quality of life; economic: additional investment consistent with needs of the people; environmental; and technological: transfer of cleaner technologies with a priority to renewables sector or energy efficiency projects. However, there are no clear indications to measure and evaluate projects against these criteria.
has been associated with bureaucratic delays and transactions costs, and the selection process has been *ad hoc* (there are broad criteria but no clear indicators for project selections). In addition, the government involvement in the climate change debates is restricted to the energy, environment and industries ministries, but with limited or no representation of the SSI ministry. The interest has broadly remained ‘top-centric’ (limited to a few ministries and industrial houses) and awareness has not percolated across stakeholders at the state or lower levels. Since 2005, though state-level CDM cells have been set up in a few states and strengthening of GEF Cell is also envisaged. In the current scenario, therefore, it seems that market power will play a crucial role for development of related projects.

### 4.4.2.1 Implications of national policy and GEF

Under the GEF climate change portfolio, India has several large and medium projects (closed, approved and operational), in addition to the small grants programme and enabling activities (see www.env.nic.in). A majority of the regular projects are renewable energy interventions, and only a small proportion (about 11%) of the GEF allocations have been for energy efficiency (including energy efficiency improvement project for small-scale steel re-rolling mill cluster). Although the portfolio is large, it does not have significant impact owing to delays and slow implementation (for example, the experience with the two biomass power projects). Only a few GEF projects have been completed, while some (e.g. project on fuel cell buses) have also been dropped for different reasons. A number of projects have been successfully implemented under the SGP, which have shown significant local sustainability results and community participation, but they have hardly led to any replicability or scaling up. Overall, there has been a lack of coherent policy and strategy in terms of GEF project development (Ahuja 2003). An attempt was made to develop a GEF country programme a few years ago; however, the evolution of the GEF portfolio has been erratic. There has been an inconsistent focus within the country, with the GEF projects not consistently addressing major climate-change needs related to either GHG emissions sources or expressed national goals (GEF 2004). Due to a lack of clarity and proactive country strategy, the choice of projects has been driven mostly by investors or consultants.

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121 For example, no official AIJ projects had been endorsed in India till March 1997, though the AIJ phase had taken off in other developing countries. It was just before COP-3 when the government approved five projects almost in one meeting. The same trend is also seen for CDM wherein several projects are discussed in a single meeting.

122 Based on private communication and discussion with officials at MoEF (2005).

123 The small players (like the SSIs) are usually not even invited for most CCI-related meetings. Like a representative of a big industrial association said “*we ourselves are not sure of the risks and costs involved, then how will the small industries fit in. They are important no doubt, but it will be some time till they become involved*”.

124 These include short-term projects for capacity-building for application of energy audit and CP tools in improving energy in specific SSI clusters.
4.4.2.2 Implications of national policy and CDM

India possesses a large GHG mitigation and CDM potential. Projections indicate a share of over 10% of the global CDM market for the country during the first commitment period (IGES 2005). Several CDM projects, mostly unilateral, have been already registered or are in the pipeline (FCCC 2005). In fact, it has the highest number of projects accepted under CERUPT and other programmes (Krey 2004), many of which are driven by consultants and donors (TERI 2005). As regards the different sectors, the portfolio is skewed primarily towards renewable energy projects. One of the reasons for this emphasis is MNES’s involvement and efforts to push renewable energy under its national programme particularly in light of the tight objectives of increasing the capacity of renewables substantially over the next few years. Renewables are also encouraged by consultants since the baselines are easier to define and initial preparation is faster than probably the energy efficiency or sink projects. Due to their GHG reduction potential, they are also being pushed by the investor lobbies. Energy efficiency projects, especially in the SSI sector, are associated with lack of a predefined approved methodology and difficulties of organizing many stakeholders.

Along with investor-demand focus and uncertainties (both financial and political or policy), the transactions costs of projects are especially important issues influencing the policy implications (IGES 2005; Krey 2004, 2005; TERI 2005). In addition, the CDM portfolio in India is also often contested on grounds of project additionality. It has been pointed out (TERI 2005) that often the transactions costs increase (for example, if it involves a number of partners or units in case of SSI clusters) when project developers may not have documentary evidence (if they do not have proper monitoring), do not want to disclose their financial status or provide the required information that leads to transactions costs (for example, if it involves a number of partners or units in case of SSI clusters). It includes projects which are already operational (before approval was sought as CDM projects) and are viable anyway. The projects hosts are private companies that are already undertaking similar projects and use demonstrated and commercially available technologies (as in CERUPT wind projects). In addition, they make use of the government’s subsidies and incentives. The question that arises is whether it really makes sense for a country like India – which already has a massive renewable energy programme and sufficient knowledge base as far as renewable energy technologies is concerned – to concentrate on these kinds of projects (such as the grid connected wind energy projects) under a mechanism focusing on additional investment opportunities and sustainable development?

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125 As per 2004, more than 65 CDM projects are being developed (including small-scale CDM). Of these, 40% are renewable energy and 16% are waste-to-energy projects. Energy efficiency in industries constitutes only 16% of projects (http://www.teriin.org/nss/index.htm). Official figures till 2003 also indicate a clear bias with GEF, AJI and CDM on renewable energy projects (based on information from http://www.gefweb.com, and http://www.envfor.nic.in/cc)
4.5 Conclusions

There are two significant aspects that may be highlighted after examining the international climate change policy and the climate-relevant national policies in India.

- The broad global landscape is changing towards rising awareness and concern for climate change. With increasing community pressure and emphasis on cleaner technologies, environmental concerns are finding a place in the policy goals of many countries, as well as private companies.\(^{126}\) India too is undertaking steps within its developmental strategy to address environmental concerns. These are likely to have indirect and trickle-down effects to other sectors of society as well.

- The CCIs are important features in the global climate change policy. Whether it is a subsidy-based financial mechanism, multilateral or bilateral transfers (CDM, direct transfers), international emissions trading or any other instrument; CCIs provide *additional* opportunities for finance, technology and/or capacity-building for addressing climate change (although the focus till now has largely been on financing). India, with a significant GHG mitigation potential, is a key host for these initiatives. The country is also pursuing liberalization and globalization policies, and presents an economically stable investment opportunity.

This implies significant policy implications of the climate change policies, which may be extended to the SSI sectors as well. The strength of the CCIs in particular is their dual objectives of sustainable development at global and national/local levels. In addition, they have specific objectives (replicability; project additionality) and characteristics (organizational structure, modalities) which determine the incentives they offer. In the current scenario, there are increased opportunities with special attention being given to small projects. The incentives, however, are strengthened or weakened by three major issues as theoretically identified in Chapter 2 (Table 4.2):

- The *uncertainties* regarding the future of the climate regime and CCI-related modalities (such as credit price and market size) make the evolution of the CCIs highly speculative. The national policies related to climate change in India have been largely reactive, though steps are being taken to improve clarity and transparency. Moreover, the scientific capacity and information base for developing climate-relevant projects as well as their methodologies and cost–benefit analysis is still limited, though it has increased significantly over the years.

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\(^{126}\) Inadequate information is considered a barrier to diffusion of cleaner technologies, and suasive instruments (e.g. building information networks, cooperation in education, training, capacity-building) do help in addressing this barrier (IPCC 2001b).
Table 4.2: Key issues related to the climate change policies

<table>
<thead>
<tr>
<th>Policy/policy instruments</th>
<th>Incentives</th>
<th>Strengths</th>
<th>Issues</th>
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<tbody>
<tr>
<td>International climate change instruments</td>
<td>• Economic opportunity: ‘Additional’ finance, sale of carbon credits</td>
<td>• Dual objectives: ‘sustainable development’ at global and national levels</td>
<td>• Uncertainty</td>
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<tr>
<td>(CCIs)</td>
<td>• Opportunity for technology access and transfer</td>
<td>• Specific platforms for inclusion of small projects and reducing costs (SGP, small-scale CDM, etc.)</td>
<td>o Regarding regime’s future, CCI modalities, carbon market (size, price)</td>
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<td></td>
<td>• Increasing awareness and capacity-building</td>
<td>• Energy projects main focus</td>
<td>• Not translated into national level instruments</td>
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<tr>
<td>National climate change policy</td>
<td>• Development initiatives address GHGs as well (e.g. for energy efficiency, renewable energy, forestry).</td>
<td>• India has acceded to Kyoto Protocol, is active in international negotiations</td>
<td>• Transactions costs: High, though efforts to reduce costs in place (e.g. PDFs, small-scale CDM)</td>
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<td></td>
<td>• Enabling organizational structure (basic support and approval system) in place for CCIs use</td>
<td>• Large CCIs portfolios and basic institutional structure already in place</td>
<td>• Market biases (e.g. renewables)</td>
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<td></td>
<td></td>
<td>• Increasing awareness; steps being taken to strengthen organizational structure</td>
<td>o Mainly consultant/investor-driven (no real developing country programme; focus on cost-effectiveness).</td>
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<td>o Focus on finance, not technology transfer</td>
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<td>o Scientiﬁc capacity limited</td>
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<td></td>
<td>• Transactions costs</td>
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<td></td>
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<td></td>
<td>o Bureaucratic approval process and procedures</td>
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<td></td>
<td>o Lack of awareness or coordination within different stakeholders</td>
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<td></td>
<td></td>
<td></td>
<td>• Market Biases</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>o Prime focus renewable energy projects</td>
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<td></td>
<td></td>
<td></td>
<td>o Mainly consultant/investor-driven</td>
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</table>

Note: GEF – Global Environment Facility, PDF – Project development funds, CDM – Clean Development Mechanism
• **Transactions costs** influence the abatement cost curves of climate-relevant activities, and are relevant at the project, national, and international levels. Internationally initiatives have been undertaken to lower these costs (simplifying procedures, streamline methodologies) and through different platforms (PDF, SGP, small-scale CDM and specific programmes like CDCF). However, the transactions costs are still high, even for small projects, across developing countries and in India (Krey 2004, 2005). The issue is how these costs are distributed among stakeholders, and how they alter their investment and hosting behaviour.

• At the national level, transactions costs are a function of country procedures and institutional structures. In general, countries with stronger capacity for CCIs, streamlined project approval processes have a competitive edge in availing potential opportunities. India’s strength lies in having the basic structure and project pipeline already in place. However, there is no attempt to translate the incentives into domestic instruments as yet. The approval process is time consuming and ad hoc at times. This is improving gradually with steps for a clear and proactive strategy for CCIs, and a more involved private sector. SSIs in general are hardly involved in the climate-related or even the environmental forums, and need much more representation.

The CCIs-related market biases are dependent on the motivations of the stakeholders. For instance, the government is likely to focus on additional benefits and political issues; private party on economic benefits; and multilateral agencies and observers on ensuring credibility within the parameters of their own interests. The major CCI portfolios show a bias to certain sectors, particularly renewable energy, as in India. As there is no host-country CCI programme, these are mostly investor- or consultant-driven projects. The focus is on cost-effectiveness, while additionality and sustainability issues are not addressed effectively. The question is, whether the focus on such projects with pre-fabricated baselines, indigenous suppliers and grid-based applications for a country like India, helps in meeting the objectives of the CCIs? Should so much attention be given to grid capacity addition when several inefficient process energy options exist which are continuing to operate the way they are? With considerable interest generated, more options across different sectors are being considered. However, with a need for convergence of interests of investors and hosts, the bias has been is on low risk projects.

Therefore, the climate change policy incentives are significant but are associated with uncertainties, transactions costs and market biases. These issues are especially relevant for small-size and small-capital SSIs. SSIs are low on the priority list in international and national climate change policies. The situation is slowly evolving and there are indications of diversification of CCI portfolios with SSI projects being considered under GEF and CDM in India (steel re-rolling, foundry, tea, brick industries). However, these are still only a few projects and are mainly for capacity-building. It thus appears that the top-down approaches though relevant will remain constrained unless the associated issues are resolved or addressed.
5. National policies for the small-scale industries

5.1 Introduction

SSIs in India hold a significant position in the socio-economic development of the country and are often referred to as the “engines of growth” (Chapter 1). The SSIs are defined under the Industries (Regulation and Development) Act 1951, in terms of the investment limits in plant and machinery (original value) up to a prescribed value. They include all industrial units, modern and traditional, in which the investment in plant and machinery does not exceed Rs. 10 million (Chapter 1), and may fall in the organized factory sector (those registered under the Factory Act 1948) or the unorganized sector (those unregistered under the Factory Act). The national policies for the SSIs have formed an important component in the planning and developmental process of the country.

This chapter examines the relevant national policies including promotional and environmental (with focus on air pollution), that address the SSI sector in India, and their implications for diffusion of cleaner technologies in the SSIs. The organizational structure, the main elements and the implications of the promotional policy is presented in Section 5.2 and for the environmental policy in Section 5.3. Based on these, Section 5.4 draws the main conclusions that will help address Research Question 2, and will complement and be supplemented by the case studies in later chapters while addressing the central research question.

5.2 National promotional policies

The foundation of the SSI policy was laid in the Second Five Year Plan in 1956, with equity as its guiding principle. Initially, the focus was on protection of the sector.

"SSIs provide immediate large-scale employment, offer a method of ensuring a more equitable distribution of national income and facilitate an effective mobilization of resources of capital and skill which might otherwise remain unutilized". (GOI 1956)

127 The definition of SSIs has undergone changes over the years in terms of the prescribed investment limit. There is no separate definition for the medium industry. The unorganized sector generally employs less than 20 workers (if power is not used) or 10 workers (if power is used).
Since the 1990s, however, with the initiation of the liberalization process in India, the emphasis is shifting from protection towards promotion of SSIs. The importance of SSIs in India’s development policy, and the specificity of their needs, has been accentuated by the fact that since then separate departments and ministries have been especially created for the promotion of SSIs. Before discussing the national policies and their implications, Section 2.1 outlines the organizational structure for SSI policymaking and implementation (illustrated in Figure 5.1).

5.2.1 Organizational structure

The responsibility of SSI development was initially under the purview of the Ministry of Industry (MoI). In 1990, the Department of Small Scale Industries and Agro and Rural Industries was set up within the MoI to provide focused attention to the promotion of the sector (with a policy shift towards promotion). Subsequently, in 1999, the Ministry of Small Scale Industries and Agro and Rural Industries was created to hold independent charge as the nodal ministry for policy formulation and development of SSIs in India. The Ministry was bifurcated further in 2001 as the Ministry of Small Scale Industries (MoSSI), and the Ministry of Agro and Rural Industries (MoARI), to deal specifically with modern SSIs and traditional, rural and agro-based SSIs, respectively.

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Protective measures aim at protecting the SSIs by giving them preferential treatment vis-à-vis the large units. Promotional measures aim at promoting the SSIs by imparting competitive strength (e.g. by improving their market access and providing infrastructural facilities).
The main implementing agencies of these ministries are the Small Industries Development Organization (SIDO), the Khadi and Village Industries Commission (KVIC), and the National Small Industries Corporation Limited (NSIC) – a public sector undertaking. SIDO is involved in evolving programmes for the modern segment of the SSIs, while the KVIC deals specifically with the promotion of village and khadi (handloom) industries. The SIDO coordinates programmes of the state governments, and liaises with the state and central ministries, Planning Commission and the financial institutions. It has several organizations under its jurisdiction like the Small Industries Service Institutes (SISIs) and the Process-cum-Product Development Centres (PPDC).

The Central Government drafts the strategy for SSI development, as well as the guiding policies for the states for implementation of select programmes. Within this framework, a State Government designs its own set of policies and initiatives. At the state level, the Directorate of Industries (DoI)\(^{129}\), the Directorate of SSIs (where present), and the Khadi and Village Boards (KVI Boards) implement the SSI policies. In addition, the State Small Industries Development Corporations (SSIDCs) assist in the procurement of raw material, marketing, etc. Under the jurisdiction of the DoI are the local field offices called the District Industries Centres (DICs), in most districts of India, which are the focal points for SSI development at the grassroot levels.

For environmental policies, there are specific and separate ministries and departments, which are detailed in Section 5.3.1.

**Financial organizations:** The apex agency for providing financial support to the SSIs is the Small Industries Development Bank of India (SIDBI). SIDBI was set up in 1990 as a subsidiary of the Industrial Development Bank of India (IDBI), and was delinked from IDBI in 2000. SIDBI not only operates through its various programmes, it has also been the main provider of refinance to state-level institutions including State Financial Corporations (SFCs), State Industrial Development Corporations or State Industrial Investment Corporations (SIDC/SIIDC) and commercial banks. Specifically for the village industries, the KVIC provides financial support, including soft loans at low rate of interest\(^{130}\), through the state KVI Boards, along with assistance from the National Bank for Agro and Rural Development (NABARD). Many commercial banks (e.g. the State Bank of India) have also introduced separate programmes for the SSIs. Along with these, rural banks and cooperative banks also offer financial options. For instance, the Primary Agriculture Co-operative Society finances agriculture-related industry and the Primary Co-operative Banks help in meeting the working-capital needs of cottage and tiny industries.

**Industrial Associations:** There are several industry associations that provide support and offer a common platform to raise specific industry-related issues. Their role in

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\(^{129}\) DoI provides a range of facilities, benefits and concessions for the SSIs registered with them, which vary across different states.

\(^{130}\) KVI Boards are considered providers of the softest loans among official providers of finance – all loans carry interest @ 4% per annum at present (can be increased by the government).
setting up common facilities and other ventures in the area of technology, marketing and other support services is increasing. These associations include major industrial associations (like the Confederation of Indian Industry (CII), Federation of Indian Chambers of Commerce and Industry (FICCI)), and those specifically for the SSIs, such as the World Association for Small and Medium Enterprises (WASME), Federation of Associations of Small Industries of India (FASII), and Indian Council of Small Industries (ICSI). Besides these, there are industry-specific associations and other associations such as the Export Promotion Council that also play an important role in the development of the sector.

Table 5.1: Significant policy statements and packages related to SSIs

<table>
<thead>
<tr>
<th>Policy statement/package</th>
<th>Salient features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Policy Statement 1977</td>
<td>Focus: Protection</td>
</tr>
<tr>
<td></td>
<td>Reservation of products for exclusive manufacture extended</td>
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<td></td>
<td>Special attention to the ‘tiny sector’</td>
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<td></td>
<td>Focal point for development shifted to district level (DIC)</td>
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<tr>
<td>Industrial Policy Statement 1980</td>
<td>Focus: Ancillaries</td>
</tr>
<tr>
<td></td>
<td>Programme for rural, backward areas accelerated</td>
</tr>
<tr>
<td></td>
<td>Emphasis on deregulation and debureaucratization</td>
</tr>
<tr>
<td></td>
<td>SSIs to include industry -related service and business enterprises</td>
</tr>
<tr>
<td></td>
<td>Shift from subsidized credit (expect for specified groups)</td>
</tr>
<tr>
<td></td>
<td>Separate package for tiny sector</td>
</tr>
<tr>
<td></td>
<td>Technology Development Cell &amp; Export Development Centre Promotion set up</td>
</tr>
<tr>
<td>Comprehensive Policy Package 2000</td>
<td>Focus: Development (in face of increased competition)</td>
</tr>
<tr>
<td></td>
<td>Fiscal and credit support (exemption for excise duty limit raised, composite loan limit raised, credit guarantee scheme)</td>
</tr>
<tr>
<td></td>
<td>Infrastructural support (especially in rural areas, cluster development scheme)</td>
</tr>
<tr>
<td></td>
<td>Technological support (capital subsidy scheme, commercial banks to develop schemes, capital grant to develop testing laboratories)</td>
</tr>
<tr>
<td></td>
<td>Other (marketing support, entrepreneurship development, promotion of rural industry and tiny units, rehabilitation of sick units)</td>
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</table>

5.2.2 Promotional policy

The SSI promotional policies in India may be discussed in two phases – before and after 1990.

Pre -1990: In post-independent India, the first Industrial Policy Resolution, 1948, assigned a prime role for the SSIs in achieving ‘local self-sufficiency’ in certain types of industrial goods. The second Industrial Policy Resolution, 1956, laid the foundation for the SSI policy regime with a focus on protection of the sector. The policies that followed the basic framework provided by the Second Plan (Industrial Policy 1967, 1977 and 1980) focused primarily on protection of SSIs, by reservation of
products for exclusive manufacturing by the SSI sector and other measures like fiscal concessions and preferential procurement by the government (Table 4.1).

Reservation of products for exclusive manufacture in the SSIs was introduced in 1967, with reservation of 47 items. This number was increased progressively and stood at 836 items in 1989. The concern related with reservation is that it does not distinguish between production units on the basis of their efficiency. While it is criticized for economic and efficiency reasons (Abid Hussain Committee 1997), it has also been justified on grounds of social and employment benefits. It is stated to have led to growth, export promotion and sub-contracting (MoSSI 2002).

**Since 1990**: The Industrial Policy of July 1991, accompanied by a special statement on SSIs, marked a conscious shift from the regulated to a more liberal policy, in line with the initiation of the process of liberalization in the country. The SSI sector is being gradually opened up, though it (at least a segment of it) is still protected. It currently produces about 7500 items, out of which about 750 items are reserved for production in the sector (some of these items are not produced or their production is insignificant). The reservation for marketing of SSI products as a measure of market support (price and purchase preference), which was emphasized since the second industrial policy, was reiterated in 1991. At present 358 items are reserved for exclusive purchase from the sector.

The current policy focus aims at phased de-reservation and provision of a conducive environment to help SSIs to sustain growth. For this, several promotional measures like fiscal concessions (SSI exemptions, excise exemption scheme) and benefits (subsidies for power, investments, ISO certification, etc.), credit facilities (priority lending, credit lending schemes), and infrastructural support (tool rooms, consultancy and training facilities, quality testing stations etc.) are offered. The emphasis is on deregulation, simplification of regulations and procedures, improving the flow of credit (under priority lending from banks and financial institutions), exports development (excise exemption) and promotion of entrepreneurship (MoSSI 2004).

### 5.2.3 Some policy implications

SSIs have enjoyed a protectionist policy for a long time. With a focus on equity, the long-term policy objective was to improve competitiveness and efficiency of the sector. The protectionist policy focus has led to growth of the sector. This trend has continued even after the 1990s. SSIs have maintained a higher rate of growth compared to the industrial sector as a whole. The number of SSI units has increased from an estimated 0.41 million comprising of 0.16 registered and 0.25 unregistered units in 1973–74, to the current 3.6 million – 2.8 million registered and 7.1 unregistered (Figure 5.2).\(^{131}\) This has lead to increased employment opportunities (about 8 million

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\(^{131}\) However, not all the registered units are operational – the working units constitute only 71% of the registered units while the rest are closed (SIDO 2003). Nevertheless, the growth in the number of units has been significant.
jobs were created between 1980 and 1997), as well as a significant rise in exports over the years (and the number of exporting units has also increased from 0.78% in 1987–88 to 2.71 in 1999–2000).

On the other hand, the national policy by providing continuous promotional measures has created an incentive for deliberately staying “small” (so as to continue to get the benefits related to the sector). One entrepreneur (or family) may own a number of small units, and larger industries may also set up ancillary units to be able to avail of the benefits. The policy has also, in general, brought in a sense of complacency and provided little incentive for the units to upgrade their technologies (since it is size, and not quality, sensitive). The basic policy objective to provide impetus for growth in the small units to a certain limit after which they may generate their own momentum without much need for assistance, therefore, has not really been met and the sector has been unable to build competitive strength as a whole (Tendulkar and Bhavani 1997). Many of the units still work below their capacity, and sickness of units have been persistent problems associated with the sector (the main reasons for sickness being marketing and financing constraints and competition (SIDO 2003)). The small size has implied that most of the SSIs cannot fully benefit from economies of scale – technological and pecuniary (Sandesara 1995). While the policy in general targets SSI units encouraging them to operate in an isolated manner, the importance of focus on clusters is increasingly becoming important.132

![Figure 5.2. Growth in total number of SSI units](image)

*Source* (MoSSI 2002)

With the phased policy shift away from promotion in light of liberalization and globalization scenarios, there is a marked need for technological improvement in order to

132 The Abid Hussian Committee Report (1997) was the first official document strongly recommending clusters as the focus of SSI development (MoSSI 2003).
survive and compete in the market. Opening up of the sector has led to opportunities with increased markets, as well as challenges for the sector in terms of rising competition from both internal (including from large industries) and external markets (particularly China and South Korea). Competition and cheap imports from other countries has also led to questions regarding survival of many SSIs (such as toys, calculators, alarm clocks). This, on the one hand, provides an incentive for the entrepreneurs to be more competitive and use efficient (and cleaner) technologies (for example, see Pradhan and Barik 1999); on the other hand, however, it is also leading to closing down of several SSI units.

The current promotional policy does provide incentives for the SSIs for technological upgradation. These include opportunities for financial and technical support under various schemes of the government and its departments, for instance, under the priority lending support (PLS), the credit-linked capital subsidy scheme for technological upgradation of SSIs (CLCSS), integrated technology upgradation and management programme (UPTECH), and quality upgradation through ISO-9000 certification. These are significant opportunities for the SSIs; however, they are normally supply-driven and discretionary, and limited in terms of the number of small units that can avail policy assistance, especially the smaller ones among the SSIs (less aware or powerful SSIs). Studies have shown that this is not only due to budgetary constraints of the government, but also due to inadequate information flow, complicated procedures and formalities (and delays), and limited expertise and co-ordination between...

133 Specific schemes for SSIs (also see, http://www.smallindustryindia.com/swachvmnts.htm):
(a) Under the PLS scheme, banks are required to ensure that a certain defined percentage of the overall lending is provided to the sectors classified as priority sectors by the government.
(b) The CLCSS scheme aims to facilitate technological upgradation by SSI units in specified products/sub-sectors by providing 12% capital subsidy for adoption of proven technologies approved under the scheme (like, natural gas- and oil-based furnaces for glass and foundry units respectively)
(c) The UPTECH or the Cluster Development scheme is exclusively for addressing modernization and technological needs for SSI clusters.
(d) The Quality Upgradation through ISO certification scheme provides reimbursement of 75% of the charges for acquiring ISO certification to each unit (up to a maximum of Rs. 75000). Till now, 2709 units have benefited from this scheme (MoSSI 2002)

134 It may be pointed out here that there is wide diversity within the SSI sector – and the strength of these incentives also varies between them. The SSIs by definition based on prescribed investment limits covers a large range of units. Some of these may include very large units which, in normal terms, may be better fitted as medium- or large-scale but owing to the definition may be included in the sector and therefore keep on availing the SSI privileges. On the other hand, there are several very small units. Though there are special schemes for tiny and village industries, there are many small units, including the small registered and unregistered modern SSIs that may be unaware or unable to avail of these benefits.
tween departments. Fiscal measures too create incentives by decreasing the price of products and creating an additional market segment by providing an advantage over large-scale industries. However, they too do not create the direct incentive to improve quality or efficiency of the production processes.

An examination of the policy initiatives for financing under the SSI policy also reveals that though there is considerable opportunity for funding, these measures are largely for investments in new firms or capacity addition, and those for cleaner technologies are limited. For example, SIDBI provides financing for the former under several portfolio heads (e.g. refinance and equity assistance, and project related financing related to equipment finance, venture capital, working capital, etc.), while that for financing of technology upgradation is limited (e.g. under its technology and modernization development fund (TDMF)). There is also a gap between the amount sanctioned and disbursed under the various schemes (SIDBI 2000).

5.3 National environmental policies

In case of the national environmental policy, India basically has a command and control regime in place. Regulatory instruments are the main features, along with the use of suasive instruments, for various industries including the SSIs. These are supplemented in some cases by economic instruments (mainly subsidies). The main thrust to the environmental policy was provided by the Bhopal gas tragedy in 1984, following which environmental concerns came to the fore and laws were made stringent. In this regard, the Environmental (Protection) Act was introduced in 1986 as an umbrella legislation for protection of the environment.

In general, the promotional and environmental policies work independently. However, there have been some instances of complementarity between the two (an important example is the UPTECH scheme, renamed as the Cluster Development Scheme for bringing in cleaner technologies in selected industries to help them meet the required standards). The environmental policy has largely encouraged setting up of end-of-pipe or cleaning technologies, and has led to relocation of some industries (e.g. leather tanneries in Kolkata) and closure of others (e.g. in Delhi and Agra). However, policy initiatives for cleaner technologies and energy conservation have been restricted to demonstration plants and awareness creation in most cases.

135 It is noted that often the finances available to the SSIs are not timely or adequate, which has also rendered several units sick. In addition, generally financial institutions (e.g. SIDBI, NABARD, SFCs, commercial banks) hesitate to deal with SSI entrepreneurs requiring a very small amount of loans (Nayak Committee 1993), even though now financing through windows for small grants is being made available (e.g. KVIC, cooperative banks, local banks).

136 For example, for project-related financing of SIDBI, between 1990–2001 the amount disbursed is almost half of the amount sanctioned, which was Rs 62 billion and 32 billion respectively. Also, the technology and modernization development fund (TDMF) of SIDBI is only 3% of the total project-related funds sanctioned by SIDBI between 1990–2001.

137 Although environmental laws and acts were in place even before this incident, they in general followed a piecemeal approach and were really ineffective.
5.3.1 Organizational structure

The Ministry of Environment and Forests (MoEF) is the nodal ministry for developing the environmental policies in India (Figure 5.1). It was set up in 1985 and is responsible for the planning, promotion and coordination of environmental programmes. Its objectives are supported by a set of legislative measures.

The main executive authority is the Central Pollution Control Board (CPCB), which was constituted under the Water (Prevention and Control of Pollution) Act, 1974. It was later entrusted with functions under the Air (Prevention and Control of Pollution) Act, 1981. The Environmental Act 1986 further increased its powers. The CPCB provides technical advice as well as develops the emissions standards at the national level (Table 5.2). Responsibility for the monitoring and enforcement at the state level, however, lies with the respective state Pollution Control Board (PCBs). The PCBs cannot relax or lower the standards set by the CPCB, but can in certain cases make them more stringent depending on the circumstances (for example, for the foundries in Howrah – Chapter 6).

5.3.2 Environmental policy and policy instruments

5.3.2.1 Regulatory instruments

The regulatory instruments are extensively used for reducing pollution in industries. These include compulsory environmental impact assessment and audit, consents (to establish and to operate), technology and effluent standards, and ban on specific technology and fuels.

### Table 5.2: Major functions of the Pollution Control Boards

<table>
<thead>
<tr>
<th>Central Pollution Control Board (CPCB)</th>
<th>State Pollution Control Boards (PCBs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Advise central government</td>
<td>• Advise state government</td>
</tr>
<tr>
<td>• Plan nation-wide programme</td>
<td>• Plan state programme</td>
</tr>
<tr>
<td>• Lay down standards</td>
<td>• Lay down standards (in addition to and above those of CPCB)</td>
</tr>
<tr>
<td>• Coordinate activities of PCBs</td>
<td>• Carry out inspections</td>
</tr>
<tr>
<td>• Provide technical assistance to PCBs</td>
<td>• Issue consents to industries</td>
</tr>
<tr>
<td>• Collect, compile, disseminate technical and statistical data and prepare code of conduct</td>
<td>• Collect and disseminate information</td>
</tr>
</tbody>
</table>

Standards: The focus has been on setting industry-wide standards, backed by penal action. The standards set for industries include effluent and emission standards for 37 and 31 categories of industries respectively, besides standards for ambient air quality, ambient noise, and fuels quality specifications (CPCB 2003). For air pollution, the emphasis has been on local pollutants such as SPM and in some cases SO2. There are no standards for CO2. In cases of energy-intensive industries, however, standards en-

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138 As per legal provisions no person can operate an industrial unit without a consent of the PCB, and any unit not adhering to the prescribed standard is liable for litigation and penalties.
couraging cleaner technologies or cleaner fuels, indirectly lead to reduction of CO$_2$ as well.

The stringency of these regulations varies according to the severity of pollution associated with them, for which the MoEF has classified the industries into red, orange and green industries categories (i.e. most polluting to least or non-polluting industries, including both the large-scale industries and the SSIs). The standards are revised when needed, and their implementation requires periodic inspections by the PCBs. The PCBs have the authority to use penalties such as fines, cutting off water and electricity connection and shut down the units (even prosecution in extreme cases), which are expected to provide the incentive for the entrepreneurs to adhere to the standards. The state governments are in a position to change the standard and make it more stringent depending on the location and nature of the industry.

Consents: The PCB issues consents for establishing a new unit and continuing operations of a running unit within its state. A consent to establish or no-objection certificate (NOC) is required in the case of new industries (essentially for site clearance), and a consent to operate is required after completion of the project but before commencement of the process (subject to installation of the required pollution control devices). The consent to operate is reviewed periodically (depending on the category of industry), and renewed provided the relevant standards are being met (Table 5.3).

Table 5.3: Minimal frequency of inspections and validity of consents for SSIs

<table>
<thead>
<tr>
<th>Category of SSI</th>
<th>Frequency of visit and effluent sampling (and comparison with large scale industry)</th>
<th>Validity period for the consent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Once in 12 months (Once in 3 months for large-scale industry)</td>
<td>2 years</td>
</tr>
<tr>
<td>Orange</td>
<td>Once in 3 years (Once in 6 months for large-scale industry)</td>
<td>3 years</td>
</tr>
<tr>
<td>Green (non-polluting SSIs covered under procedure of simplified consent)</td>
<td>Once in 3 years on random check basis (Once in 1 year for large-scale industry)</td>
<td>5–10 years</td>
</tr>
</tbody>
</table>

Notes: (1) Sampling frequency for air emission shall be in accordance with the details given in the CPCB 1985. PCB may specify sampling frequency separately for the industries. (2) Industry are directed to submit monitoring reports on a monthly basis and as per the monitoring frequency and parameters stipulated in the consent order. (3) Depending on the manpower and availability of resources/infrastructure, etc. PCBs may improve upon the frequency as may be necessary.

Source: Based on the MoEF Notification dated 20 December 1999 (MoEF 1999).

For the SSIs, however, many units (falling in the “green” category) are normally excluded in the regulation purview of the PCBs. The method of granting consent has also been simplified for the sector. For all SSI units, except for those SSIs that are
included in the list of 17 hazardous industries\textsuperscript{139}, only an acknowledgment of the application by the state PCB is sufficient and serves the purpose of consent.

In addition, no industrial license is generally required for an SSI unit located in cities with a population of less than 1 million. In cities with a population of more than a million, polluting industries may be located in designated industrial areas (however, this too is difficult to enforce). One of the reasons for local pollution has been rapid expansion of urban areas and inefficient town planning which have led to environmental problems in many cities (e.g. some areas developed as industrial pockets in Delhi fall within the residential area, in Howrah improper town planning led to residential and industrial areas developing together). In this regard, relevant government authorities many a times resort to relocation or closure measures for some SSIs. However, relocation simply means relocation of pollution, unless infrastructure is developed at the alternative site\textsuperscript{140}, and closure leads to social impacts.

5.3.2.2 Economic instruments

While environmental policy has been largely regulatory, it has been occasionally supplemented by the use of economic instruments. Some examples include, cess on water consumption for industries, subsidies for cleaner technologies and the eco-mark scheme\textsuperscript{141}. For SSIs, fiscal benefits (like subsidies, tax exemptions, depreciation allowance, and reduced customs duties) are also provided under the environmental as well as the promotional policies (previous section). Again as in the case of promotional policies, while these instruments have benefited some SSIs – an example is the subsidy provided under the TDMF for foundries (Chapter 6) – they are limited in terms of their reach and availability of support.

Subsidies include those for cleaner technologies (like pollution control devices, waste recycling, phasing out of ozone depleting substances and renewable energy technologies). Since the early 1990s, a thrust is also being given to waste management (subsidy and awareness creation for waste minimization and common effluent plants (CEF)). This has led to setting up CEFs in many clusters – where SSIs can treat their wastes by setting up a common CEF, thereby reducing individual costs (e.g. see (Kennedy 1999)) – and has highlighted the benefits of collective efficiency as opposed to the isolated manner in which most of the units have been operating.

However, on the other hand, the impetus provided by the economic (combined with persuasive) instrument was a one-time solution. This has led to problems in the long run

\textsuperscript{139} These industries are: fertilizer (nitrogen/phosphate), sugar, cement, fermentation and distillery, aluminium, petro-chemicals, thermal power, oil refinery, sulphuric acid, tanneries, copper smelter, zinc smelter, iron and steel, pulp and paper, dye and dye intermediaries, pesticides manufacturing and formulation, basic drugs and pharmaceuticals.

\textsuperscript{140} For example, the leather tanneries in Kolkata were ordered, as per a Supreme Court regulation, to relocate to an alternative site – the leather complex, which was to have facilities for waste management, etc. This complex is under construction.

\textsuperscript{141} Government of India launched the eco-labelling scheme known as ‘Ecomark’ in 1991 for easy identification of environment-friendly products. However, it has not been very successful.
in terms of maintenance and the associated costs (CSE 2002), and the inability to maintain the collective effort on a sustained basis.

The benefits of using economic instruments like industrial pollution taxes, have been recognized (e.g. in the MoEF’s Policy Statement on Pollution Abatement, 1992), and ways are being discussed to develop and use economic instruments. In the current circumstances, an immediate reliance on economic instruments is not feasible, however, their potential to compliment the regulatory instruments is still considered significant (Kuik et al. 1997). The efficient working of the economic instruments will depend on the way markets operate, and some of the barriers include bureaucracy, public entities, and partial protection in the case of SSIs.

5.3.2.3 Suasive instruments – and focus on public interest litigation

Environmental protection is incorporated in the Constitution of India, and is included as a constitutional right and a fundamental duty of the citizens. Civil society has played a significant role with the increase in environmental concerns, and activities of the environmental activists and NGOs. Yet, awareness and general concern for the environment is still low. This is in spite of the several suasive measures (e.g. awareness creation, training, opportunities for technical support) undertaken under central and state policies. In fact, many of the SSI policy provisions related to cleaner technologies and energy efficiency are restricted to demonstration plants and awareness creation (waste minimization projects, energy conservation programmes, etc.).

In this regard, the judiciary and public interest litigation (PIL) have been important for raising environmental and social concerns. They have encouraged the development and enforcement of stricter rules and regulations, and created incentives for entrepreneurs. Under a PIL, any individual or group can file a form of writ petition, even when not directly affected by the perceived injustice. PIL in effect has served as a proxy for formal implementation of pollution regulation since the beginning in mid-1980s. In 1996, the Supreme Court gave twelve judgments in different pollution related cases, including protection of the Taj Mahal and cleaning of the river Ganges. The court’s verdict in a PIL is not usually self-executing and has to be enforced by relevant agencies (e.g. the PCBs). Environmental pollution in several SSIs has

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142 It is estimated that by reliance on regulatory regimes the cost of the economy has been three times of the costs of relying on least-cost strategies (TERI 2000a).

143 Some famous examples of civil society involvement in India are the Chipko movement (for saving trees) and Narmada Bachao Andolan (for saving river Narmada).

144 Pargal et al. 1997, Sawhney 2003, have observed that community pressure does not induce lower pollution levels, but does seem to have significant effect on the level of inspections.

145 Generally in all environmental cases, the Supreme Court has prescribed time limits within which the order is to be implemented, asked for periodic reports from the concerned authorities and has even instructed the State High Courts to monitor enforcement. It is by passing strictures, asking for personal appearances and explanation of officials, ordering closure of faulty units, extending time limit for compliance, etc. that the Court is able to enforce its decisions (MoEF 2002a).
been addressed under the PIL (brick making, leather tanneries, foundries, glass units, etc.), and has met with varied success. Even with these, the issue arises of enforcement of the court’s orders. All the three case studies in this thesis have been influenced by judicial intervention.

5.3.3 Main policy implications

Environmental policy provides incentives for the SSIs to adopt cleaner technologies by threat of penal action, opportunities for financial and technological support and capacity-building (Table 5.4). However, there is still continued use of outdated and inefficient technologies that have an adverse impact on the environment, and the level of pollution caused by the sector in India per unit of output remains high (CPCB 2001).

The focus of the environmental policy has been on regulatory instruments for diffusion of cleaner technologies (for example, see Chakrabarti and Mitra 2005). The incentives they provide are greatly dependent on the manner of their enforcement. The SSIs are provided concessions (in terms of stringency of regulations, frequency of inspections and validity period of the consents) and the enforcement of the policy provisions also has more-or-less been weak. The large number of SSIs, the scattered nature and existence of many unregistered units (without any pre-existing ties with the government) are some of the reasons for this. Some other reasons include:

a. Frequency of inspections: the inspections in many cases are sporadic, and may even tolerate non-complying units (due to work overload, lack of staff, limited resources, and inadequate equipment and facilities). “We have less staff and there are too many units. It is difficult for us to monitor them all”. Even in the case of inspections, there is some evidence that pollution remains unaffected, possibly because firms activate the equipment only when inspections are scheduled (Pargal et al. 1997).

b. Emphasis: The focus has been on initial compliance (by installation of PCDs) rather than continuous compliance (to ensure that the PCD is actually operating). In addition, the penalties for non-compliance are normally low and are insensitive to the degree of default (same penalty is normally charged irrespective of the size of violation or the pattern of offence) (Sawhney 2003).

c. Crucial activities like training of staff, generation of awareness among public and research and development remain low on the priority for most PCBs (also due to limited budgets).

d. Composition of the PCBs: The PCBs require both technicians and non-technicians, and representation by the industry and local bodies. However, in most PCBs, there is inadequate technical staff, and there is a tendency not to fill

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146 Effective penalty is dependent on the probability of getting caught (which is low due to weak enforcement) and probability of it getting imposed (which is low due to political and social links, etc.)
vacancies for members represented by local authorities (Planning Commission 2000).\textsuperscript{147}

e. Political interest and social reasons: In some cases, political interests affect obtaining consents and penal actions. There has been evidence of units operating despite not having consent (Kathuria and Haripriya 2000). Worker resistance, social unrest (due of employment loss), and sometimes also political motivations (SSIs form a large vote bank) make enforcement of penalties difficult. The regulatory incentives, however, are also associated with issues such as weak enforcement, concessions for the SSIs, discretionary and limited support and delays, which tend to weaken the incentives for the sector. In addition to the incentives mentioned, impetus has been provided in some cases by the judiciary and civil society, and plays an important role in strengthening the incentives created by the policy provisions.

Though regulatory instruments have brought in environmental consciousness and changes in some industries, a large proportion of units in the SSI sector have been left out, and the sector still constitutes a significant contributor to environmental concerns. The changes have largely been in bringing in end-of-pipe solutions and efficiency concerns still are not the primary concern for the units.

The economic and suasive instruments under the environmental policy (in combination with the promotional policy) add to the regulatory incentives by creating opportunities for financial and technical support and creation of additional markets. In addition, the judiciary (and the civil society) provides critical impetus in this direction. However, the policy measures for introducing cleaning technologies are more often supply-driven and limited (e.g. where renewable energy sources like baggase cogeneration, biomass gasification, and cleaner fuels like natural gas are encouraged). Some of the reasons for this have been mentioned before (in Section 2.3): budgetary constraints, inadequate information, complicated procedures and delays, not maintaining proper accounts,\textsuperscript{148} etc. Shortage of funds has been a significant constraint for SSIs in installing cleaner technologies.

The tendencies of the SSIs to stay small, and focus of the protective measures on their size rather than the quality, has also not helped in bringing in cleaner technologies within the sector. The shift since 1990s to a more liberal policy focus is creating

\textsuperscript{147} The staff composition in PCBs (on average) – is 34% technical staff, 45% non-technical and 25% vacant positions. On an average, for 100 polluting units (red and orange industries – both large and small) there are less than 4 technical staff members (GoI 2000).

\textsuperscript{148} Only 15.5% of the SSI units actually maintain proper accounts (SIDO 2003).
Table 5.4: Incentives under the national SSI policy

<table>
<thead>
<tr>
<th>Policy/policy instrument</th>
<th>Incentive</th>
<th>Strength</th>
<th>Weakness</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Promotional policy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Protective measures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Regulatory</em>: Reservation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Economic</em>: Fiscal benefit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional market creation</td>
<td>Impetus for growth</td>
<td>Incentive to stay “small”</td>
<td>Little incentive to upgrade technology, improve quality</td>
<td>Growth of SSIs – number of units, production, exports</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tendency of units to stay “small”</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Technological complacency amongst many units</td>
</tr>
<tr>
<td><strong>Promotional measures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Economic</em>: Credit provision</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Suasive</em>: Capacity-building</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunity for finance and technical support</td>
<td>Limited support for technological upgradation</td>
<td>Some units/clusters have benefited. But support and know-how (<em>vis-à-vis</em> cleaner technologies) has remained inadequate across the sector.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Environmental policy</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Regulatory</em>: Standard, consent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Economic</em>: Subsidy (fiscal, credit)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunity for financial support</td>
<td>Availability of discretionary and limited support</td>
<td>Concessions for SSIs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weak enforcement</td>
<td>Design: Focus on end-of-pipe options</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Change in some clusters and units</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Environmental impact (esp. local pollution) still high</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Little emphasis on efficiency</td>
</tr>
<tr>
<td><em>Suasive</em>: Capacity-building</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunity for training, technical support</td>
<td>Limited support availability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impetus from judicial intervention, civil society</td>
<td>Delays</td>
<td>Lack of coordination</td>
<td>Some units/clusters have benefited. But support for cleaner technologies has remained limited across the sector</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Increased awareness and consciousness in some units/clusters. But support and know-how remain limited across sector</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Judiciary, civil society important in implementation of policy provisions</td>
</tr>
</tbody>
</table>
an incentive for the SSIs to become more competitive and bring in efficiency considerations within their production processes. Having operated in a protected policy environment, many units find it increasingly difficult to operate in a competitive market structure, which raises the issue of survival of these units. On the other hand, this then does provide additional incentive to bring in efficient technologies.

The policy instruments have also been associated with a lack of coordination between the departments responsible for them (Tendulkar and Bhavani 1997). For instance, the policy measures for providing technical support and consultancy for technology upgradation may be implemented through various agencies with considerable overlap of functions (such as SISI, NSIC, DIC). Implementation by each of these organizations involves complicated formalities and procedures (which differ across organizations). In addition, there is little co-ordination between promotional agencies and those dealing specifically with the environmental issues and policy making. Most policy provisions remain supply-driven and involvement of the SSIs in policy making (e.g. standards, etc.) is not common.

5.4 Conclusions

SSIs are important contributors to the socio-economic development of India. The SSI policy in general has been motivated by social and equity concerns. The environmental policy in particular has provided concessions for SSIs, weakening the incentives provided by the regulatory instruments for environmental protection. Wherever change has been brought about it has been through motivations (in the case of protection of specific heritage sites and ecologically sensitive areas and rivers) other than energy efficiency considerations. Even in the case of promotional policy, the policy shift for the SSIs from protection to promotion has come about following the macro policy of liberalization (and globalization). These indicate that the sector cannot be looked at in isolation, but as an important component within the national economy that may be impacted by international developments as well.

In terms of support and environmental objectives of SSI policy, there is a lack of an integrated approach and distinct demarcation between the two. Till the late 1980s, there was little done in the case of SSIs. This was the time when the sector was protected – and thereby policy influence could have been significant. However, environmental concerns largely were ignored not only for the SSI sector but also the economy as a whole. The Bhopal gas tragedy opened the minds of the regulators for environmental reform, but progress has been slow. An important observation is that community pressure and PILs, as well as the judiciary have been important players in the enforcement of environmental policy specifications for the sector. In the current development and policy scenario, the SSI faces several challenges of which two challenges emerge as especially relevant:

a. With the ongoing processes of liberalization and globalization, the SSIs face the threat of increased competition, both from within (other clusters and large-scale industries) and outside the country (e.g. China). They no longer enjoy the protec-
The SSIs, therefore, will have to improve their processes and adopt cleaner technologies to become more cost-effective, competitive, and to meet the current and future emission norms. What is needed is a transition of the SSI sector towards more sustainable developmental paths. Given the large number of these industries, and other national concerns, government support available for technology upgrading in SSIs will be limited. Therefore, innovative strategies for diffusion of cleaner technologies are required if the SSIs are to survive and grow in a sustainable manner.
6. Iron foundry cluster in Howrah

6.1 Introduction

This chapter presents the case study of the SSI iron foundry cluster in Howrah in West Bengal. It is the largest foundry cluster in India in terms of number of units and production and export of iron castings. It relies mainly on traditional processes and technologies, and contributes significantly to environmental pollution. The environmental policy for the cluster has largely focused on creating and sustaining a regulatory regime for the units by setting environmental standards for local air pollutants. A major impetus to the enforcement of the standards was provided by judicial intervention that led to installation of pollution control devices (PCDs) across almost all the units in the cluster.

This chapter examines the implications of national policies, and attempts to identify the main factors affecting the diffusion of cleaner technologies in the cluster based on field observations, primary survey and stakeholder interviews. The chapter is organized as follows: Section 6.2 discusses the SSI–environment interactions; Section 6.3 describes the relevant national policies and their implications, and Section 6.4 examines the main contextual factors that influence the diffusion of cleaner technologies across the cluster. The main conclusions are discussed in Section 6.6.

6.2 SSI–environment interaction

The Howrah foundry cluster is the oldest in India. It enjoys an advantageous position with a large marketing network (port, rail junction), proximity to Kolkata (major

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149 The district of Howrah or Haora is the oldest (500 years) industrial township in West Bengal. It is also called the Twin City of Kolkata, due to its proximity with the state capital.

150 Castings are metal objects obtained by allowing molten metal to solidify in a mould or cast that have a wide variety of uses (see Photo 6.1). The industry includes ferrous and non-ferrous foundries. The former is sub-divided into grey iron and others (ductile, malleable, etc.). More than 75% of the castings produced in India are grey iron and are the focus of the chapter. The Howrah cluster has an installed capacity of 0.8 million (of the 4 million in India), and produces 0.6 million tons and exports 0.2 million tons of iron castings annually.

151 The cluster originated in 1860, when the first foundry was set up on a commercial basis in India, and developed fast to meet the demands of West Bengal and the rest of the country. It grew rapidly, especially in 1940–1950, mainly due to industrial concentration (jute, sugar, textile and engineering) in the region. In the 1950s, its share in production was 60%. After this, however, the market for Howrah castings began to decline, and its share fell to the current 20%. Other clusters had come up, and industrial stagnation and active trade unionism started taking root in West Bengal. Other reasons that also contributed are power shortages, poor infrastructure and obsolete technology (Mitra 2001; TERI 1999).
trading centre) and access to raw material (coke and pig iron). Several other clusters have also developed, including those located in Punjab (Batala and Ludhiana), Tamil Nadu (Coimbatore), Gujarat (Ahmedabad) and Maharashtra (Pune and Kolhapur). The Howrah cluster, however, retains its position as the largest iron foundry cluster accounting for 20% of the total castings produced in the country. It mainly produces low-grade gray iron castings of medium tension strength including manhole covers, pipes, fittings, industrial castings and agricultural machinery (Photo 6.1). The main products are sanitary and industrial castings. The cluster caters to private industry including automation and engineering, local markets, and government departments such as railways, post and telegraph, and municipal corporations. It also caters to the export markets in developed and developing countries. It provides employment to about 100,000 workers, directly and indirectly.

6.2.1 Industrial activity

The industrial activity of producing iron castings is highly energy intensive. It involves five major steps: pattern making; mould preparation; furnace charge preparation, melting and pouring (into the moulds manually or by machines); cooling, quenching and sand handling; and fettling, finishing and cleaning.  

6.2.1.1 SSI foundry units

At present, there are 380 registered units in the cluster; however, all are not operational (DIC 2001). In addition, there exist several unregistered units. According to estimates, there are a total of about 400 operational units in the cluster, including 232 operational registered units, the rest being unregistered. Most units are old (averaging 25 years in the sample) and family-owned and inherited businesses. The units differ in their size ranging from large to very small foundries. There is no uniform classification for the units, and they can be classified in many ways based on production, installed capacity, number of workers or market orientation. In this thesis, they have been classified according to size in terms of their monthly production (Table 6.1), and clubbed into three main categories namely big, medium and small.

The big units account for more than half of the total castings produced in the cluster. These generally are the large and “progressive” (in terms of market share and marketing capacities) export-oriented units. The small units, on the other hand, are significant in number but account for only 15% of the production. They operate for only a few days of the week (2–4 days), have limited capacities, and basically cater to the local market. Among the medium units, 50% cater only to the domestic market, while the rest also cater to export markets directly or on sub-contract basis.

152 The melting process is the most energy-intensive stage, and is focused upon in the chapter.

153 Interview no. 2. IFA 2001.

154 This classification is close to the three tiers in (Nadvi and Schmitz 1994).
### Table 6.1: Classification of the foundry units as per their size (production)

<table>
<thead>
<tr>
<th>Category</th>
<th>Production (ton/month)</th>
<th>Number of units in the cluster*</th>
<th>Number of units Surveyed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 1: Big (&gt;500 ton/month)</td>
<td>&gt; 1500</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>500–1500</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Category 2: Medium (100–500 ton/month)</td>
<td>300–500</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>100–300</td>
<td>200</td>
<td>16</td>
</tr>
<tr>
<td>Category 3: Small (&lt;100 ton/month)</td>
<td>&lt;100</td>
<td>165</td>
<td>36**</td>
</tr>
</tbody>
</table>

* Source: Interview no. 2. IFA 2001. ** Includes 18 very small units with production less than 50 ton/month

### 6.2.2 Energy consumption and environmental impact

The production process, particularly the melting stage, is highly energy intensive. Most units use coal or coke as the main fuel, while some also use other fossil fuels including oil, LPG and electricity. On an average, foundries within the cluster have low productivity and high rejection rates (Ray 2000). Thereby, the cluster contributes significantly to local pollutants such as sulphur dioxide (SO$_2$), carbon monoxide (CO) and suspended particulate matter (SPM), and to global carbon dioxide (CO$_2$) emissions. A typical foundry contributes between 400–2500 mg/Nm$^3$ to SPM and between 750–1500 mg/Nm$^3$ to SO$_2$ emissions (Rao et al. 2001). The SPM levels differ based on the kind of PCD that may be installed (e.g. wet scrubber, cyclone, multi-cyclone, bag filters). However, most PCDs do not check the CO$_2$ emissions much. On an average, the potential annual CO$_2$ emissions are around 1300 kg/unit (calculated using survey data for coke consumption, standard calorific values of coke in India and the default emission factors prescribed by the IPCC).

The working conditions in the cluster are not good (Mitra 2001). In addition to the local emissions, waste generation, coal stocking and material handling all make the working conditions a cause for concern. The units on an average employ around 75 workers, mostly male contract workers (a reason for entrepreneurs preferring contract workers is the strict labour laws and strong labour unions in the state). Women work in very few units, but not at furnace operations. While some owners prefer to hire them for minor jobs as they are “subdued” and are paid less, not many women want to work in the industry due to the “dirty” working environment.

---

155 The coke used is normally of low quality (with high ash content). Most of the units use beehive (B.H.) coke from Dhanbad coal fields with ash content of 28–32%.

156 Material handling facilities are bad in most units. There is hardly any automatic handling and even pouring of hot molten metal is mostly done manually.

157 Women work in very few units, but not at furnace operations. While some owners prefer to hire them for minor jobs as they are “subdued” and are paid less, not many women want to work in the industry due to the “dirty” working environment.
ered with soot and congested (in many units the sheds have become low due to continuous pouring of sand which is not removed regularly).

Photo 6.1: Stacked grey iron foundry products

Photo 6.2: A worker pouring hot molten metal in the mould
6.2.2.1 Technology used

The main technology for melting of metal used in the units is the coke/coal cupola furnace. It is economical and easy to operate, and is the dominant technology across India and the world as well. Penetration of other technologies like oil-based rotary and electricity-based induction furnaces is very limited.\(^\text{158}\)

There are two types of cupola used in Howrah. These are single blast cupola (SBC), which is the most basic and traditional technology, and the divided blast cupola (DBC), which is a modified form of SBC to enable better combustion of fuel. The performance and energy efficiency of the cupolas depends a lot on their design, maintenance and on the type and quality of fuel used. While the coke to metal ratio for SBC is between 1:2 to 1:4 (sometimes even 1:5), for the DBC it is between 1:4 and 1:8/1:9 (energy-efficient DBC can even go as high as 1:12). Most cupolas used are old versions of the conventional design.\(^\text{159}\) Although there have been some modifications, such as installing sand moulding and charging machines, the basic technology has remained the same and efficiency is low. Only a few units have modern and efficient furnaces in place.

6.2.2.2 Potential for technological change

There is significant potential for cleaner technologies across the cluster. Firstly, proper housekeeping measures, such as maintenance and cleaning of cupola and measurement of inputs, can reduce energy wastage by 10–15\%\(^\text{160}\). Secondly, cupolas with improved and efficient designs can also save fuel by 20–65\% compared to conventional technology (Chand and Krishnan 2000; Grubb et al. 1999) (SBI 2000). For instance, a demonstration for energy-efficient cupola, set up under the Swiss Agency for Development and Cooperation (SDC) initiative, can achieve energy savings of 33–65\% compared to a conventional cupola (TERI 2001). Thirdly, other furnace technologies, including rotary and induction and those being developed such as the cokeless cupola, also offer significant potential (Table 6.2). While these have significant benefits (increasing competitiveness, product diversity), they are also associated with technology specific (costs, appropriateness for less capacity) and infrastructural constraints (poor power supply and non-availability of natural gas).

6.3 National policies

The national and state policies provide a conducive environment for growth of foundries. For instance, they offer fiscal incentives and credit schemes like the credit

\(^{158}\) Technology-wise break-up based on the sample surveyed is: Divided Blast Furnace (54\%), Single Blast Furnace (42\%), Rotary Furnace (3\%) and Induction Furnace (1\%).

\(^{159}\) Based on various interviews and field observations.

\(^{160}\) Interview no. 17. EEPC 2001.
linked capital subsidy scheme for technology upgradation. In light of the export potential of foundry industry, the central government had granted it a “thrust industry” status in 1991. The state government has also introduced an incentive package for SSIs largely comprising of fiscal benefits in 2001.

### 6.3.1 Organizational structure

The organizational structure for policy making and implementation for the cluster is presented in Figure 6.1. The state government designs state promotional and environmental policies through the Directorate of Industries (DoI) and Directorate of Small Scale Industries (DoSSI), and the Department of Environment (DoE) respectively. These are implemented through various state agencies including the West Bengal Industrial Development Corporation Limited (WBIDC), West Bengal Small Industries Development Corporation (WBSIDC) and West Bengal Financial Corporation (WBFC), and the West Bengal Pollution Control Board (WBPCB) for environmental policy. The District Industries Centre (DIC), Howrah, is the field office under the jurisdiction of the DoI for SSI development at the district level.

![Organizational structure for policy making and implementation](image)

**Figure 6.1:** Organizational structure for policy making and implementation

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161 This scheme facilitates technology upgradation by providing 12% back-ended capital subsidy for induction of proven technologies in select SSIs, including foundries.
Table 6.2: Furnace technologies: Some comparisons

<table>
<thead>
<tr>
<th>Item</th>
<th>Conventional cupola</th>
<th>Efficient divided-blast cupola</th>
<th>Rotary furnace</th>
<th>Induction furnace</th>
<th>Coke-less cupola</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single blast</td>
<td>Double blast</td>
<td>Example – 1</td>
<td>Example – 2</td>
<td>Oil based</td>
</tr>
<tr>
<td>Fuel used</td>
<td>Coke</td>
<td>Coke</td>
<td>Coke</td>
<td>Oil/gas</td>
<td>Electricity</td>
</tr>
<tr>
<td>Fuel consumed (per tonne)</td>
<td>200–250 kg</td>
<td>100–250 kg</td>
<td>80–100 kg</td>
<td>180 kg</td>
<td>125–150 litres</td>
</tr>
<tr>
<td>SPM (mg/Nm³)*</td>
<td>400–2500</td>
<td>53</td>
<td>212</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>SO₂ (mg/Nm³)**</td>
<td>750–1500</td>
<td>37</td>
<td>43</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Indicative cost of a typical furnace</td>
<td>Rs 40000–65000 (5 ton capacity)</td>
<td>Rs 1–1.1 million (100 ton per month capacity)</td>
<td>Rs 1–1.2 million (1 ton capacity)</td>
<td>Rs 6–7 million (350 ton per month)</td>
<td></td>
</tr>
</tbody>
</table>
| Benefits | • Economical  
• Easy to operate | • Higher energy efficiency  
• Better product quality  
• Possible product diversification  
• Appropriate for smaller capacity  
• Better quality  
• Better working conditions  
• Clean and energy efficient | |
| Technology-specific barriers | • Low temperature limit  
• Can only make gray iron castings  
• Poor working conditions  
• High costs (initial + consultancy)  
• Initial costs high  
• Technical difficulties  
• Operating, initial costs high  
• Infrastructural constraint (power)  
• Lifecycle analysis may imply higher net CO₂ emissions  
• Higher costs  
• Infrastructural constraints (fuel availability)  
• Technology still in demonstration phase | |

*Vary depending on the PCD installed; ** based on IPCC methodology and CO₂ emission factors for coke/coal 1.76kg/kg and 1. 3kg/kWh for electricity consumption (thermal power) in India (ALGAS 1997); ***prices differ depending on capacity, size, etc.

Sources: Compiled from various sources including CII, TERI, Roy, NML.
There has been a communist government in West Bengal since 1977. Although the overall industrial development in the state has stagnated over the past years, SSI development has been given special focus considering their potential for generating employment. At present, foundries are not included in the list of the major thrust areas of the state government. DIC, however, has been and is planning to organize awareness and capacity-building programmes and initiatives aimed at quality management for SSI including the foundries (DIC 2001). The present state government is giving trust on reviving the industrial sector.

6.3.1.1 Other organizations

The other organizations active within the cluster include industry associations that provide support and offer a common platform to raise specific industry-related issues. The main associations are the Indian Foundry Association (IFA) at the national level and the Howrah Foundry Association (HFA) at the district level. Most registered units are members of at least one of the associations. The IFA is more organized and has a larger representation than the HFA.

Besides these associations, the Engineering Export Promotion Council (EEPC), through its East India regional office is also engaged in promotional support activities for export of castings. The National Metallurgical Laboratory (NML) is one of the technical institutes undertaking research for the industries including the foundries. The Institute of Indian Foundrymen (IIF) at Kolkata also maintains a databank of information related to foundries.

6.3.2 Environmental policy

The environmental policy is especially relevant for the cluster. This is because, firstly, Howrah is amongst CPCB’s list of “most critically polluted” cities in the country. Secondly, foundries fall in the “red category” or heavy polluting industries in the state. The focus of the policy has been on regulatory instruments – mainly, emission standards for curbing local pollution and installing end-of-pipe

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162 West Bengal has 1,67,130 registered SSIs, employing 6,14,640 people. They directly account for almost 22% of the state revenue. The main issues related to the SSIs are the labour laws, rehabilitation of sick units, infrastructure building, need for modernization and working capital funds (SIDBI 2000).

163 Howrah figures as the critical problematic area in terms of the \( \text{SO}_2 \), \( \text{NO}_2 \), and SPM levels (CPCB 2000). It has developed with industries, residential areas and markets coexisting.

164 The industries are classified as red, orange or green, as per their pollution potential. Based on this and the sitting policy for entry-level restriction, the WBPCB issues consents for all units. New ‘red’ units cannot be set up in Kolkata Metropolitan Area (KMA), which includes Howrah industrial belt, and can be set up beyond KMA only with adequate PCDs and site clearance by local bodies.
technologies or PCDs. The timeline indicating the major policy decisions relevant for the cluster is given in Figure 6.2.

**Figure 6.2: Timeline and events related to environmental policy for the cluster**

**Emission standards:** The CPCB emission standard for the foundries was introduced in 1990 (based on the EPA Notification, GSR 742 (E), 30th August 1990). The standard was set for SPM levels for units using the cupola, induction and electric arc furnaces. The SPM limit for the units with cupola furnaces in particular was differentiated based on the furnace capacity (450 mg/Nm$^3$ for foundries with cupola capacity less than 3 tons per hour, and 150 mg/Nm$^3$ for foundries with cupola capacity above 3 tons per hour). The standard was modified in 1996 to include a limit on the SO$_2$ level as well (the limit on SO$_2$ emissions was set at 300 mg/Nm$^3$ for all cupola furnaces) (MoEF Notification dated 2nd April 1996).

In 2001, the WBPCB made the emission standard more stringent for the cluster by prescribing the CPCB’s lower SPM standard for all foundries in the Kolkata Metropolitan Area (KMA) – including the Howrah industrial belt, irrespective of their capacities (WBPCB Memo Number 907-4Z-1/2001 dated 11th May 2001). Thereby, for all cupola-based foundries, the SPM level was set at 150 mg/Nm$^3$.

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165 The standards are set by CPCB and enforced by WBPCB. WBPCB cannot relax or lower them but can make them more stringent depending on the circumstances (chapter 5).
Others: The judiciary, in particular the Supreme Court, played an important role in enforcement of emission standards by issuing orders for time-bound installation of PCDs in foundries to meet the prescribed norms. A Green Bench at the Kolkata High Court was also set up in 1996, on the direction of the Supreme Court, to specifically look into environmental cases.

In order to help the units meet the emission standards, under the modernization programme the state government introduced a subsidy for setting up PCDs in 1995 (reimbursement of 50% of PCD costs maximum up to a limit of Rs 0.5 million). Initially introduced for five years, the subsidy was later extended. In addition to this, the UPTECH programme for technology upgradation was launched for the cluster in 1998, with the State Bank of India (SBI) as the main agency involved.

6.4 Policy implications

6.4.1 Main incentives and their effects

The regulatory instruments, primarily the emission standards backed by penal action, have provided the main incentives under the environmental policy (Table 6.3).

6.4.1.1 Regulatory instruments

Before 1990. Prior to 1990, environmental protection was not much of an issue for the cluster nor was any major policy provision in place. With little policy incentive, there was hardly any change in technology during this period. For instance, though the DBC was introduced in 1973, there were few takers for the technology. Motivation for change really came about in 1990 with introduction of the emission standard.

1990–1995. This was the period of very limited compliance. A committee set up at the suggestion of the NML in 1990 formulated the first emission standard. It followed the notification and standards of the Environmental Protection Agency (EPA) in the USA. In this committee constituted for reviewing the proposed standard, there was some representation from large-scale industries but none from the SSI sector.

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166 The Supreme Court became involved in environmental issues related to foundries, following a public interest litigation by Mr M C Mehta, an environmental lawyer. A major impact of the Court’s intervention was felt in Agra in Uttar Pradesh, where more than 200 foundries that used coal/coke were ordered to close down (also see Chapter 7).

### Table 6.3: Incentives under the environmental policy

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Type</th>
<th>Incentive Strength</th>
<th>Weaknesses</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main instrument</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Regulatory | Emission standard | • Threat of penal action  
• Judicial intervention: leading to increased enforcement measures | • Focus on end-of-pipe measures  
• Lack of dynamic incentive | Successful:  
• Installation of PCDs in almost all units  
Failure  
• Little focus on efficiency  
• Many PCDs not efficient or operational at all times |
| **Other instruments** | | | | |
| Economic | Subsidy (for PCD installation) | • Opportunity for support (financial, technical) | • Lengthy procedures and formalities | Successful:  
• Assisted some units in compliance with emission standards  
• Change in about 35 units as a collaborative effort (SIDBI, NML & HFA). The initiative not sustained/replicated for further change  
Failure:  
• No incentive for further change |
| Economic + Suasive | UPTECH scheme | • Opportunity for financial & technical support | • Lengthy procedures and formalities | Successful:  
• Benefit to few units  
Failure:  
• Only few units have been mobilized  
• Training sessions not well attended |
| Suasive | Capacity building | • Opportunities for technical support, training | • Not necessarily needs-based training | |
Introduction of the emission standard did provide an incentive for the cluster for adopting cleaner technologies; however, this incentive was weak. The main reasons included ineffective enforcement or no ‘real’ threat of penal action, and lack of information on how to meet the standards (there was insufficient knowledge even within the PCBs and the technical institutes), and the standard itself. The situation changed only with Supreme Court intervention in the 1995–96.

After 1995. The period 1995–1996 was particularly marked by enforcement of the emission standard triggered by the intervention of the Supreme Court, and consequent and rapid technical change in order to comply with the specifications. After the Court’s orders, the inspections of the WBPCB increased significantly, and compliance became necessary for the units. In light of the increased regulatory incentive owing to enhanced enforcement, there was a rush by entrepreneurs to install PCDs, and make the necessary adjustments in their cupolas to meet the emission norms.

In 1996, the WBPCB also started laying stress on DBC technology in order to meet the emission standard. A number of units converted to DBC, with the main motive being compliance and not energy efficiency or cost benefits. Some units also closed down unable to meet the pollution control norms and specific ations.

Effect: Environmental policy has brought in two main changes within the cluster: (i) installation of PCDs in almost all the units; and (ii) conversion in some units from SBC to DBC (Figure 6.4). Diffusion of other furnace technologies like rotary and induction has remained negligible.

Two points are relevant here. Firstly, these changes should, in effect, have brought about improvement in the air quality and the environmental condition in the district. However, although the technological goal was attained with all units installing PCDs, the environmental objectives were not necessarily achieved. Installing the PCDs did not always imply that they were being run efficiently. Many PCDs are ineffective, inefficient or are not operated throughout the production cycle. For instance, some PCDs are run only for a few days, hours, or when there is a possibility of the WBPCB inspectors visiting the site. Secondly, a majority of the changes were undertaken to suit the needs of individual units basically to satisfy the regulators, without proper technical considerations. Thereby, the full benefits of the technology could not be realized. There were some accidents that were also reported in the initial stages due to insufficient knowledge about the PCDs and the cupola conversions.

Energy efficiency across the cluster still remains low with a large potential for improvement in most of the units. The policy focus has been on cleaning rather than on cleaner technologies, and energy efficiency did not get the focus it deserved. The coke to metal ratios of SBC and DBC for the sample in the survey (Table 6.3) is high, leaving room for improvement in almost all units (though energy efficiency is slightly higher for medium industries). Though the big and medium units in general are the more progressive units in terms of capacities, marketing and administrative

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set-ups, the technologies have not changed and efficiency remains almost the same. The slight variation between units may also be because the furnaces are operating for more days, and because of use of better quality (but expensive) fuel.

Figure 6.3: Dispersion of the furnace technologies in the cluster

Beyond 2004. The emission standard for the cluster has been made more stringent in 2001. Again, there is little information on how to meet the standards cost-effectively. While it encourages further change within the cluster, it also raises uncertainty among the entrepreneurs about the future. Without clarity about the existing standards and how they will change in the future makes it difficult for the entrepreneurs to plan any long-term technological improvements especially for cleaner technologies. For example, in order to comply with the SPM norm, some entrepreneurs set up a dry cleaning system which is not capable of handling SO₂, and therefore very soon had to change it when the standard was modified in 1996 (TERI 1999). Interestingly, it is the small entrepreneurs with cupola capacity less than 3 tph, who will have to bear the brunt of this modification. The options available to them are to close down (as has been the case for small units in this cluster, as well as other clusters in India and other countries), evade, install cleaning technologies (as has happened till now) or adopt clean technologies. It appears that a number of units will

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169 The survey was carried out before July 2001, and it was not possible to analyse the impact of the revised standard. However, as per the interviews and assessment undertaken during the study period after July 2001, the general impression is that compliance to the revised standard has been limited.
have to close down. This, however, could lead to social impact, and in turn have political ramifications in the socialist structured state. Some of the small units may also merge or associate with the large ones, or shift over to more viable businesses.

Table 6.4: Average coke to metal ratio in the cupola

<table>
<thead>
<tr>
<th>Category</th>
<th>Coke to metal ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>According to furnace type</strong></td>
<td></td>
</tr>
<tr>
<td>Single blast cupola</td>
<td>0.36</td>
</tr>
<tr>
<td>Double blast cupola</td>
<td>0.23</td>
</tr>
<tr>
<td><strong>According to classification of units</strong></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>0.30</td>
</tr>
<tr>
<td>Medium</td>
<td>0.24</td>
</tr>
<tr>
<td>Big</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Source: Based on survey data

Alternatively, the units could be relocated. But this would have financial implications, and raise issues of land allocation and associated opportunity costs. In addition, it was debatable as to how many units will be willing to go; most were likely to try and stay where they were till the last minute possible. There was talk in the late 1990s of setting up a “Foundry Nagar (city)” outside the KMC, and relocate Howrah units there. This idea, however did not really take off. The owners could also diversify to other products or occupations, but given the fact that they are traditional family operations this may be difficult for them as well.

However, with prospects of increasing industrialization in West Bengal, there is a possibility of the demand situation improving owing to vertical integration. In addition, with the progress of the Haldia downstream project (for oil and natural gas availability) in progress and thrust being given of renewable energy in the state, chances of availability of cleaner fuels and thereby diffusion of cleaner technologies may also improve.

6.4.1.2 Other instruments

The provision of a subsidy for installation of PCDs achieved some success, particularly under the joint initiative of SIDBI and HFA in collaboration with WBFC and NML for support for technology modernization and upgradation in 1995–98. The initiative provided financial and technical support to about 35 units for adopting

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170 It is even suggested by some entrepreneurs that this may just be a way of pushing these units out of the district! However, it was beyond the scope of this thesis to analyse this aspect. In any case, if the inefficient units do close, then the entrepreneurs and workers will have to shift over to other productive activities, and their market share will be taken over by the rest of the cluster. The general perception across various stakeholders was that a lot of small units will close down over the next few years.

171 SIDBI and WBSFC provided financial support, NML the technical support, and HFA motivated and represented the entrepreneurs.
cleaner technologies that led to PCD installation in all units and switch over the DBC furnaces for some units and resulted in a fuel saving of Rs 20,000 per month per unit according to SIDBI estimates\textsuperscript{172}. This was due to the mix of the policy instruments and not just by putting the subsidy in place. The threat of penal action combined with an opportunity for financial and technical support and the involvement and motivation provided by a known local association (HFA) was the complete package that could bring about this change. However, this initiative could not provide enough incentive for further change and was also not replicated. Though, the opportunity under the subsidy still existed, with absence of the collaborative effort and a further regulatory incentive, the subsidy could no longer provide a strong incentive.

The UPTECH programme launched in 1998 for upgradation of technologies, on the other hand, has made only limited progress related to the activities in the foundry cluster. The programme objectives include capacity building as well as market study and drawing plans for lifting the technology level of the units agreeing to adopt modernization. The survey conducted showed that seven units had either consented or were planning to upgrade, and a few others had expressed their interest. This included a unit planning to install a “cokeless cupola” (based on oil or gas) under this scheme (SBI 2001) with energy consumption almost 40% less and CO\textsubscript{2} emissions just one-third of a conventional coke-fired cupola (NML 2001). But this initiative had been able to mobilize only a few units because of its timing. It was introduced only in 1998, by which time most units had already installed PCDs and were in principle in compliance with the emission standard. Thus, due to lack of a strong regulatory incentive, the initiative could not generate much interest. The big and medium units are more interested in this initiative compared to the small units.

6.5 **Contextual factors for diffusion of cleaner technologies**

This section discusses the main contextual factors that affect diffusion of cleaner technologies across the cluster. The scenario is complex with multiple factors in play (Table 6.5). An interesting aspect is the diversity across the cluster, and differences between the perceptions of the entrepreneurs and other stakeholders (Table 6.6).

Overall, the entrepreneurs view economic factors such as market constraints, low profit margins and availability of finance, as the main barriers for adopting cleaner technologies, followed by limited technical knowledge. What they seem to need most, therefore, is finance as well as the supportive attitude of the policy makers to improve their technical status. The other stakeholders perceive the main barrier to be the complacent attitude of the entrepreneurs. Many feel that unless a drastic need is felt, the entrepreneurs will not bring in any change ("\textit{till this works it is fine, when the problem will come they will see}").

\textsuperscript{172} Interview no. 15. SIDBI 2001.
<table>
<thead>
<tr>
<th>Factor</th>
<th>Driver</th>
<th>Barrier</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>• High pollution levels in Howrah</td>
<td>• Low consciousness</td>
<td>• Increased awareness</td>
</tr>
<tr>
<td>Organizational</td>
<td>• Workers: Contract workers (as carriers of knowledge)</td>
<td>• Limited awareness and traditional practices</td>
<td>• Limited marketing and management skills in many units</td>
</tr>
<tr>
<td>Economic</td>
<td>• Increased market competition</td>
<td>• Economic capability low</td>
<td>• Economic capability low for many, esp. small units</td>
</tr>
<tr>
<td></td>
<td>• Niche market for selected products</td>
<td>• Limited financial support</td>
<td>• Financial support limited</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Market uncertainty and conditions (demand situation, competition)</td>
<td>• Competition is a major factor</td>
</tr>
<tr>
<td>Technological</td>
<td>• Technical support may be available</td>
<td>• Limited technical capability (access, know-how)</td>
<td>• Technological capability limited for small units</td>
</tr>
<tr>
<td></td>
<td>(technical institutes, consultants, associations)</td>
<td>• Technical support is limited (little help from associations – lack of appropriate technologies; consultants are expensive)</td>
<td>• Technical support limited</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Infrastructural constraints: coke quality and price, unreliable powersupply</td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>• Involvement of younger generation (brings in awareness, IT, etc.)</td>
<td>• Attitudes: Motivation, attitudes, mindsets</td>
<td>• Attitudinal constraints</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Networking: Limited interaction (weak associations, competition)</td>
<td>• Limited networking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Social status of units: Disinterest of younger generation</td>
<td></td>
</tr>
</tbody>
</table>
6.5.1 Environmental factors

Given the high local pollution in Howrah and poor working conditions in the foundry units, diffusion of cleaner technologies across the cluster is desirable. However, basically it is the cost–benefit business considerations that mostly dominate the technology-related decisions of entrepreneurs (Figures 6.5 and 6.6). Environmental considerations largely hold relevance due to government policies.

Table 6.6. Barriers for cleaner technology diffusion – stakeholders’ perspectives

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Main constraint/barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrepreneurs</td>
<td>• Competition from abroad, market (demand) constraints</td>
</tr>
<tr>
<td>➢ Big units</td>
<td>• Low profit margins, market (demand) constraints</td>
</tr>
<tr>
<td>➢ Medium units</td>
<td>• Low profit margins, lack of finance, market (demand) constraints</td>
</tr>
<tr>
<td>➢ Small units</td>
<td>• Lack of motivation and initiative of entrepreneurs to avail incentives</td>
</tr>
<tr>
<td></td>
<td>• Fixed mindsets, attitude of entrepreneurs (inertia, complacency)</td>
</tr>
<tr>
<td></td>
<td>• Limited awareness and capabilities of entrepreneurs</td>
</tr>
<tr>
<td>Policy makers</td>
<td>• Fixed mindsets, attitude of entrepreneurs (inertia, complacency)</td>
</tr>
<tr>
<td>Policy implementing organizations</td>
<td>• Limited awareness and capabilities of entrepreneurs</td>
</tr>
<tr>
<td></td>
<td>• Lack of an integrated policy approach (“they are currently looking at the system and process in isolation and not in its totality”)</td>
</tr>
<tr>
<td>Associations</td>
<td>• Lack of motivation of entrepreneurs</td>
</tr>
<tr>
<td>Financial institutions</td>
<td>• Limited financial and marketing capabilities of entrepreneurs</td>
</tr>
<tr>
<td>Technology consultants</td>
<td>• Little technical knowledge among the entrepreneurs</td>
</tr>
<tr>
<td></td>
<td>• Fixed mindsets of entrepreneurs and workers (resistance to change)</td>
</tr>
<tr>
<td>Technology suppliers</td>
<td>• Lack of awareness among entrepreneurs regarding technologies</td>
</tr>
<tr>
<td></td>
<td>• Difficulties in approaching the smaller entrepreneurs</td>
</tr>
</tbody>
</table>

There is little awareness among the entrepreneurs about climate change, the potential 
CO₂ emissions from their units and the CCIs. On learning about the potential opportunities under CCIs, however, most entrepreneurs expressed interest in availing them provided they get a premium on the emissions reductions. The small units were more or less resigned to the fact that only when the market becomes better will they be able to look at other options, and felt that the instruments could be helpful if they will improve the economics of their production and sale (Table 6.7).

6.5.2 Economic factors

Economic capability. The economic capability of entrepreneurs, particularly the small and medium ones, is limited. It is difficult for them to bear the upfront cost of cleaner technologies, even if the payback periods are not very long. For instance, while the payback period for the demonstration energy-efficient DBC developed under the SDC initiative is only 2–5 years considering the energy savings (TERI 2001),
many entrepreneurs cannot afford the upfront technology costs. They also do not have enough motivation to change as the currently used technology is simple, eco-
nomical and passed on for generations, and thereby is a “lock-in” technology for the cluster. The only change was because of the policy pressures, but that too in terms of local pollution control and not energy efficiency.

**Access to financial support.** Though financial support for technological improvement is available, it is limited and does not reach the majority of the unit owners. Either they do not know about it or find the procedures too complicated to follow. Some financial institutions have special programmes; but again, the requirement to get services from these institutions is complicated and inflexible. The question is: do these financial institutions meet the needs of the entrepreneurs? Most rely on private sources or local banks to meet their financial needs. Some entrepreneurs, the big units, also avoid these facilities so as to evade income tax or other formalities.

### Table 6.7: Entrepreneurs Response – role of policy initiatives in adopting cleaner technologies

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Positive responses by unit category (%)</th>
<th>All units</th>
<th>Small</th>
<th>Medium</th>
<th>Big</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to capital</td>
<td>63</td>
<td>67</td>
<td>60</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Access to technology</td>
<td>48</td>
<td>53</td>
<td>40</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Initiative by associations</td>
<td>37</td>
<td>39</td>
<td>30</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Increase in price</td>
<td>86</td>
<td>92</td>
<td>85</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Government regulation</td>
<td>52</td>
<td>47</td>
<td>65</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Tax on energy related emission</td>
<td>52</td>
<td>44</td>
<td>70</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Subsidy for technology installation</td>
<td>79</td>
<td>83</td>
<td>75</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>Payment for emissions reduction</td>
<td>63</td>
<td>56</td>
<td>75</td>
<td>71</td>
<td></td>
</tr>
</tbody>
</table>

**Market.** Market uncertainties and demand shifts constrain the economic capabilities of the entrepreneurs. Demand is shifting towards synthetic and high-grade items (pipes, railway sleepers), but very few units in the cluster produce these castings. Competition from other clusters in India, which generally are more modern (Roy 2001), and other countries like China, Korea and Taiwan, is increasing as well.

At the same time, the cluster still enjoys a niche market for sanitary and low-grade industrial items in local and export markets.\(^\text{173}\) Opportunities are arising with units in some countries closing down (e.g. mainly due to inability to comply with environmental controls in USA) (TIFAC 2001). To keep up with the changing markets and increasing competition, the units have to be more quality conscious, diversify their products and imbibe efficient and cleaner technologies.\(^\text{174}\) Thus, the market situation also acts as a driver for units to adopt cleaner technologies to be competitive.

There is divergence in the perceptions of entrepreneurs regarding finances and competition from abroad. While availability of finance is a much greater concern for the

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\(^{173}\) Interview no. 17. EEPC 2001

\(^{174}\) Interview no. 2. IFA 2001.
small units, the big units are more concerned with competition from abroad. However, some small units even consider foreign competition a potential threat in the future years as they feel that the export-oriented units facing external competition will try to take over a share of the domestic market. Thus, while support is needed by all units, finance is required relatively more by the small units.

6.5.3 Technological factors

According to the survey results, most entrepreneurs appear to be satisfied with their present technologies. About 65% wanted to make some improvements, but few knew what they wanted to do. Why are the entrepreneurs not able and what constrains them from adopting cleaner technologies? At the outset, most entrepreneurs say it is their size of operations, and the lack of affordable and accessible technology. The alternative options have technology-specific constraints (Table 6.6). The coke/coal used is also of low quality. There are some units that do use superior quality coke; however, that is much more expensive and not affordable for all.

**Access to technical support.** There is, though limited, technical support available for the cluster (from NML, IIFA). In addition, demonstration projects have been set up (for example, efficient cupolas), but these have not succeeded in bringing a change in the cluster (Dasgupta 1999). While the big units are able to employ qualified consultants, the small ones are financially constrained to do so. Moreover, most consultants provide a one-time job without follow-up. Entrepreneurs find their instructions complicated for the workers to follow, while the consultants point out that the units do not adhere to the specifications and guidelines.

It is here that technical institutions and associations may play a role. However, the associations’ functions are largely administrative (like clearances, availability of raw material) and do not focus on technical support. They do organize seminars in order to deal with the pollution norms but these are generally not well attended. The associations claim that the entrepreneurs’ lack motivation to attend the seminars, while the latter question their usefulness. The joint initiative to set up PCDs (see 6.4.1.2) achieved results owing to HFA involvement that motivated the entrepreneurs and the entrepreneurs in turn co-operated because of the threat of government regulators; but this effort was not repeated.

6.5.4 Organizational factors

Many units are old and family-owned businesses, which have been handed over to the entrepreneurs by earlier generation(s). These entrepreneurs have little technical

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175 A big export oriented unit owner reported a decline in the percentage exports of total production for his unit from 85% in 1996 to only 60% in 2000, with production remaining static.

176 The institutions involved cited difficulties in bringing everyone together, due to lack of motivation of the entrepreneurs.
and scientific knowledge as well as managerial and marketing skills, and depend on their workers for operating their units, who in turn may be dependent largely on traditional knowledge. As they generally operate with low profit margins (normally Rs 2–3 per kg of castings), the entrepreneurs face financial limitations that limit investment in cleaner technologies. Many units, especially the smaller ones, work on an on-demand and contract basis. A large number of them also sell molten metal to contractors, who in turn make and sell finished castings.

**Workers.** Strong labour unions in the state and its communist structure will oppose the closure of the units on account of environmental or any other reasons (as was clear from the interviews with the workers). However, workers have fixed ideas and continue to operate in the way they have been used to over the years. Fixed mindsets of workers pose a problem for diffusion of cleaner technologies; and, closure of the units can cause unrest among workers and labour unions.

### 6.5.5 Social factors

**Attitude.** The main barrier towards diffusion of cleaner technologies as perceived by different stakeholders in most cases has been the lack of motivation of the entrepreneurs themselves (Box 6.1). In general, entrepreneurs are perceived as complacent, averse to taking risks, and having short-term perspectives. However, it is not just the attitude of the entrepreneur alone that matters, but of the workers and other stakeholders as well.

**Interaction.** There is limited interaction and networking between the entrepreneurs and stakeholders. Many entrepreneurs said that they were hesitant to go out and meet other entrepreneurs as they lived in a small community and were all competitors. This was illustrated by the fact that most small unit owners knew about the demonstration plant set up but few had actually seen it. Though the associations provide a forum for interaction, there are only a few active members (a majority of them are big unit owners and they do not always reflect the needs of the cluster as a whole). The IFA and HFA also operate independent of each other, including the period in which they were opposing the introduction of the emission standards or finding solutions for compliance among the units.

As regards the different government departments, there appears to be little coordination between their policies and approaches. At the district level, the DIC wants to develop SSIs (including foundries) recognising their economic importance. At the state level, the emphasis is on building a competitive sector, and the foundries not only have to become more competitive they have to reduce pollution as well: “*Inefficient and uncompetitive industries will have to go*”. The WBPCB’s concern, on the other

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177 A system known as “*Gala maal wala*” or molten metal trading, is very popular in the cluster: A unit owner may set up a cupola and provide molten metal to another entrepreneur who will then employ workers to produce the casting.
hand, is ensuring compliance with emission norms and hence would rather see them close down.\footnote{None of the state-level industrial departments really wanted to comment on the social development aspects of the cluster and what would happen if they were to close down. When asked what would happen to the people who lose their jobs if the industries closed down, they said that employment and social considerations were not in the scope of their work!}

![Figure 6.7: Assistance needed to facilitate cleaner technology adoption at unit level](image)

**Figure 6.7:** Assistance needed to facilitate cleaner technology adoption at unit level
Grades – 1: not important, 2: slightly important, 3: important, 4: very important, and 5: most important

**Social status.** The social status of the cluster has been gradually declining over the years. In several cases, the educated younger generation (even those with a technical background) is not interested in continuing in this business and is moving away to other professions. The older generation therefore does not feel the need to expand or introduce new technologies: “let it continue as it is”. On the other hand, the involvement of the younger generation in some other units has led to change in the work culture and there is willingness among them to learn and experiment in order to make their units “better”. The workers too, in some cases, cited their preference to move out of the industry and gave examples of their fellow workers who are moving to other industries such as jewellery.

### 6.6 Conclusions

The case study shows that environmental regulations have been a driver for technical change in the cluster. However, it provides a largely ‘static’ incentive for change. It may also be concluded that the regulatory instruments do not work unless there is a proper enforcement mechanism in place, in this case being triggered by the legal
framework. While end-of-pipe solutions can help arrest local environmental problems to a certain extent, it is the energy-efficient cleaner technologies that could help meet the objectives of development of the units as well.

The main reasons for the entrepreneurs not complying or finding it difficult to comply with the regulations are lack of motivation and capabilities (economic and technical). In addition, the available financial and technical support has also been limited. Networking or intervention by the local industry association helps build confidence in a new initiative. While all the units require external support, it is the small units that require capacity building, access to financial and technological support much more. As the environmental policies become more stringent, it is getting more difficult for the entrepreneurs, in particular the small units, to comply with them. The options available to them are to close down (as has been the case for small units, and other units across and outside India), evade or set up cleaning technologies (as has happened till now), or adopt clean technologies.

In general, there is a gap between the environmental and promotional policies of the government. The climate change instruments can perhaps help bridge this gap and improve compliance of the national policies or remove the barriers towards diffusion of cleaner technologies.
7. Glass cluster in Firozabad

7.1 Introduction

This chapter presents the case study of the SSI glass cluster in Firozabad in Uttar Pradesh (U.P.). The cluster is particularly relevant from the environmental policy perspective as it lies within the “Taj Trapezium Zone (TTZ)” – an area demarcated for protection of the famous Taj Mahal\(^{179}\) from environmental degradation (Chapter 3). A ban on the use of coal in the TTZ has forced fuel switching (coal to natural gas) in several units within the cluster.

Firozabad, also known as the “glass city” or the “glass capital of India”, is recognized nationally and internationally for its glass products, especially glass bangles (or bracelets)\(^{180}\). It accounts for more than 70% of glass products produced in the SSIs in India. Almost everywhere in the city one can see glass products or bangles, and at any time during the day there are several carts loaded with glittering bangles of various colours on the roads. It is a unique township, with its entire population (of over 0.5 million people) directly or indirectly dependent on the industry. One feels that if glass was not there, the city would have ceased to exist. In recent times, however, it has been in the limelight on account of issues related to its production practices like environmental impacts and child labour.

This chapter begins with describing the SSI–environment interaction in Section 2. Section 3 examines the development and implications of the environmental policy, while Section 4 identifies the contextual factors affecting diffusion of cleaner technologies for the cluster. These are mainly based on primary survey, interviews and field observations. Lastly, Section 5 draws the main conclusions.

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\(^{179}\) The Taj Mahal in Agra, U.P., is one of the wonders of the world. This marble tomb was built by the Mughal emperor, Shah Jahan, in the seventeenth century, in the memory of his wife, Mumtaz Mahal. The Varadharajan Committee Report (1978) reported that a possible cause of the “yellowing/blackening” of marble in the Taj Mahal is the SO\(_X\) and SPM emissions from the SSIs (mainly foundries, brick and glass units) and the power plants, including the Mathura Refinery, located near the Taj Mahal.

\(^{180}\) Glass bangles have a special significance in Indian culture and society. Indian women, especially married Hindu women, have worn glass bangles since ancient times. In fact, Firozabad is also called the ‘suhag nagri’ or city associated with marriage, as it meets the entire demand for bangles of the ‘suhagins’ (married women).
7.2 SSI–environment interaction

The first organized glass factory in India was set up in Firozabad more than a 100 years ago (CPCB 1993). Since the beginning, the cluster has specialized in the manufacture of bangles. Gradually, it has diversified and started producing other glass items as well. At present, it produces a variety of products like tableware, hollow wares, bulbs, headlight covers, beads and decorative items; and is the only producer of glass bangles. It caters to local, national and export markets.

7.2.1 Industrial activity

The industrial activity in the cluster involves a number of interrelated steps including raw-material mixing, melting, reheating, decorating and finishing (see Annexure 1 for details). For production of glass bangles, in particular, the whole process is undertaken in several vertically interrelated units. While the melting and reheating are undertaken in the SSI units (factories) or glass units; activities like decorating, and straightening and joining of bangles, are normally done in household units (cottage industry).

7.2.1.1 Glass units and technology used

There are 412 registered glass units in Firozabad (Table 7.1); however, not all of them are operational. As a policy implication, there has been no expansion in the number of registered glass units since the mid-1980s. Most of the units are old (new units are the old units taken over), and family owned businesses involving a capital cost between Rs 0.5 to 4 million. The average number of workers in a unit is between 40 and 250, most working on contracts. The units may be classified in

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181 In 1918, there were 14 units in the cluster, which rose to 236 units after significant expansion in 1939-45 (CPCB 1993).

182 Production of artistic glassware in different colours was started in 1989 (NIC 2001).

183 Almost 50% of the production (mostly glass items) is now exported (NIC 2001).

184 The steps may differ depending on the product type and may be undertaken in different units. For bangles in particular it is said that a single bangle passes though 76 different hands before finally reaching the consumer (Interview no. 9, DIC 2002).

185 Operational units are just around 200 (various interviews). There are unregistered units as well. Association members mentioned that several coal based units have closed down.

186 Interview no. 9, DIC 2002.

187 More than 90% of the units surveyed were family owned businesses.

188 Data based on survey. However, official figures differ from actual numbers (e.g. a tank unit owner said that officially there were 250 workers in his unit but actually there may be 1000). The entrepreneurs prefer to employ contract workers so that they can avoid giving employment benefits (such as gratuity). This arrangement also gives the workers more flexibility.
various ways, on the basis of the product (bangles or others), technology (pot or tank furnace), process (automation, semi-automation or manual) or fuel used (gas or coal).

**Table 7.1: Registered glass units in Firozabad**

<table>
<thead>
<tr>
<th>Type of unit</th>
<th>Number of units*</th>
<th>Number of units surveyed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Operating on natural gas</td>
</tr>
<tr>
<td>Tank furnace (with mouth blowing)</td>
<td>28</td>
<td>20</td>
</tr>
<tr>
<td>Tank furnace (automated press)</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Pot furnace – Open pot</td>
<td>186</td>
<td>53</td>
</tr>
<tr>
<td>Pot furnace – Closed pot</td>
<td>109</td>
<td>13</td>
</tr>
<tr>
<td>Others (like beads, pottery, chemicals, pakai bhatti)</td>
<td>91</td>
<td>91</td>
</tr>
</tbody>
</table>

*Source: DIC 2002a

Depending on the product, these units may be either “bangle-making units” (those producing bangles) or “glass making units” (those producing glass items other than bangles). Since the past few years, some units make both glass items and bangles, and thus may be called the “glass-and bangle-making units”. These units involve one or more furnace operations, and have one main furnace or “bhatti” for melting of glass. There are two types of melting furnaces used within the cluster:

1. Pot furnace – this may be (a) an Open-pot furnace – which is a traditional furnace and is used for producing different coloured bangles in the bangle-making units; or (b) a Closed-pot furnace – used for making decorative items of different colours in the glass making units.

2. Tank furnace – is a large-capacity furnace mainly used for making glass items (like tableware, headlight covers, hollowware) in the glass making units. Some units also use them to produce bangles as well. They may rely on mouth blowing or automation for shaping of the glass items.

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189 They may produce finished or semi-finished products. See photos 7.1-7.6.

190 Other smaller furnaces are also used in the glass units. These include those for reheating or the ‘sekai bhatti’ for baking of glass items, and the bangle-making furnace or the ‘belan bhatti’ – for making glass spirals to be later converted to bangles (the spiral or ‘belan’ used could be either manual or automatic).

191 Each furnace contains 10–12 pots and uses direct firing for melting glass.

192 Is also known as Japanese or monkey mouth furnace. It is similar to the open-pot furnace, but is smaller in capacity and designed such that there is no contact between glass and flue gases.

193 The melting capacity of an average tank furnace is around 25–40 tonne per day, while that of an average pot furnace is 3–5 tonnes per day (various interviews). Tank furnaces are generally regenerative and can handle only single-colour jobs at a time.
Photo 7.1: Action in a typical glass unit (tank furnace)

Photo 7.2: Action in a bangle unit (pot furnace)
Photo 7.3: A pot furnace for making bangles

Photo 7.4: Another view of the pot furnace
Photo 7.5: Glass spiral in a ‘belan bhatti’

Photo 7.6: Raw bangle spirals being stacked
In addition, there also exist several (around 1000) very small, normally unregistered units called the “muffle units”. These are involved in the finishing (baking and strengthening) of the semi-finished bangles that may be produced in bangle making units. In the muffle units, muffle furnaces or “pakai bhatti” is used for baking and finishing of the semi-finished or decorated glass bangles. The muffle and bangle making units, therefore, are dependent on each other.

7.2.2 Energy consumption and environmental impacts

The melting of glass in a tank or pot furnace is the most energy-intensive stage of the production process, for which coal, oil or natural gas (and fuel wood) may be used. It is associated with emissions of air pollutants like sulphur dioxide (SO\(_2\)), suspended particulate matter (SPM) and carbon dioxide (CO\(_2\)). The muffle furnaces also consume significant quantities of fuel (mainly coal), adding to the emissions. The working conditions also raise concerns such as those related to unsafe handling of materials and disposal of slag and waste, exposure to high temperatures and smoke, health effects of the mouth blowing operations. In the household units, kerosene or LPG is used for straightening and joining the raw bangles, usually in small closed units, which too are associated with adverse health impacts.

Prior to 1997, most glass units used coal for their processes, while a few units also used oil (mainly fuel oil). According to an estimate (TERI 1994), the total coal and oil (RFO) consumption in the cluster was about 730 tonnes and 25 kilolitres per day respectively; and the pot, muffle and tank furnaces (open and closed) accounted for 48%, 27% and 25% of the total coal consumption, respectively. This implied that the CO\(_2\) emissions due to fossil fuel use were around 41 kilo tonnes per month. Since 1997, however, many units (91 units till 2002) have converted to natural gas use (details in next section). This has led to significant benefits in terms of health and environmental impacts (e.g. in a muffle unit it is difficult to even stand during feeding – as Photo 7.7a shows, but the situation has vastly improved by introduction of natural gas – as seen in Photo 7.7b). The present gas consumption is over 0.6 million standard cubic metres per day (MMSCMD). This includes natural gas use not only in the furnaces but for other operations as well (like captive power generation). Coal is still used in many glass units and in the muffle units.

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194 The melting stage typically consumes 70–80% of the total energy (Chand and Krishnan 2000; Dasgupta 1999).

195 Muffle units account for 75–80% of the local pollution (Interview nos 2, 6, 7. Firozabad 2002).

196 For instance, kerosene burners emit carbon monoxide and volatile hydrocarbons.

197 Estimate based on default emission factors for coal (1.76 ton/ton) and fuel oil (3.13 ton/ton).

198 In some units that use gas, coal is still being used ‘unofficially’ to meet the extra fuel demand for some activities (other than melting).
**Photo 7.7a:** A conventional coal-based muffle unit

**Photo 7.7b:** A natural gas-based muffle unit
Another issue related to the cluster is child labour. Though the situation has improved significantly over the years, the problem continues to exist particularly in the household units (Agarwal 2004). The children working in the units suffer on account of education, health and overall development (ICF 2001; Mishra 2000; UNICEF 1997). Justifications given include that the children learn and add to family earnings, and the impact of not employing children in the glass units will become evident after some years as they will find it difficult to learn these skills at a later stage in life.  

7.2.3 Potential for technological change

The technology used in the cluster has changed little over the years. Some degree of mechanization has come in, especially since 1992 (there were six mechanized units in 2002-2003). The major change, however, was the switch to natural gas.

The furnaces (coal, oil or natural gas based) used presently are generally outdated and operate below capacity. Ideally, the energy requirement to melt 1 tonne of glass ranges between 1–2 Gcal (giga calories) depending upon the quality of glass to be melted (TERI 1999). However, most units operate much below their efficiency levels (Table 7.2). According to estimates (and experience with the existing pilot projects), the energy saving potential through short-term housekeeping measures may be more than 20% (UNDP 2001), while that of upgradation and better design of various furnaces may be between 20–60% (CDGI 2000; Chand and Krishnan 2000).

<table>
<thead>
<tr>
<th>Furnace type</th>
<th>Specific energy consumption* (Gcal/tonne of melt)</th>
<th>Fuel to metal ratio* (kg/kg)</th>
<th>Thermal efficiency*</th>
<th>Potential CO₂ emissions** (kg/kg of melt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tank (coal fired)</td>
<td>3–4</td>
<td>0.6</td>
<td>12–13</td>
<td>1.1</td>
</tr>
<tr>
<td>Tank (oil fired)</td>
<td>2</td>
<td>0.2</td>
<td>21–22</td>
<td>0.6</td>
</tr>
<tr>
<td>Open pot (coal)</td>
<td>5–6</td>
<td>1.0</td>
<td>9–10</td>
<td>1.8</td>
</tr>
<tr>
<td>Closed pot (coal)</td>
<td>9–10</td>
<td>1.7</td>
<td>5</td>
<td>3.0</td>
</tr>
<tr>
<td>Muffle furnace</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7.2: Performance of conventional furnaces

Note: *Source: TERI 2002 **Potential CO₂ emissions are estimated based on default emissions factors, 1.76 and 3.13 ton/ton for coal and fuel oil respectively.

Natural gas furnaces on an average have led to a 30% improvement in fuel efficiency compared to the coal fired furnaces (DIC 2002). However, there is still a potential to improve efficiency by another 30% (Chand and Krishnan 2000). Improvements are possible in other furnaces as well that have till now remained fairly untouched. Thus, there is significant potential for cleaner technologies within the cluster.

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199 Various interviews (including Interview nos 5 and 6. Firozabad. 2002).

200 Mechanization started in 1941, when the first automated glass container unit was set up; later machines were introduced to replace mouth-blowing jobs; but it has been slow (CPCB 1993). Changes include mechanization of belan bhatti and use of temperature metres.
7.3 National policies

This section describes how the government policy for the glass cluster has developed over the years. Before discussing the environmental policy in particular (Section 4.2), an outline of the organizational structure for policy development and implementation for the cluster is presented in Section 4.1.

7.3.1 Organizational structure

The central government\(^\text{201}\) provides the national policy strategy for the SSIs, within which the U.P. state government designs its own policy and initiatives (Figure 7.1 gives the relevant organizational structure). The national policy presents favourable conditions, for example by providing financial and fiscal incentives. Labour regulations (particularly related to child labour) also are important for the industry. In particular, the Uttar Pradesh Pollution Control Board (UPPCB) implements the environmental policy in the State.

![Organizational structure for policy development and implementation](image)

**Fig. 7.1:** Organizational structure for policy development and implementation

\(^{201}\) As pointed out in chapter 4, the Ministry of Small Scale Industries (MoSSI) is the nodal agency for policy making for SSIs in India. The main implementing agencies are the Small Industries Development Organization (SIDO) and the Khadi and Village Industries Commission (KVIC). The KVIC is a statutory body of the MoSSI and deals specifically with the promotion of village industries (and khadi industries). For environmental policy, the Ministry of Environment and Forests (MoEF) is the nodal agency for policy setting and the executive body is the Central Pollution Control Board (CPCB).
The responsibility for overall industrial development in the State lies with the Directorate of Industries and the Uttar Pradesh State Industrial Development Corporation Ltd. (UPSIDC) is the main implementing agency. The state government emphasizes SSI cluster development and export promotion. The District Industries Centre (DIC) in Firozabad is the main body responsible for implementing the schemes of the central and state governments at the local level. The Small Industries Development Bank of India (SIDBI) and UP Financial Corporation (UPFC) are the main organizations for financial support.

**Technical institute.** The Centre for Development of the Glass Industry (CDGI) in Firozabad provides technical support to the glass industry, including the cluster. It is a joint venture of the central and state governments, United Nations Development Programme and United Nations Industrial Development Organization.

**Industrial Associations.** There are several industrial associations operational in the cluster. The main ones are UP Glass Manufacturers Syndicate, Glass Industrial Syndicate, and Industrial Estate Samiti. These mainly deal with issues such as labour or bureaucratic problems, prices and conflict resolution. “When a group of people sit together they make up a syndicate or association.” Another observation was that the associations are still based on religion or type of units. For instance, there are separate associations for glass-making and bangle-making units; and within the bangle-making units there are separate associations for Hindu and Muslim entrepreneurs.

### 7.3.2 Environmental policy

The environmental policy for the cluster attained significance only in the 1980s, when it was recognized that the polluted ambient air was affecting the famous Taj Mahal adversely. As Firozabad is located near the Taj Mahal and lies within the

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202 SSI s hold an important place in the state’s economy. There are 340,000 SSI s in U.P. with investment of Rs. 32310 million, providing employment to 1.5 million people (www.upgov.nic.in).

203 The origins of the CDGI date back to 1984, when a committee set up to investigate the reasons for high coal consumption in the glass industry recommended the establishment of a glass technology institute. The project was approved by UNIDO in 1990 and by the Indian government in 1991.

204 The Associations differ in their composition and structure. The UP Glass Manufacturers Syndicate is an association of entrepreneurs with tank units (membership varies: 36 members at the time of the survey), and mainly deals with issues like natural gas availability and price. The Glass Industrial Syndicate is an association of bangle manufacturers (open-pot units), and is the oldest in Firozabad (membership varies: 30 members in 2002). It deals with issues of labour, fuel, clearance, etc. The Industrial Estate Samiti is an association for all units in the Industrial Estate area, where number of units are located.
TTZ\textsuperscript{205}, it too came in the preview of environmental concerns. There were four main developments that helped shape the environmental policy in the cluster (Figure 7.2).

7.3.2.1 Demarcation of the TTZ

Till the late 1970s, little attention was given to environmental aspects related to the cluster. The late 1970s and early 1980s marked the beginning of environmental awareness. Several assessments were undertaken (e.g. by the UPPCB, Varadharajan Committee, and technical institutions like NEERI), which added to the knowledge base. In this regard, the TTZ was demarcated in 1983 by the central government vide its notification (dated 3 May 1983), for protection of the Taj Mahal.

7.3.2.2 Public interest litigation filed

The impetus, however, was provided in 1984. Mr M C Mehta, an environmental lawyer, filed a public interest litigation (PIL) seeking protection of the Taj Mahal from environmental pollution (Writ Petition (Civil) No. 13381 of 1984).

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\textsuperscript{205} The TTZ is a geographical area measuring 10,400 sq. kms around the Taj Mahal. It includes Agra, Mathura and Firozabad. Firozabad is located at a distance of 40 kms from Agra.
The Supreme Court passed various orders in this regard, such as directing the relevant authorities and organizations to undertake increased air monitoring, survey for identifying polluting industries and explore possible alternatives (like access to cleaner fuels or relocation of industries), issued notices to polluting industries to install pollution control device (PCDs) and waste treatment plants and that no new polluting unit could be set up in TTZ. A study of the glass industry (CPCB 1993) came up with recommendations for emission standards to control the SPM levels (under the umbrella Air and Environment Protection Acts), with the UPPCB as the relevant authority to monitor its performance. In 1992, the CDGI was also set up.

7.3.2.3 Supreme Court’s decision

The Supreme Court gave a landmark decision in response to the PIL on 30 December 1996 (M.C. Mehta v. Union of India, WP 13381/1984 (1996.12.30) (Taj Trapezium Case)). The ruling led to a ban on the use of coal/coke in the TTZ. A time schedule was set up for specified industrial units to make a switch-over to cleaner fuels (though the litigation did not specify the alternative fuel that may be used, it was inferred that it meant a switch-over to natural gas), or alternatively relocate or shut down. It thus became mandatory for the glass cluster to switch over to cleaner fuels.

7.3.2.4 Commencement of natural gas supply

The Supreme Court order (1996) had also directed the Gas Authority of India Limited (GAIL) to enable supply of gas to the TTZ. In response, GAIL started supply of gas to the glass cluster in Firozabad in December 1997. A main criticism of imposing the ban has been the non-availability of alternative fuel sources (if there were no alternatives available how should the units comply – or was it a way to completely shut them down!). However, with commencement of the natural gas supply enforcement of the policy instrument became more feasible.

As per the initial assessment, the total natural gas allocation for Firozabad was fixed at 0.3 million standard cubic metres per day (MMSCMD). However, it was estimated that the total gas requirement of the glass cluster might be more than 0.8–0.9 MMSCMD and thus may far exceed this allocation (another 0.3 MMSCMD of gas was allocated for the cluster by GAIL in February 2000). GAIL also commissioned a study to ascertain the safety aspects of natural gas supply and thereby declared seven pockets as ‘no gas zones’ – areas where supply of gas was not feasible or practical.

In 1998, the central government had also constituted the “Taj Trapezium Zone Pollution (Prevention and Control) Authority” to ensure compliance and monitor progress.

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206 This included a standard for the pot furnace at Firozabad set at 1200 mg/Nm3 for particulate matter (see www.cpcb.delhi.nic.in/standard33.htm; EPA, Notification [GSR 93(E); Feb. 21, 1991]). It required the units to set up PCDs (such as settling chamber, cyclone, chimney).

207 GAIL provides the gas supply through the HBJ (Hazira–Bijapur–Jagdishpur) pipeline, which passes through the states of Gujarat, Madhya Pradesh, Rajasthan, U.P., Delhi and Haryana.
of the implementation of various schemes for environmental improvement in the TTZ (*The Gazette of India, Extraordinary*, Part II – Section 3 (ii) dated 13 May 1998). Some of the schemes that have or are being introduced are the credit-linked subsidy scheme for technology upgradation of the SSIs (CLCSS)\(^{208}\), and the technology development and modernization (RTDM) scheme.\(^{209}\)

### 7.4 Policy implications

Based on the previous section, this section deals with the policy implications for diffusion of cleaner technology in the cluster. Here, we discuss the main incentives provided by the policy and their effects. In the next section, we will deal with the main contextual factors that also helped in shaping the SSI–environment interaction.

#### 7.4.1 Incentives

The environmental policy has provided incentives for change in the cluster especially after the Supreme Court’s decision. It has largely relied on the use of regulatory instruments (basically, ban on coal use), supplemented by economic and suasive instruments. The main incentive provided has been regulatory (Table 7.3).

**Regulatory**: Avoiding penal action for non-compliance in terms of relocation or closure provides a direct regulatory incentive for the entrepreneurs. The incentive is strong particularly as it was triggered by the Supreme Court’s decision to protect the Taj Mahal and is backed by threat of penal action. Judicial intervention also led to the closure of coal/coke-based iron foundries in Agra (in the TTZ). This precedence of penal action by government authorities portrayed their seriousness about enforcement of the ban.\(^{210}\)

The ban was followed by the initiation of natural gas supply, which made the switch-over from coal feasible. Strict measures undertaken by local authorities to ensure compliance made the incentive stronger. These even included some drastic measures like actually pouring water on the furnaces to put out the fire. However, in practice enforcement has been more lenient in the case of the SSI units in Firozabad than in other parts in the TTZ (particularly Agra). In Firozabad, coal is still used (including in some units that have switched to natural gas), and the ban, though it has brought about a drastic change, has not been able to achieve as much as it could have. There is a general feeling of complacency among entrepreneurs and government agencies.

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\(^{208}\) The scheme aims at technology upgradation of SSIs in specified sub-sectors (including glass) by providing 12% capital subsidy for induction of technologies approved under the scheme.

\(^{209}\) Interview no. 12. SFC 2002.

\(^{210}\) Before imposing the ban, an emission standard was also recommended. However, it could not control emissions. There was a lack of alternative fuels, and as it was not matched with effective enforcement measures, it lacked the intended regulatory incentive for the entrepreneurs.
(including UPPSB) after a unit has switched over to natural gas. The policy also provides no dynamic incentive for continued innovation or change.

In addition, the possible relocation site (New Industrial Area, Jalesar Road) being set up (by UPSIDC) on the outskirts of Firozabad is not yet developed. It is at a distance of about 10 kilometres from the main market (and where most household units and workers are based), the access road is not good, and entrepreneurs are unwilling to shift there (for various reasons, e.g. logistic, infrastructural and relocation costs)\(^{211}\).

In addition, suasive instruments have helped in awareness creation and capacity building (though primarily due to concern for the Taj Mahal!). An important step in this direction was setting up the CDGI. The institute has good infrastructure and research facilities (and is often quoted as an important cluster development initiative) and provides increased opportunities for technical support for the cluster. However, there is very little interaction between the entrepreneurs and the researchers at the institute. Most of the products and technologies that have been developed there have not been introduced in the cluster. In fact, the institute is commonly known as a “white elephant” among the glass-makers community.

7.4.2 Incentives and their effects

7.4.2.1 Till 1980

With hardly any policy pressure or incentive, there was very little change in the technology used in the cluster over many years. Although some mechanization was brought in, in terms of energy efficiency improvement there was little change.

7.4.2.2 Period between 1980 and 1995

The period between 1980 and 1985 saw increased environmental awareness in the cluster, and considerable interest generated among many local, national and multinational agencies (like ADB, UNDP and UNIDO) for reducing pollution. The focus has been on reducing SO\(_2\) and SPM emissions due to coal consumption in the glass units. Inefficient use of energy also leads to CO\(_2\) emissions, but this aspect has not been highlighted or documented substantially. At this time, the emission standard was introduced; however, progress in terms of effective implementation was limited. The ban on setting up new coal-based units though, did manage to freeze the number of registered glass units.

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\(^{211}\) The CDGI is also located in this area. It may be one of the reasons why CDGI have been isolated and unable to network and interact more with the entrepreneurs.
<table>
<thead>
<tr>
<th>Instrument</th>
<th>Type</th>
<th>Incentive</th>
<th>Strengths</th>
<th>Weaknesses</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main instrument</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulatory</td>
<td>Ban with penal action for non-compliance (relocation, closure)</td>
<td>Threat of penal action</td>
<td>• Judicial intervention: Backed and triggered by Supreme Court’s decision to protect the Taj Mahal</td>
<td>• Ban without proper infrastructure</td>
<td>Successful: Fuel switch in 145 units (out of 410 in TTZ) has or is likely to occur (others face threat of relocation or closure)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Precedence of penal action – closure of iron foundries operating on coal/coke in Agra (part of the TTZ)</td>
<td>• Focus on fuel switch not efficiency</td>
<td>• Lack of dynamic incentive: No pressure for continued innovation; complacency after switch is made</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Enforcement</td>
<td></td>
<td>Failure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Leniency vis-à-vis SSI units in Agra</td>
<td>• Relocation finds no takers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other instruments</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic</td>
<td>Subsidies (like credit-linked subsidy scheme)</td>
<td>Opportunities</td>
<td>• For financial support</td>
<td>• Bureaucratic procedures, conditions and formalities</td>
<td>Failure: Limited reach</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Logistical constraints (offices of SIDBI and UPFC not in Firozabad)</td>
<td>• No real help during the transition</td>
</tr>
<tr>
<td>Suasive</td>
<td>Capacity building – Institute exclusively for development of the industry</td>
<td>Opportunities</td>
<td>• For technical support</td>
<td>• Mismatch between environmental and support objectives</td>
<td>Failure: CDGI known as a “white elephant” among glass makers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• For training</td>
<td>• Little interaction between local entrepreneurs and the CDGI staff</td>
<td>• Unable to win industry confidence or help in transition</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Pilot technology not replicated</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Training programmes not well attended</td>
</tr>
</tbody>
</table>
7.4.2.3 Period between 1996 and 2004

This period witnessed significant change following the strong regulatory incentive provided under the ban on coal. These changes were in terms of fuel switch rather than energy efficiency. However, due to reasons such as delay in setting up the gas distribution network, resistance from the entrepreneurs (owing to uncertainty, lack of technical know-how), and the review petitions filed in the Supreme Court by various stakeholders, the actual enforcement of the ban has been slow over the years.

Switch-over to natural gas. Initially, there was strong resistance by the entrepreneurs to the switch-over. But once the actual operations started more entrepreneurs began to get interested in switching over. Here, the regulatory incentive was made stronger when combined with economic motive as use of natural gas reduced production costs. As of early 2004, 91 units have gas supply and another 54 have an agreement with GAIL for the supply of gas (Table 7.4).

Technical change The majority of changes in the glass units was brought about locally by simple modifications of the traditional technology, and often was not based on technical considerations. These leave significant scope for energy efficiency improvements (see Section 2.5). Most closed-pot furnaces that had switched to gas converted to the conventional open-pot furnaces (TERI 2000).

The fuel switch has reduced production (fuel) costs, led to improvement in quality of products (more significantly for glass items, which has contributed towards increase in their exports), and better working conditions. On the other hand, it has also led to an increase in production (because the allocation of natural gas is fixed for the units, the production is no longer flexible, especially in the case of bangles). In addition, many tank owners have started making bangles (earlier made largely by the open-pot units), and closed-pot units have converted to open pots – again adding to the production (and eating into the market of the smaller unit owners). Increasing production has also been a major factor in the decline in the prices of glass products in

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212 Also see (Rajalakshmi 2000).

213 In the first phase of registration by GAIL, gas was allocated to 64 units (24 tank, 30 open-pot and 10 closed-pot furnace units). In the second and third phases, 16 and 6 units were given gas respectively.

214 The main advantage of closed pot is that the glass is protected from soot and ash arising during coal combustion. When natural gas is used, the glass products do not need protection as much.

215 The fuel costs have come down by 30–50% (survey figures and interview 3. Firozabad. 2002)

216 In 1997–98, only five units were making direct exports of about Rs 62.6 million. In 2001–2002, the number of exporting units rose to 26, and the quantum of exports rose to Rs 430–470 million (DIC 2002).

217 Earlier, entrepreneurs could adjust production according to market demand, but now they have to more-or-less produce fixed amounts irrespective of the demand since they get (and pay for) fixed amounts of gas.
the local markets\textsuperscript{218}. The associations, however, do play some role in controlling production (for instance, by organizing strikes).

### Table 7.4: Glass units and natural gas

<table>
<thead>
<tr>
<th>Item</th>
<th>Number of units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total units in Firozabad</td>
<td>421</td>
</tr>
<tr>
<td>Units in the TTZ</td>
<td>410</td>
</tr>
<tr>
<td>Units located in the “gas zone”</td>
<td>381</td>
</tr>
<tr>
<td>- Operating on gas</td>
<td>91</td>
</tr>
<tr>
<td>- Not operating on gas but have an agreement with GAIL</td>
<td>54</td>
</tr>
<tr>
<td>Units located in the “no gas zone”</td>
<td>29</td>
</tr>
<tr>
<td>- Tank furnace</td>
<td>5</td>
</tr>
<tr>
<td>- Pot furnace (open and closed)</td>
<td>24</td>
</tr>
</tbody>
</table>

Source: DIC 2002b

Main technology initiatives: Initiatives were undertaken by various organizations to introduce cleaner technologies (e.g., efficient melting furnace design), but they came in late and have not found any real takers. The main initiatives in this regard are:

One, the CDGI has been involved in developing better designed furnaces. However, there has been hardly any actual implementation of these designs in the cluster. In the two units where the energy-saving measures (process control software) were introduced, a reduction in fuel use by 18–22% has been reported (UNIDO 2002).

Two, the Swiss Agency for Development and Cooperation (SDC) initiative has set up an open-pot furnace demonstration unit with energy consumption that is 58% less than the conventional coal-based furnaces (implies a reduction of about 1300 tonnes of coal equivalent and 1850 tonnes of CO\textsubscript{2} per annum). The furnace is also 35% more efficient than the conventional gas furnaces (Chand and Krishnan 2000). The unit (first based on oil in 1999 and then on natural gas in 2000), however, failed in its objective of being a “demonstration project” as only very few entrepreneurs have actually seen it. On the other hand, it does bring out the potential for energy efficiency improvements for the cluster. In another development under this initiative, a demonstration gas-fired muffle furnace was also set up in 2001 that is almost 30–40% more energy efficient than the conventional coal-based furnaces (TERI 2002).

7.4.2.4 Beyond 2004

At present, 145 units, of the 381 located in the gas zone, have or will be provided natural gas for their operations. For allocation of gas from GAIL, units require a registration and no-objection certificate from the DIC. They are charged a fixed security deposit as fees for laying the pipeline and for metering\textsuperscript{219}. The procedure has favoured

\textsuperscript{218} According to some entrepreneurs (also Interview no. 1. Firozabad 2002), at the time of the field study, the price of glass bangles was Rs 42 per tora (a set of about 300 bangles) as compared to Rs 58 per tora two years before. Similarly, price of plain glass tumblers had declined from Rs 60 to Rs 30 per dozen in two years.

\textsuperscript{219} Interview no. 11. GAIL, 2002; and Interview no. 9. DIC. 2002.
the bigger units who were able to get the connection more easily, and generally the smaller units find it more difficult to get the connection. In addition to this a large component of units, i.e., the muffle units, has been left out.

There is no provision of gas for the muffle units as of now (as their gas requirement is small, they are not registered and many lie in the no-gas zone). The working conditions are bad but can be considerably improved by using a gas-based furnace. Some of the bigger glass unit owners, who have been allotted natural gas for their tank/pot furnaces, are now *sub-letting* portions of their space (and natural-gas allocation) for muffle operations. Also, muffle-unit owners are trying to form *cooperatives/societies* so that they can collectively file for natural gas connections. At present, seven societies of muffle owners have been registered with the DIC. However, registration of new cooperatives is time-consuming, and whether these will be allocated gas connectivity is still questionable (as supply of gas has been fixed).

The glass units that continue to use coal and do not have gas connections do face an uncertain future. “*Jab tak chal raha hai theek hai*” (till it is going on, it is okay with us) some of them say. But this “wait-and-watch attitude” does show uncertainty in the current scenario. These units will keep using coal, but for how long (with the ban on coal, and energy costs for the coal-fired units being on average about 30–40% more than the gas-fired units)? They will eventually have to *close down or relocate/shift out of the TTZ*.

Alternatively, in a more optimistic scenario, the energy needs of the cluster may be met more effectively if the infrastructure is developed such that natural gas supply to the cluster is increased (or may be even use of renewable energy); energy efficiency of the existing units is improved; and/or the conditions in the new industrial area are made more conducive for the units to shift there. However, this will also depend a lot on the contextual factors discussed in the next section.

Thus, the main implications of the environmental policy have been the following:

1. The environmental policy has been a driver in bringing in technological change (fuel switch) by providing a direct incentive for the entrepreneurs. The change has resulted in the improvement in environment (local – SO$_2$, SPM; and global – CO$_2$ emissions) and working conditions. However, there is still significant potential for further improvement. Most of the changes have been brought in without the use of economic instruments or technical support from the CDGI. The conversions also indirectly impact the market conditions.

2. Coal is still being used in the cluster despite the ban and the related developments. It is used not only in the coal-based units, but also in some of the units that have gas connections.

3. For the natural gas-based units, there is little regulatory incentive for further change (or no dynamic incentive). As far as they are concerned, they have made the switch to natural gas and have done what was required. Thus, even though there exists significant potential, the current policy does not provide them incentive for undertaking any further change.

4. The units without gas (those located in the no-gas zone or those without access or commitment for gas) face threat of relocation or closure. For the muffle units,
there is no clear policy as yet (they are normally unregistered but are important for the production process). On the other hand, the policy has also led to other developments like emergence of subletting and cooperatives.

Overall, the policy incentive has been strong enough to force a substantial change. However, there are differing perceptions regarding the policy development process itself. There are still doubts on whether the cluster should have been included in the TTZ at all, should the SSIs be the major targets of regulatory pressures, and the manner in which the policy has evolved. For instance, (i) little consideration was given to gas supply and capacities of different units, and (ii) no technical solutions were available to the industry to make the switch-over from coal when the ban was imposed. In addition, as the city has numerous power cuts, use of diesel generators, and the transport situation (Varadharajan Committee Report 1995) adds to the local pollution; the SPM levels are still high in the TTZ (CSE 2000a, b). It was suggested that a better alternative would have been to improve infrastructure or even set up a natural gas-based power station instead of directing the coal-based SSIs to close down in the first go.

7.5 Contextual factors affecting cleaner technology diffusion

This section deals with factors that affect diffusion of cleaner technologies in the cluster (Table 7.5). In this regard, there are differences in perceptions of the entrepreneurs and other stakeholders (Table 7.6).

7.5.1 Environmental factors

Proximity to the Taj Mahal has forced awareness and concern for the local environment within the cluster (though the global environment is not yet an issue for the local actors). The need for better working conditions, safety and pollution control is a driver for diffusion of cleaner technologies. Improvement in working conditions and other benefits with the use of natural gas also demonstrated additional benefits (other than the environmental benefits) of a cleaner technology. In spite of this, however, environmental concerns remain a low priority for entrepreneurs.

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220 This issue came up in several interviews. A common reason is that the Supreme Court’s order for TTZs specifies that the brick kilns within 20 kms from the Taj Mahal and all unregistered kilns in the TTZ should shut down. However, in the case of glass units all the coal-based units in Firozabad, which is 40 kms from Agra, have to close. In 1992, the government even commissioned a study (NEERI 1993) to look into the need for redefining the TTZ.

221 There is also the question of distribution of natural gas. The gas connections are given based on a fixed amount, and are used by entrepreneurs for the production processes as well as for electricity generation, subletting, etc. The cost of natural gas to the cluster is considered to be high as compared to some other consumers along the same gas pipeline.
7.5.2 Organizational factors

The units across the cluster are old, with technologies passed on from one generation to the next. Normally, the smaller units are operated by entrepreneurs with inadequate managerial and marketing skills (there are only a few large units with proper marketing and management in place), and with flexibility in production.\(^{222}\) No unit has any certification (e.g. ISO), though a few are now planning to apply. Many entrepreneurs are dependent on their workers for technical inputs and advice. However, they do not invest much in capacity building since a majority of the workers are employed on contract and are not permanent employees. On the other hand, the contract workers do in some cases take information from one unit to the next where they are employed.

7.5.3 Economic factors

**Finance:** As most entrepreneurs work with limited capital and at low profit margins, their financial capability is limited (this may not be the case for the large unit owners like the tank units). They are unlikely to invest in cleaner technologies unless they are convinced of the benefits\(^{223}\). Even if they are, they still may not invest due to unavailability of low-cost finance or if the upfront cost is too high\(^ {224}\). The financial support available is limited despite the increasing opportunities owing to the interest among the local, national and international agencies and initiatives in the TTZ. Most of the financial needs of the industry are still met either through local banks or usually through their own resources.

\(^{222}\) Flexibility in production has declined with natural gas use. With coal, owners worked mostly on credit. With gas, they have to keep the units running as they pay a fixed minimum fuel charge.

\(^{223}\) There was strong resistance to the policy to switch over to natural gas initially. But with the demonstrated benefits in terms of cost savings, more entrepreneurs want to work with gas.

\(^{224}\) For instance, the payback period for the pot furnace under the demonstration project is 3–5 years, but the capital cost is about 5 times more, which is a strong barrier for the entrepreneur.
Table 7.5: Contextual factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Driver</th>
<th>Barrier</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>• Proximity with Taj Mahal forcing environmental awareness</td>
<td>• Limited awareness and traditional practices.</td>
<td>• Increased awareness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Old, family-owned, informal units (few big/automated units) with flexibility in working.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Limited managerial and marketing skills (one-man show usually).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No product/process certification</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reliance on workers and contract workers</td>
<td></td>
</tr>
<tr>
<td>Organizational</td>
<td>• Skills: Production skills, availability of skilled workers</td>
<td>• Limited awareness and traditional practices.</td>
<td>• Limited marketing and management skills</td>
</tr>
<tr>
<td></td>
<td>• Workers: Contract workers (as carriers of knowledge)</td>
<td>Old, family-owned, informal units (few big/automated units) with flexibility in working.</td>
<td>• Limited capacity building of workers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Limited managerial and marketing skills (one-man show usually).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• No product/process certification</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reliance on workers and contract workers</td>
<td></td>
</tr>
<tr>
<td>Economic</td>
<td>• Reduced production cost with natural gas use</td>
<td>• Economic capability low</td>
<td>• Economic capability low for many units</td>
</tr>
<tr>
<td></td>
<td>• Interest of multilateral, national, local agencies increasing</td>
<td>• Limited financial support</td>
<td>• Economic support limited</td>
</tr>
<tr>
<td></td>
<td>opportunities for financial support</td>
<td>• Market uncertainty and conditions (overproduction, competition, demand situation)</td>
<td>• Competition a driver for tank units.</td>
</tr>
<tr>
<td></td>
<td>• Increased market competition</td>
<td></td>
<td>• Market uncertainty a barrier for smaller bangle units</td>
</tr>
<tr>
<td>Technological</td>
<td>• Existing local technological skills, capability</td>
<td>• Dependence on traditional knowledge</td>
<td>• Technological skills limited</td>
</tr>
<tr>
<td></td>
<td>• Technical support may be available due to technical institutes,</td>
<td>• Low technical capability (access, know-how)</td>
<td>• Technical support limited</td>
</tr>
<tr>
<td></td>
<td>consultants and demonstration projects</td>
<td>• Technical support is limited (demonstration projects are captive; no help from technical</td>
<td>• Perceived natural gas benefits a</td>
</tr>
<tr>
<td></td>
<td>Perceived benefits of natural gas use like reduced production costs,</td>
<td>institute, associations; consultants are expensive)</td>
<td>a driver</td>
</tr>
<tr>
<td></td>
<td>improve quality and better working conditions</td>
<td>• Infrastructural constraints: associated with natural gas, unreliable power supply</td>
<td>• Infrastructural constraints a barrier</td>
</tr>
<tr>
<td>Social</td>
<td>• Networking: Collective efficiency (joint action, subletting)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Culture: involvement of younger generation (IT, techniques)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Attitudes: Motivation, attitudes, mindsets</td>
<td>• Attitudinal constraints</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Networking: Limited interaction (weak associations, competition)</td>
<td>• Limited networking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Culture: Dependency on the industry; entrepreneurs suspicious of government</td>
<td>• Social, cultural, political significance a driver</td>
</tr>
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</tbody>
</table>
**Market:** The market situation presents both a driver and barrier. There is significant market potential for glass bangles and items that are a driver for the entrepreneurs. However, competition has been increasing from other units within the cluster (increased production), from alternative materials such as plastic (e.g., metallic and plastic bangles and other items are also becoming popular as they last longer), as well as products from other countries (like Chinese glass items) (Dutt 2000). There is hardly any product differentiation across the units, as almost all produce similar kinds of products. On the one hand, competition is a driver towards energy efficiency. On the other, market uncertainty (due to overproduction, unstable demand) is also a barrier.

### Table 7.6. Most important constraints perceived by various stakeholders

<table>
<thead>
<tr>
<th>Actor</th>
<th>Main potential factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big unit owners (with gas)</td>
<td>Rules and procedures</td>
</tr>
<tr>
<td>Small unit owners (with gas)</td>
<td>Natural gas pricing (and inflexibility)</td>
</tr>
<tr>
<td></td>
<td>Competition (and market conditions)</td>
</tr>
<tr>
<td></td>
<td>Limited finance</td>
</tr>
<tr>
<td>Unit owners (without gas)</td>
<td>Infrastructure and availability of fuel</td>
</tr>
<tr>
<td></td>
<td>Government rules and procedures</td>
</tr>
<tr>
<td></td>
<td>Limited finance and technical support</td>
</tr>
<tr>
<td>Glass-making units (association)</td>
<td>Natural gas pricing</td>
</tr>
<tr>
<td>Bangle-making unit (association)</td>
<td>Marketing and demand conditions</td>
</tr>
<tr>
<td></td>
<td>Labour issues</td>
</tr>
<tr>
<td></td>
<td>Limited finances and technical know-how</td>
</tr>
<tr>
<td>Technical institute</td>
<td>Lack of motivation/willingness of entrepreneurs</td>
</tr>
<tr>
<td>Consultancy organization, NGOs</td>
<td>Lack of interaction and competition</td>
</tr>
<tr>
<td></td>
<td>Limited government initiatives</td>
</tr>
<tr>
<td>Government departments</td>
<td>Lack of motivation of entrepreneurs</td>
</tr>
</tbody>
</table>

Almost all the units are dependent on the local market or agents, with very few units that have their own marketing networks\(^\text{225}\) or use the marketing support provided by the associations or government. There are various stages through which the bangles go both during production and marketing, which makes the profit margins smaller.

#### 7.5.4 Technological factors

Costs associated with the cleaner technology\(^\text{226}\) do pose a barrier as most entrepreneurs are averse to taking risks. They have a “wait, watch and copy” attitude, and are more comfortable with simple and less costly technologies that can provide them

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\(^{225}\) Only some of the bigger units (maybe 6–7) have their marketing networks. As per the survey results only about 35% of the units actually sell their products outside Firozabad.

\(^{226}\) For instance, the demonstration technology leads to more than 30% fuel savings, but costs 5 times more.
flexibility of operations (many cannot afford or do not feel the need to hire qualified technical consultants).  

With natural gas use, awareness has been created regarding the benefits of cleaner technologies and fuels. After the initial resistance, the entrepreneurs, including the small muffle unit owners (or operators), want to shift over to gas (even though initial costs are high). Non-availability of natural gas supply poses a barrier in this case. Some small unit owners also face problems due to natural gas allocation and pricing, as they have to make a fixed monthly payment for the gas supply and do not enjoy the flexibility they had before. On the other hand, GAIL emphasizes the problem of overdrawing of gas by the glass units above their allocation (for which there is no real penalty).

**Technical knowledge**: The majority of modifications in the technology are brought in by the workers or by entrepreneurs themselves. Almost all the entrepreneurs agree that technical know-how is a major constraint (Figures 7.3, 7.4). A few big tank unit owners, on the other hand, are exploring possibilities for improving technology based on experiences in other countries.

Basically, although opportunity exists, there is little technical support available, including that from CDGI – the institution specially developed to provide support to the industry. Entrepreneurs say that there is need for practical knowledge – the CDGI model is not practical. However, there has been little interaction between the various institutions, support agencies and the entrepreneurs. The TERI model on the other hand is costly, and has not really been “demonstrated” across the cluster. The training provided in some cases by the CDGI or DIC is usually not well attended and according to those who have attended not needs-based.

### 7.5.5 Social factors

The cluster is the main livelihood for the town’s population. Its development is therefore important for the authorities and people alike (it also makes strict enforcement measures by the authorities difficult given their social and political ramifications – especially their influence on the votes (e.g., see Raguram 1996). Another constraint is the lack of motivation of the entrepreneurs – not only to make technological changes but also to avail the opportunities (e.g. government schemes

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227 For example, the burners in the demonstration unit cost Rs 40,000. Other good burners cost about Rs 50,000. The units copy them and claim to make them in just Rs 20,000 (Interview at the demonstration unit).

228 Earlier most of the coal was bought on credit, which is no longer the case with natural gas. In case of non-payment for gas, an interest rate charged. On exceeding a stipulated time period, gas supply may be cut off.

229 A unit was reported to be overdrawning as high as 110% (Interview no. 11. GAIL. 2002)
Many of them have limited technical knowledge and short-term perspectives, and are constrained by the procedures in availing these incentives as well as limited information. Fixed mindsets of the various stakeholders including the workers are all barriers. With the involvement of the younger generation, however, new concepts and skills are being introduced (e.g. information technology).

**Figure 7.3.** Factors affecting adoption of technologies at the unit level

Grades – 1: not important, 2: slightly important, 3: important, 4: very important, and 5: most important (based on survey results – perspectives of entrepreneurs)

There is limited interaction between the entrepreneurs (not socially, but for exchange of information, etc.); they see themselves as competitors. Though the associations do provide a platform, it is used to discuss administrative matters (raw materials, strikes, and political issues) rather than for exchange of technical information. In some cases, they are based on religion or common social interests rather than economic interests. In addition, there is very little interaction between the various institutions, support agencies, government departments and entrepreneurs, as in the case of the DIC and the CDGI in spite of them having several common objectives regarding the development of the cluster.

Thus, there are several contextual factors that together with the policy implications influence SSI–environment interaction. These include not only techno-economic but organizational, social (including political) and environmental factors as well.

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230 Various interviews and Dasgupta 1999.
Figure 7.4: Factors that can encourage adoption of cleaner technologies at unit level

Grades – 1: not important, 2: slightly important, 3: important, 4: very important, and 5: most important (based on survey results – perspectives of entrepreneurs)

7.6 Conclusions

This case study brings out clearly the significance of SSI–environment interaction and the policy implications. The environmental policy by banning coal usage provides a direct incentive for a fuel-switch in the cluster. This coupled with the economic motivation due to reduced production cost with natural gas use has brought in a significant change within the cluster.

Reliance on the use of regulatory instruments on the other hand has restricted the dynamic incentive for diffusion of cleaner technologies. While focusing on switching to a cleaner fuel, it has ignored the energy efficiency aspects (though cleaner fuel is increasingly being used, the energy efficiency still is low across the cluster). The policy has resulted in a number of units switching over to natural gas, however, the coal consumption within the cluster still remains significant. The top-down approach of setting up an institute for technical support has also not been very successful. Thus, there still exists a potential for energy efficiency and thereby CO$_2$ reduction.

Several contextual factors are significant in influencing the cluster. The issues pertaining to units that have or will be shifting to natural gas (like natural gas pricing, marketing of products, etc.) and those still operating on coal (like natural gas availability, relocation possibility, etc.), are different in spite of many common ones (like technical, financial, bureaucratic procedures). These also influence the development and implications of the national policies. In a business-as-usual scenario, it is difficult to expect much change in the current situation as far as cleaner technologies are concerned.
The case study shows that strong regulatory incentive can bring in technological change in which the judiciary also played an important role. On the other hand, top-down approaches (like setting up of high profile technical institutes) do not work unless these really cater to the needs of, and work with, the local industry. This case provides an evidence of how innovative options like subletting, cooperative formation, and in general networking and increased interaction, can be an important means of bringing in cleaner technologies and make economic or business sense as well.
8. Brick cluster in Chandigarh

8.1 Introduction

Brick making is one of the oldest activities in the world. India is the second-largest producer (next only to China), with an annual production of more than 140 billion clay bricks. The activity falls mainly in the unorganized rural sector and is among the largest employment-generating industries in India. It is also a major coal-consuming industry (Chapter 3) and is associated with environmental concerns such as emissions of local pollutants and CO₂, topsoil erosion and deforestation.

The SSI constitutes a seasonal (with production limited to the dry season of 5–6 months in a year) and weather-dependent activity. Based on the soil quality, the brick making regions in India are divided into two zones, which differ in terms of technologies as well as the national policy focus. Zone 1 includes the Indo-Gangetic plains in north and north-eastern India (i.e. from Punjab to Assam), and accounts for almost 65% of the production in India. Zone 2, on the other hand, includes peninsular and coastal areas in the southern and south India (i.e. all states below Uttar Pradesh). This zone accounts for 35% of the brick production, but comprises 70% of the total number of units in the country.

This chapter presents the case study of the brick cluster in Chandigarh, Punjab. Punjab is the largest brick-producing state in Northern India in zone 1. As the brick units are quite scattered and tend to be located in small or micro-clusters, a cluster here is taken as a combination of the micro-clusters located around the Chandigarh city (the units have to be located beyond the city limits). The cluster has experienced technological changes over the last few years largely because of the national policy provisions and related initiatives. Section 8.2 describes the SSI–environment interaction. Section 8.3 discusses the implications of national policy, and Section 8.4 outlines the main contextual factors for the cluster. An additional Section, 8.5, briefly presents the findings of a study undertaken in Pune, Maharashtra in zone 2. As the production methods in zone 1 are quite different from those in the other parts of India, and the second case study allows for a comparison of the two zones. Section 8.6 presents the main conclusions.

An estimated 40,000–50,000 acres of land and 300 million tons of topsoil are used every year for obtaining clay for the bricks (Clancy and Garg 2002; TERI 2000b). The SSI consumes 2.6 million tonnes of wood and 41.6 million tonnes of coal annually, and accounts for 4.5% of GHG emissions in India (PSCST 2001b).
8.2  SSI–environment interaction

8.2.1  Industrial activity

The brick-making production process may be divided into four stages: clay preparation (and winning), moulding of bricks, drying, and firing (Annexure 1). The units are normally located on leased-out lands near clay sources.

8.2.1.1 Cluster profile

The Chandigarh cluster comprises around 100 operational brick units located in four micro-clusters (Table 8.1). Three of these micro-clusters are in Punjab state, while one (in Kakarmajra) is in the state of Haryana. They produce clay bricks and tiles for meeting the local demand (clay brick is the most popular construction material). A few units cater to outside markets as well (other districts in Punjab and Haryana, and neighbouring states of Delhi and Himachal Pradesh). Most units comprise traditional activity for the entrepreneurs (64% of units surveyed were owned by more than one generation). On an average, the age of units is around 15 years (with 30% less than 10 years old), and they provide employment to 150–200 workers each.

Table 8.1. Brick units around Chandigarh

<table>
<thead>
<tr>
<th>Microcluster</th>
<th>District</th>
<th>Total number of units (approximate)*</th>
<th>Number of units surveyed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derabassi</td>
<td>Patiala (Punjab)</td>
<td>45</td>
<td>14</td>
</tr>
<tr>
<td>Parol</td>
<td>Ropar (Punjab)</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Togan</td>
<td>Ropar (Punjab)</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>Kakarmajra</td>
<td>Ambala (Haryana)</td>
<td>30</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>Other (Punjab)</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

*Source*: various interviews

These units may be classified in various ways (e.g. on the basis of size, technology, number of workers, production capacity). However, two classifications are especially relevant – one based on technology, and the second on size. Based on size, the unit categories may be small (production: less than 1 million bricks per year), medium (production: between 1–2.5 million bricks per year) and large (production: more than 2.5 million per year) (Maithel et al. 1999). Availability of alluvial soil in Punjab (as

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232 Chandigarh is the state capital of the two states, Punjab and Haryana (as well as a Union Territory). The brick micro-clusters lie very close (on the outskirts) of Chandigarh city. Though the focus of the case study is on Punjab, Kakarmajra in Haryana is also included as it forms part of the brick cluster in Chandigarh. In addition, to the operational units, there are some non-operational units as well which have closed down their production for the time being. In fact, the Chandigarh Brick Association has approximately 250 members.
in zone 1) makes large-scale production viable; and thereby, the units around Chandigarh are either medium- or large-sized.

8.2.1.2 Technology used

The common kiln technology used for brick making (essentially firing of bricks) in Punjab is the continuous kiln. The continuous kilns, generally used in the medium- or large-sized units, include the Bull’s trench kiln (BTK), the High Draught kiln (HD kiln) and the Hoffman kiln (the latter two are generally more efficient than the BTK). The BTKs may be either moving metallic chimney BTKs (traditional technology) or fixed chimney BTKs (efficient version of the moving chimney BTK). In the Chandigarh cluster, the main technology used is the fixed chimney BTK (in more than 80% units). A few units also use the HD kiln. There is no moving chimney BTK in the cluster, though it was the prominent technology till some years ago (the transition is discussed in Section 8.3). Most units use hand-drying and manual moulding methods during raw brick preparation (very few units have moulding machines).

Table 8.2 provides a comparison of main technologies in India. It may be mentioned here, that in zone 2, scattered and smaller deposits of suitable soil (and availability of building stones and concrete blocks as alternate materials) encourage production in small- and medium-sized units. For these units, intermittent kilns or clamps are used (biomass or coal based), which are the most basic and traditional kilns and less energy efficient than continuous kilns (see Annexure 1).

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233 As per survey figures, 75% of the units are large sized with the average production of around 5 million bricks in one year.

234 Almost all the units in the country employ hand-moulding and sun-drying methods for brick pre-firing stages. Only a few units, about 1% of units in the country, including two–three in the Chandigarh cluster, have installed clay mixing and moulding machines (Damle 2002). Also, there is one highly mechanized unit in the cluster, and it is probably the only one in India with an ISO certification. No other unit has any kind of quality certification.

235 There are some modern kilns used in other countries but they are not appropriate for Indian conditions. For example, the tunnel kilns are modern but they require high degree of mechanization and investment (Maithel et al.).
Table 8.2. Comparison of the main kiln technologies used in India

<table>
<thead>
<tr>
<th>Kiln type</th>
<th>Size  (capacity)</th>
<th>Specific energy consumption (MJ/kg of fired bricks)</th>
<th>Specific fuel consumption (tons of coal per 100,000 bricks)</th>
<th>CO₂ emissions due to coal use (per 100,000 bricks)</th>
<th>Potential SPM in flue gas (mg/Nm³)</th>
<th>Approximate cost of kiln (Rs)</th>
<th>Benefits</th>
<th>Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>More applicable in Zone 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moving chimney BTK</td>
<td>Medium to large</td>
<td>1.2–1.75</td>
<td>20–28</td>
<td>35.2–49.3</td>
<td>500–2000</td>
<td>• Economical</td>
<td>• Chimney needs regular replacement</td>
<td>• High energy use, emissions</td>
</tr>
<tr>
<td>Fixed chimney BTK</td>
<td>Large</td>
<td>1.1–1.5</td>
<td>16–24</td>
<td>28.2–42.2</td>
<td>1200–4200 (without GSC)  100–500 (with GSC)</td>
<td>1,000,000 (for PSCST design)</td>
<td>• Coal saving</td>
<td>• Construction costs</td>
</tr>
<tr>
<td>High Draught Kiln</td>
<td>Large</td>
<td>0.9–1.1</td>
<td>13–16</td>
<td>22.9–28.2</td>
<td></td>
<td></td>
<td>• Coal saving</td>
<td>• Initial and operating costs</td>
</tr>
<tr>
<td>More applicable in Zone 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Technological complexity</td>
<td>• Need power (approx. 5–6 kWh/1000 bricks)</td>
</tr>
<tr>
<td>Clamp kiln</td>
<td>Small</td>
<td>1.0–3.0 (Biomass fired: 1.9–3.0 Coal fired: 1.0–1.75)</td>
<td>32–48</td>
<td>56.3–84.5</td>
<td>Almost zero</td>
<td>• Low costs</td>
<td>• Brick quality not very good</td>
<td>• Energy wastage</td>
</tr>
<tr>
<td>VSBK</td>
<td>Small to medium</td>
<td>0.8–1.0</td>
<td>13–16</td>
<td>22.9–28.2</td>
<td>50–300</td>
<td>1,200,000</td>
<td>• Fuel saving</td>
<td>• Construction and operating costs (esp. compared to clamps)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Better brick quality, work condition</td>
<td>• Only few units operating</td>
</tr>
</tbody>
</table>
8.2.2 Energy consumption and environmental impacts

The brick-making SSI is highly energy intensive and involves use of significant quantities of fuel especially during firing (bricks are fired at temperatures between 600–1000°C).\textsuperscript{236} The main fuel used in the cluster is coal, with each unit on an average consuming 800 tons of coal per production season.\textsuperscript{237} Other energy sources like fuel wood, agricultural residues, and for the HD kiln – electricity, are also used. Energy intensity leads to environmental concerns including local pollutants (such as SPM, CO, SO\textsubscript{2} and CO\textsubscript{2} emissions (CO\textsubscript{2} emissions related to coal use are of the order of 1408 tonnes per season per unit, using the default emissions factor and coal consumption figure). Another major impact (though not related to energy use) is topsoil erosion due to the excavation and use of clay for making bricks. The relevance of the SSI to the environment, on the other hand, is also associated with its potential to contribute towards addressing the problem of fly-ash disposal (by using various combinations of clay and fly ash for making bricks).\textsuperscript{238} This indirectly also means, using less topsoil than otherwise required (thereby, addressing the problem of topsoil depletion). Fly-ash bricks save energy as well.

There are major social issues associated with the cluster as well (Gupta, J 2003; MoLR 1984). First, there are health problems due to the working conditions in the brick units. The workers involved in moulding, raw material mixing, firing and coal sieving encounter respiratory, skin and orthopaedic disorders. These are aggravated by the unhealthy living conditions at the unit sites, and also for the firemen who live in small rooms on top of the kilns.\textsuperscript{239} Secondly, is the issue of child labour (Dwivedi 2001) – children staying at the kiln rarely go to school, and many “help” their parents especially in moulding.\textsuperscript{240} In addition, are issues related to bonded labour – most

\textsuperscript{236} Energy is extensively required during drying and firing of bricks (Zhang 1997). However, as the units mainly rely on sun or natural drying methods, firing is most the energy intensive.

\textsuperscript{237} Interview no. 9. PSCST 2002.

\textsuperscript{238} Fly ash is a by-product resulting from coal combustion in thermal power plants. Over 60% of the power plants in India are coal based that result in 80-100 million tonnes of fly ash each year. Of this, only 10% ash is used (Chand and Krishnan 2000). It is estimated that even if only 20 billion bricks (of the 100 billion produced every year) use 25% fly ash, 15 million tonnes of fly ash can be gainfully utilized, saving 15 million tonnes of topsoil (TERI 2000b).

\textsuperscript{239} They are responsible for feeding coal in the kilns at regular intervals (usually 15 minutes), working 12 hours a day (2 shifts).

\textsuperscript{240} Main reason is that brick making is a seasonal activity. Also, moulders are employed as families (husband, wife and children) and paid on the basis of number of moulded bricks. In Pune, some workers are enrolled in adult education schools, and in a cluster (Sangamner) a school is being run for children of brick workers.
workers are migratory and seasonal\textsuperscript{241}, and are employed as contract labour and in effect are bound by the contract (DA 2003).\textsuperscript{242}

8.2.3 Potential for cleaner technologies

The efficiency of the kiln depends on its design, operating practices (particularly firing), and type and the quality of fuel used.\textsuperscript{243} Only a few units actually run efficiently across the cluster\textsuperscript{244}, and the coal used has high ash content. Use of cleaner technologies can improve energy efficiency and reduce the associated environmental impacts (local pollutants and CO$_2$ emissions).\textsuperscript{245} It can also improve product quality and working conditions, and lower production costs (as fuel costs are 35–50% of the total costs).\textsuperscript{246} The importance of cleaner technologies is even greater considering it is difficult to reduce the other components of the cost (land, labour, raw material).

The technology options include cleaning technologies or pollution control devices (PCDs) such as the gravity-settling chamber (GSC), scrubbers or filters, for reducing local emissions (Box 8.1). Those that lead to energy efficiency improvements (and thereby local and global environmental benefits) or cleaner technologies include: use of more efficient kilns and modifications in design of existing kilns (e.g. more efficient designs of BTKs and HD; and even options like tunnel kilns); use of efficient operational and firing practices (e.g. optimizing coal feeding rate and coal particle size, and reducing air leakages in kilns); use of better quality coal (with lower ash content) or alternative cleaner fuels (industrial wastes, renewable energy); and use of internal fuels (e.g. sustainable biomass, fly ash). Simple changes like constructing sheds can reduce risk of rain (and make annual production feasible), or the way bricks are stacked during firing can reduce wastage and breakages. Improvements in operating practices can help reduce fuel consumption up to 20% in fixed BTKs.\textsuperscript{247}

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\textsuperscript{241} Most workers are migratory – firemen mainly come from Pratapgarh in Uttar Pradesh, while moulders come from Madhya Pradesh and Rajasthan. The local workers work mostly as labourers (for loading, stacking, handling bricks) or transporters.

\textsuperscript{242} Labour laws ban bonded labour and child labour, but they are part of the social system. Some important laws include the Contract Labour (regulation and abolition) Act, 1970; Employees’ Provident Funds and Miscellaneous Provisions Act, 1952, and Interstate Migrant Workmen (regulation of employment and conditions of service) Act, 1979. There have also been suggestions for a separate legislation for brick kilns (Gupta, J 2003; MoLR 1984).

\textsuperscript{243} Type of clay used, moisture content, amount of first grade and rejects obtained are also important parameters that affect performance, but in most cases no information is provided on these subjects making direct comparison between different kilns more difficult (FAO 1993).

\textsuperscript{244} Almost 90% of the units are run inefficiently (Interview nos 1, 9 and 10. Chandigarh 2002).

\textsuperscript{245} Other factors also influence like weight and quality of bricks fired (Maithel et al. 1999).

\textsuperscript{246} These are especially relevant as many stakeholders interviewed felt that, in the coming years, several smaller units will be rendered uncompetitive, with the increasing coal prices and market competition, and will have to close down unless they upgrade.

\textsuperscript{247} Interview no. 1. TERI 2002; and interview no. 9. PSCST 2002.
8.3 National policies

This section discusses the main policy implications of the environmental policy for the brick units around Chandigarh. As in the previous chapter, we begin with describing the organizational structure before discussing the main policy provisions and implications.

<table>
<thead>
<tr>
<th>Box 8.1. Technological options for the cluster</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cleaning technologies</strong></td>
</tr>
<tr>
<td>- Installation of pollution-control devices (e.g. gravity-settling chamber, scrubber, filter)</td>
</tr>
<tr>
<td><strong>Cleaner technologies</strong></td>
</tr>
<tr>
<td>- Operational practices and housekeeping</td>
</tr>
<tr>
<td>- Use of efficient kilns (e.g. HD/Hoffman, tunnel kilns)</td>
</tr>
<tr>
<td>- Modifications in designs of existing kilns (e.g. efficient BTK)</td>
</tr>
<tr>
<td>- Use of better-quality or cleaner fuels (better-quality coal, renewables)</td>
</tr>
<tr>
<td>- Use of internal fuel (e.g. fly ash)</td>
</tr>
</tbody>
</table>

8.3.1 Organizational structure

The organizational structure for policy making and implementation in the cluster is provided in Figure 8.1. The central government frames the national policy and strategy for the SSIs (Chapter 5) within which the Punjab state government designs its own policies and initiatives, and extends the incentives through its implementing agencies. Brick kilns, however, are unique in the sense that unlike other SSIs, they can be installed and operated on getting a license from the Department of Food and Supplies (DoFS), Punjab. For obtaining this license, one of the conditions is to have a no-objection certificate from the Punjab Pollution Control Board (PPCB). The department, however, does not have promotional functions for the kilns. The labour laws (especially those related to bonded and child labour) also bear a significant relevance for the SSI.

For financial support to SSIs, the apex institution is the Small Industries Development Bank of India (SIDBI) at the national level, and the Punjab Financial Corporation (PFC) at the state level. It is only the mechanized brick kilns that normally qualify for direct financing from the PFC; while the brick kilns based on hand-moulding and sun-drying methods are not eligible. Specifically for them, the Khadi and Village Industries Commission (KVIC) provides financial support including soft loans through the Punjab KVI Boards.

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248 SSIs occupy an important position in the development of the state. There are presently more than 0.2 million SSI units, employing more than 0.8 million workers and constituting a vital and dynamic segment of industry. The units include bicycles, sewing machines, agricultural tools, medical instruments, hosiery, machine tools and sports goods (www.punjabgovt.nic.in).

249 Earlier, the supply of coal to the brick kilns was regulated and the units were registered with the DoFS. Even with deregulation of coal, brick units remain under the purview of the department.
Photo 8.1: Brick cluster near Chandigarh

Photo 8.2: Conventional Bull trench kiln with a moving chimney
**Photo 8.3a:** Stacking of bricks in a conventional clamp kiln

**Photo 8.3b:** A vertical shaft brick kiln
Photo 8.4: Mixing of clay for preparing bricks

Photo 8.5: A girl carrying bricks for stacking them in a clamp
**Photo 8.6:** A Bull trench kiln with fixed chimney

**Photo 8.7:** A high draught brick kiln
Technical organisations

The main organisations associated with technology development in the cluster are the Punjab State Council on Science and Technology (PSCST) in Chandigarh, which functions under the aegis of the Department of Science, Technology and Environment of the state government, and the Central Building and Research Institute (CBRI) in Roorkee in Uttaranchal state, which undertakes research and development activities for the building industry. While PSCST has been involved with developing and disseminating an “efficient” design of BTK with fixed chimney (with GSC), the CBRI was responsible for indigenously developing the HD kiln.

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Figure 8.1: Organizational structure for the brick SSI

Brick Associations

The brick association at the national level is the All India Bricks and Tiles Manufacturers’ Federation (AIBTMF). The AIBTMF takes up issues of the industry with the government and concerned regulatory bodies, and is linked to the lower level associations. The other relevant associations include the Punjab Brick Manufacturers’ Association (PBMA) at the state level, the Chandigarh Brick Association (CBA) at the cluster level, and associations at the district and micro-cluster levels.

8.3.2 Environmental policy

The environmental policy for the brick SSI is largely regulatory, and is implemented at the state level by the PPCB. As mentioned before, the environmental aspects of the brick industry are significant. These got translated within the national environ-
mental policy in the mid-1980s, and started to gain importance especially following the writ petitions filed by Mr M C Mehta, which also led to closing down or relocation of the brick units in Delhi and Agra (Delhi land use; and protection of Taj Mahal cases). The brick units are to be located beyond the city limits.

First emission standard for SPM level:
•1000 mg/Nm$^3$ for small kiln capacity:<15,000 bricks per day (less than 4.5m trench width)
•750 mg/Nm$^3$ for medium kiln capacity:15,000-30,000 bricks per day (4.5-7.0 trench width)
•750 mg/Nm$^3$ for large kiln capacity:>30,000 bricks per day (more than 4.5m trench width)

Ban on moving chimney BTKs: Existing kilns to be dispensed by December 31, 1997
All units within a radius of 50 kilometers (km) from any thermal power plant, shall utilize fly ash in optimal proportion

Ban on movable chimney BTK: Extension till June 30, 2001
Ban on movable chimney BTK: Extension till June 30, 2002

Figure 8.2: Timeline related to environmental policy for the cluster

8.3.2.1 Incentives

The focus of the national environmental policy is on regulatory instruments: (i) emission standard for the kilns (set under the umbrella legislations – Air Act and Environment Act), and (ii) regulation for the promotion of use of fly ash (Figure 8.2). While the former targets and provides incentive for process changes, the latter deals with both process and product change. The need to regulate the use of topsoil is also recognized by imposing a “royalty” (tax) on the soil excavated as a deterrent towards over-exploitation.

Emission standard and ban on moving chimney BTKs

The MoEF notification in 1996 introduced the emission standard for SPM level. It specifies the SPM level limit of 750 mg/Nm$^3$ for medium- and large-sized kilns (Gazette of India, Extraordinary, Part III – Section 3 – subsection (i), April 1996). Although the regulation emphasized only the limits on the SPM level, generation of SPM (as well as the CO$_2$ emissions) is closely linked to the energy efficiency of the kilns. The notification recommends meeting the standard by installing fixed chimney
BTKs, HD and/or PCDs (such as the GSC), and imposes a ban on the use of moving chimney BTK. The notification had defined a time limit (up to 31 December 1997) for the existing moving chimney BTKs to convert to fixed chimney BTKs or HD kilns. Subsequently, however, based on representations by the AIBTMF, the MoEF has been granting extensions by which the deadline has been extended. These revisions are subject to furnishing affidavits and submitting bank guarantees to the respective state PCBs for completing the conversion in the prescribed period.

**Promotion of the use of fly ash**

The MoEF notification of 1996 also provided that the brick-making units within the radius of 50 kms from any thermal power plant shall utilize fly ash in ‘optimal’ proportion. This would help to address problem of fly-ash disposal as well as topsoil depletion. Further, in 1999, MoEF prescribed the ‘means’ of utilizing the fly ash (mixing at least 25% ash – fly ash, bottom ash or pond ash – with soil by weight), and restricted excavation of topsoil, for the units within a radius of 50 km of a thermal plant (*Gazette of India, Extraordinary*, Part II, Section 3, Sub-section (ii), 14 September 1999). In case of non-compliance, the consent order issued to establish the kiln and/or its mining lease could be cancelled. The stipulation, however, could be modified (waived/relaxed) by the state government in case of non-availability of ash from power plants in sufficient quantities.

### 8.3.3 Policy implications

There had hardly been any change in the technology over the years till the mid-1990s. The policy notification in 1996, initiated changes with respect to diffusion of the BTK with fixed chimney. Punjab is amongst the states where the largest number of fixed chimney kilns have been constructed (the other states being Haryana, U.P., Rajasthan and West Bengal; limited largely to selected regions in the north-western parts of India). However, there are still a large number of units that have not installed any PCD or are still using the moving chimney BTK (Table 8.3). In some areas, new moving chimney BTKs are also coming up despite the regulations. As regards the MoEF notification, enforcement has been weak; and though some units have been set up in which fly ash is used, its use is still very limited (states where units have come up include Orissa and Andhra Pradesh). In Chandigarh, however, significant change has been experienced (as mentioned before) – none of the units use the moving chimney BTK any longer, and all units have switched over to either a fixed chimney BTK with GSC or the HD. There has, however, been less significant change with using fly ash as per the notification. (Table 8.4).

**8.3.3.1 Incentives and their effects**

*Regulation – emission standard and ban on moving chimney BTK*

Prior to 1996, there was little change in the technology in the cluster used over the years with no real policy incentive or pressure to make a change. The first fixed chimney BTK (also known as the Beant chimney BTK) was installed in the region in
the 1980s, but its diffusion was slow in spite of the potential advantages it offered, and the moving chimney BTK remained the main technology. 

**Table 8.3**: Some indicators related to the brick industry

<table>
<thead>
<tr>
<th>Kiln type</th>
<th>Chimney type</th>
<th>PCD</th>
<th>Total number</th>
<th>Production per season (million)</th>
<th>Fuel consumption per 100,000 bricks (tonnes)</th>
<th>CO₂ emissions per 100,000 bricks (tonnes)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Coal</td>
<td>Wood</td>
</tr>
<tr>
<td><strong>India</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BTK</td>
<td>Fixed</td>
<td>GSC</td>
<td>9194</td>
<td>3.7</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>BTK</td>
<td>Fixed</td>
<td>None</td>
<td>10217</td>
<td>3.8</td>
<td>16.0</td>
<td></td>
</tr>
<tr>
<td>BTK</td>
<td>Moving</td>
<td>None</td>
<td>12444</td>
<td>2.7</td>
<td>15.9</td>
<td></td>
</tr>
<tr>
<td>HD/Hoffman</td>
<td>Fixed</td>
<td>-</td>
<td>549</td>
<td>1.6</td>
<td>14.8</td>
<td></td>
</tr>
<tr>
<td>Clamps</td>
<td>-</td>
<td>-</td>
<td>58086</td>
<td>0.6</td>
<td>16.6</td>
<td></td>
</tr>
<tr>
<td><strong>Punjab</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BTK</td>
<td>Fixed</td>
<td>GSC</td>
<td>2020</td>
<td>5.3</td>
<td>13.5</td>
<td>1.0</td>
</tr>
<tr>
<td>BTK</td>
<td>Fixed</td>
<td>None</td>
<td>410</td>
<td>4.7</td>
<td>15.0</td>
<td>1.5</td>
</tr>
<tr>
<td>BTK</td>
<td>Moving</td>
<td>None</td>
<td>50</td>
<td>4.5</td>
<td>17.0</td>
<td>2.0</td>
</tr>
<tr>
<td>HD/Hoffman</td>
<td>Fixed</td>
<td>-</td>
<td>20</td>
<td>4.9</td>
<td>12.0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Notes: PCD: pollution control device – the GSC (gravity-settling chamber) ** Own calculations for emissions only from coal combustion, using CO₂ emission factor for coal in India – 1.76 kg/kg (ALGAS 1997).

Source: (PSCST 2001a) based on a countrywide survey.

The post-1996 period saw rapid changes in light of the environment policy, and the enforcement initiatives of the state government. Between 1996 and 1998, the shift from the moving to fixed chimney in some units, and modifications in fixed chimney BTKs in others, was initiated. However, most of the changes were brought about by local “mistries” (or the kiln constructor), who generally provided the traditional design that has significant scope for improvement especially related to the installation of a proper PCD. In this regard, therefore, two important initiatives related to technology development of more efficient kiln designs (that also met the emission standard, one involving PSCST and the other involving CBRI) were started to assist in compliance. Subsequently, after 1998, there were increased conversions to ‘efficient’ design BTK of the PSCST, and in a few cases to HD kiln of the CBRI. 

In this period, the PBMA approached the PSCST for providing air pollution measures for the cluster (and other units in Punjab). The PSCST found out that the pollution load in terms of SPM levels of the units around Chandigarh was between 1200–4200 mg/Nm³ (more than the prescribed emission standard), and started getting involved in developing and disseminating an ‘efficient’ design of BTK that met the emission norm. It was in 1998 that the PSCST in collaboration with M/s Priya Bricks set up the first efficient kiln design. It quickly became popular in the cluster, and the design is being replicated in several units around Chandigarh even as of 2006.
### Table 8.4: Policy implications for the cluster

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Type</th>
<th>Incentive</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main instruments</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulatory</td>
<td>Emission standard and ban on moving chimney BTK</td>
<td>Threat of penal action, Availability of technology option approved by government (Reduced bureaucratic procedures in obtaining clearances + technology package offered by PSCST)</td>
<td>Threat of penal action, Availability of technology option approved by government (Reduced bureaucratic procedures in obtaining clearances + technology package offered by PSCST)</td>
</tr>
<tr>
<td>Regulation for fly ash use</td>
<td>Threat of penal action, Indirect incentive (free provision of fly ash by power stations; less clay use and thus less royalty)</td>
<td>Enforcement very weak with little action from state departments</td>
<td>Enforcement very weak with little action from state departments</td>
</tr>
<tr>
<td><strong>Other instruments</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suasive</td>
<td>Capacity building</td>
<td>Opportunity for training, technical support</td>
<td>Opportunity for training, technical support</td>
</tr>
</tbody>
</table>
The importance of the initiative lies not only in developing but also efforts taken for disseminating the technology.\textsuperscript{251} The SPM level on an average from a PSCST designed kiln is 369 mg/Nm\textsuperscript{3} (meets emission norm).

At the same time, the CBRI, on the other hand, was approached by the AIBMTMF to develop a suitable design of fixed chimney suitable to meet the emission standards (for brick kilns across India). The importance of this initiative also lies in the effort of the AIBMTMF to approach a technical research institute for technology development (the HD kiln design with GSC was thus developed).\textsuperscript{252}

In addition to these, another important development was SDC’s (Swiss Agency for Development and Cooperation) initiative: the ‘\textit{India Brick Project (IBP)}’.\textsuperscript{253} This project brings together a network of institutions (including the PCSCT) for dissemination of cleaner technologies and providing technical support for the phase-out of moving chimney BTK, and promoting cleaner technologies in India. The main focus, however, is on diffusion of the vertical shaft brick kiln (VSBK), a technology more suited for small and medium units rather than those in Chandigarh. The India Brick Project also focuses on other technologies like improving energy efficiency in existing fixed chimney BTKs kilns.

\textbf{Effect} What is important is that the regulation has been ‘\textit{diffusion forcing}’ and successful in bringing significant change across the cluster. The diffusion of fixed chimney BTK followed a typical S-shaped curve with the acceleration phase being triggered by the introduction of the emission standard (Figure 8.3). In more than 75\% of the sampled units using BTKs, the design provided by the PSCST is being used (installed mostly in 1998–1999). Most of the conversions have been financed by the entrepreneurs themselves (though PSCST is a government agency, the consultancy was not offered at a discounted price, and a fixed consultancy fee was charged). The diffusion of the design may be linked to three major reasons:

a) Proximity to the state capital made information dissemination as well as enforcement of the regulations easier than in other regions; and proximity to PSCST made interaction between the entrepreneurs and the institute easier.

b) The design was developed by PSCST and was approved (and therefore indirectly pushed) by the state government (and backed by the PBMA). The PPCB nor-

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\textsuperscript{251} Punjab was probably the only state where a government institution (the PSCST) provided consultancy and design for technology improvement; and the technology has been replicated in about 2500 brick kilns across the country (mainly in North India, particularly in Punjab).

\textsuperscript{252} The HD kiln had been developed by CBRI in the 1970s. At present, there are about 150 HD kilns operating in India. It improved this design to include the GSC. This was probably the first time that AIBMTMF has been involved in efforts for technology development.

\textsuperscript{253} The Swiss Agency for Development and Cooperation (SDC) initiated the India Brick Project (IBP) in 1995. As part of this initiative it introduced in India the VSBK technology (originally Chinese, but adapted to meet Indian conditions). At present, there are about 27 VSBKs in operation in India (in Madhya Pradesh, Maharashtra, Orissa, Uttar Pradesh, Karnataka and Tamil Nadu).
nally awards a no-objection certificate easily in cases in which the units use the PSCST designed kiln (which is needed get the licence to operate from the DoFS).

c) The nature of the PSCST initiative and efforts of their consultancy cell: (a) it provided a consultancy package including technical advice, design and training; (b) for the first time training of the entrepreneurs and the workers was attempted in an organized manner, and (c) it brought in cooperation between SSI entrepreneurs and government agencies (PSCST, PPCB).

![Figure 8.3: Diffusion of kiln technologies in the cluster](image)

Takers for the CBRI design, on the other hand, have been fewer (though it is more energy efficient than BTK, is state-government approved, and had the AIBMF backing). This may be because of the nature of the HD kiln technology itself (it is more costly, needs power, etc.), and also logistical factors (PSCST is in Chandigarh, and therefore more accessible and reliable; and its efforts in disseminating the technology).

Thereby, energy efficiency improvements were brought in, and this has led to a decline in the related emissions across the cluster. As per PSCST estimates, there have been benefits in terms of 10% of coal savings (Rs 0.2 million per season in monetary terms), and increase in output by 10–15% for an average capacity kiln. Although most entrepreneurs were not able or willing to give exact figures, one entrepreneur reported that the changes in energy consumption recorded by him in his unit were as follows:

- Moving chimney BTK: 23–24 tons of coal consumed per 100,000 bricks;
• Fixed chimney BTK (traditional): 22 tons of coal consumed per 100,000 bricks; and
• Fixed chimney BTK (PSCST design): 18–20 tons of coal consumed per 100,000 bricks.

While the efficiency of kilns has definitely improved, the sample data reveals that the coal consumption is still high (Table 8.5). Theoretically, the coal consumption in an ideal kiln could be around 9 tonnes per 100,000 bricks (Maithel 2002). The PSCST design aims at coal consumption between 12–14 tonnes per 100,000 bricks. But in the cluster, average coal consumption in the units with PSCST design as against those quoted by the entrepreneurs using other BTK designs is only slightly higher. Even though the data has a margin of error (as it is based on information collected from the entrepreneurs themselves), it does highlight the potential for further improvement and the significance of proper operational and firing practices.

Table 8.5: Average coal consumption by technology type

<table>
<thead>
<tr>
<th>Type of technology</th>
<th>Coal consumption in ton per 100,000 bricks*</th>
</tr>
</thead>
<tbody>
<tr>
<td>BTK (with fixed chimney)</td>
<td>15.83 (14–22)</td>
</tr>
<tr>
<td>High Draught</td>
<td>12.00 (11–14)</td>
</tr>
</tbody>
</table>

*the range is given in parenthesis.

So, why haven’t the units been able to achieve the efficiency that is potentially feasible? One of the reasons is that though there has been a change in ‘hardware’ component of the technology, the basic operating and management practices have remained almost the same. The emission standard though made suggestions for improvements in technology and installation of PCDs, but it did not mention the need for improving operating practices. It thereby laid stress on SPM reduction and end-of-pipe solutions rather than on energy efficiency improvements. There still remains significant scope for improvement in energy efficiency – at least another 10–20% of energy saving can be achieved through proper firing and management practices (PSCST 2001b). Thereby, diffusion of cleaner technology does not necessarily lead to upgrading of technological capabilities, and these too need to be looked at while designing policy prescriptions.254 This has been mainly due to contextual factors as discussed in the next section.

Beyond 2004: The regulation has mixed implications for the future development of the cluster. On the one hand, it does not provide any incentive for further change (dynamic incentive) once the units have installed a PSCST-designed kiln (based on this, they can get the PPCB certificate for 1–10 years, sometimes even 15 years). On the other hand, the level of awareness has increased across the cluster not only due to the enforcement of the emission standard, but also due to the efforts of the state departments including PSCST, and other initiatives under the IBP. Punjab is known for

254 The emphasis is on production capability – skills and knowledge required to run a given production technology efficiently (Lall 1992).
its entrepreneurial skills and the kiln owners here are generally competitive. Rising levels of awareness have made the entrepreneurs realize the importance of cleaner technologies and further changes. In another development, a project proposal is being developed by the GEF/UNDP-India office with its partners for reducing GHG emissions from the brick SSI through capacity building and technology demonstration and promotion (GEF Operational Programme–5). This proposal, if accepted is likely to have a significant impact for the cluster.

However, regarding the regulation itself, many entrepreneurs do feel that the regulations do not take into consideration aspects like soil quality and availability of clay. They see advantages of using a better technology, but also recall facing difficulties during the transition period (especially financial and access to information) and resisting any change in technology (technical uncertainty). In addition, many first changed over to a traditionally designed BTK and then to the PSCST-specified design, which added to their costs. The main incentive for most entrepreneurs for conversion to a PSCST or CBRI-design kiln seems to have been the reduction of bureaucratic hassles in achieving a no-objection certificate from the concerned government departments rather than availing the benefits of the new technology.

Regulation related to fly ash

The fly ash regulation is not applicable in most units around Chandigarh. Only the units in Ropar district fall in the purview (many are within a radius of 50 km of Guru Gobind Singh Super Thermal Plant in Ropar) and are covered under the MoEF notification of 1999. However till 2002, none of the brick kilns functioning in the district had complied with the regulation. Only one unit, that too in Derabassi and not in Ropar, is using fly ash from the thermal power stations in Ropar and Bhatinda. The steps are taken by the PPCB to ensure the use of fly ash have been limited (Mohan 2002).

The incentive under this regulatory instrument is weak as it is not suitably enforced. The notification specifies the regional officer of the PPCB as the authority for ensuring the use of specified amount of fly ash by the brick-kiln. However, it was only after almost three years of notification that the PPCB have issued notices to the brick-kiln owners to use the fly ash in manufacturing bricks (Mohan 2002). The entrepreneurs have also opposed the regulation on fly ash (Singh 1998; Tribune News Service 2002). Their main arguments are that there is limited technological know-how on fly-ash utilization and related costs, and the cost of transportation will add to the production costs (there is disinterest on the part of the power plants in disposal of the fly ash). In addition, uncertainty regarding availability of fly ash (they are not fully aware of the policy) and no real existing market or any premium for fly ash bricks adds to the reasons for non-compliance. There is no demonstration unit set up in the

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255 This was also reflected in the fact that some entrepreneurs have made modifications in the existing technologies to suit their needs. For instance, in one unit the design is based on the CBRI technology but the chimney is like in the BTK (instead of high draught power-run fan).

256 Interview no. 10. CBMF 2002.
region that could be a model for other units. However, a demonstration project would be successful if a market exists (Srivastava 2002), or if there is incentive to undertake these efforts. With little regulatory incentive as of now, and lack of awareness and initiative regarding the technology among the consumers, the power stations and the entrepreneurs, the effect of the regulation is negligible.

Other policy instruments
The performance and significance of the other instruments has been much less dramatic than the regulatory instrument. For instance, imposing a “royalty” on soil excavated does serve as a negative incentive towards exploitation of topsoil; however, it is not big enough to induce the entrepreneurs towards cleaner technologies (e.g., use of alternative and internal fuels) or to take care of the reclamation costs of the affected land (Damle 2001). In addition, there have been widespread protests across the cluster (and in other regions in Punjab) against imposition of the royalty (and fine on failure in payment) by the state government (Tribune News Service 2001, 2002).

The suasive efforts in terms of opportunities for training, capacity building, and technical support offered by various governmental departments and other organizations (PSCST, SIBDI and under the IBP), on the other hand, have brought in some change. The main success has, of course, been the PSCST initiative for technical support. However, this alone do not provide a strong incentive; only when combined with the regulatory incentive, will they together be able to bring about a significant change. While, on the one hand, these have been successful in increasing awareness regarding technical options, environmental concerns, etc., on the other hand, it is felt that these are often not needs-based (e.g. do not adequately train the workers or mistries who are largely responsible for working of the kilns).

8.4 Contextual factors
The important features of the brick SSI are its scattered and seasonal nature. It is a complex process influenced by a number of factors including soil quality, fuel used, skills available and local climatic and market conditions. In addition, more often it is only a secondary occupation for the entrepreneurs due to which their motivation for bringing in cleaner technologies is limited. However, there are a number of factors at play (Table 8.6).

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257 The only unit that is using fly ash is a mechanized unit which is private so other entrepreneurs are not allowed to see it.
<table>
<thead>
<tr>
<th>Factor</th>
<th>Driver</th>
<th>Barrier</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>• Environmental concerns</td>
<td>• Low awareness and traditional practices. Old, family-owned units with flexibility in working</td>
<td>• Increased awareness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Brick unit may be secondary occupation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Limited <em>managerial and marketing</em> skills</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reliance on ‘mistries’</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Use of contract workers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Traditional firing practices being used</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Limited capacity building of workers</td>
<td></td>
</tr>
<tr>
<td>Organizational</td>
<td>• Use of contract workers (as carriers of knowledge)</td>
<td>• Limited marketing and management skills in many units</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Limited marketing and management skills in many units</td>
<td></td>
</tr>
<tr>
<td>Economic</td>
<td>• Financial support available</td>
<td>• Economic capability low (high risk activity)</td>
<td>• Economic capability low for many units</td>
</tr>
<tr>
<td></td>
<td>• Demand (sustained)</td>
<td>• Financial support limited</td>
<td>• Financial support limited for many units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Market conditions (consumer preference)</td>
<td>• Market conditions a factor</td>
</tr>
<tr>
<td>Technological</td>
<td>• Technical support available (CBRI, PSCST)</td>
<td>• Limited technical capability (know-how)</td>
<td>• Technological capability limited for many units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Technical support is limited (benchmarking, demonstration units, fly ash technology)</td>
<td>• Technical support available; however, con-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Seasonality/weather dependence</td>
<td>tined support limited</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Infrastructural constraints: (coal quality, power supply)</td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>• Initiative by associations (AIBTMF, CBMA)</td>
<td>• Attitudes: Motivation, attitudes, mindsets</td>
<td>• Attitudinal constraints</td>
</tr>
<tr>
<td></td>
<td>• Involvement of younger generation (brings in awareness, IT, etc.)</td>
<td>• Networking: Limited interaction (competition)</td>
<td>• Limited networking</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Bureaucratic procedures</td>
<td></td>
</tr>
</tbody>
</table>
8.4.1 Environmental factors

The environmental concerns related to the SSI, are a driver towards diffusion of cleaner technologies. However, environmental consciousness (and motivation), though somewhat increasing with rise in awareness, is still low.

8.4.2 Organizational factors

Most stakeholders feel that one of the barriers for diffusion of cleaner technology is the limited involvement of the entrepreneurs and their dependence on the ‘mistries’ (firemen). Most entrepreneurs (85–90%) do not devote adequate time to their units leading to little supervision and control over workers. Some entrepreneurs own more than one unit within the family, and for yet others it is their secondary occupation. Thereby, majority of the entrepreneurs are dependent on their “mistries”, and follow their advice. Being only a seasonal activity, hiring managers on a full-time basis does not seem lucrative to them. It has been observed that when the owner goes to his kiln regularly or the younger generation takes over, efficiency is higher.

The workers play an important role in technology diffusion. As mentioned before, they are migratory and are hired on contract (workers go home after the production season and return in the next season, but may or may not work in the same unit). On the one hand, entrepreneurs do not want to invest time and money in training them, as it is not sure whether they will stay during the next season. On the other hand, however, the workers act as ‘carriers’ of technology information when they move from one unit to another. This is significant as normally there is little exchange of technology information between entrepreneurs due to increasing competition, as the market is limited to local and neighbouring areas. Some of the bigger unit entrepreneurs said that they did not allow other entrepreneurs to see their units, and there was limited exchange of information.

8.4.3 Economic factors

One of the main barriers towards adoption of cleaner technologies is the capacity of the entrepreneurs to take economic risks – “production process is highly dependent on labour and nature”. Low profit margins and their economic positions make them

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258 There are two kinds of mistries in the industry – one for kiln construction and another for supervision of the firing activities at the kilns. The head fireman is usually the supervisor.

259 Being a labour-intensive activity, the performance of the operation depends a lot on worker efficiency. For instance, during firing, coal has to be fed at regular intervals. Under little supervision and tiring conditions (and heat), workers often adopt a relaxed attitude, and coal feeding is rendered inefficient (without proper measurement, irregular intervals).

260 For example, a son and father each own and manage a unit using the same technology, but the former is doing better as he spends time at the unit regularly inspecting the operations.

261 I too experienced this during the survey when I asked one entrepreneur if he had received help from any of the financial institutions such as PFC or SIDBI, and he replied in the negative. However, later in an interview at the PFC, I found that he had received funds from there.
risk averse. This is especially for the medium units, for whom access to external financial resources is also limited. As the production process is continuous – each cycle for production of one batch of bricks takes 28–30 days – it is not possible to monitor the workers all the time, which further lowers the risk-taking ability. Thereby, the economic capability of many units is low. There are opportunities for getting financial support (PFC, KVIC, etc). For instance, a few large unit owners (five units – two in Derabassi and one in Ropar) have been provided funding by PFC for installing moulding machinery and other equipment. But for the medium and non-mechanized kiln owners, however, access to finances is a limitation (they are not eligible for direct funding by the PFC, SIDBI, etc, and they normally prefer to rely on their own resources to avoid procedures). Most of these units also undertook the kiln conversions using their own resources.

A sustained demand for bricks (as a main input for the construction industry) is a driver for improving productivity and efficiency. Market conditions in the last three years have shown a decline in demand, however, by and large, it has been stable. The costs of production have gone up slightly due to labour and raw material costs. On the other hand, competition has also increased – though there are units that have closed down or decreased production, others have also been set up. Consumer preference is also important in shaping market demand (e.g. there is no premium paid on fly ash bricks).

8.4.4 Technological factors

The very nature of the brick-making activity – seasonal and weather-dependent – incubates flexibility in the production process. It is a high-risk activity (e.g. there is high breakage and in the event of rain the material can get ruined and the production process may have to be stopped), making the entrepreneurs wary of using new or unproven technology. There also exist technology-specific and infrastructural constraints. Technology-specific constraints include costs, and electricity requirement as in the case of HD kilns; whereas infrastructural constraints are poor access roads which add to damage during transport, and lack of or delay in getting electricity connections. The technology used therefore is simple to operate, and workers skilled in its operations are available in the cluster.

While technological knowledge is traditional and limited, there are opportunities for technology support – both in terms of technology access and know-how (from

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262 Interview no. 11. PFC 2002.
263 The average selling price for bricks is between Rs 1100–1400 for 1000 bricks. It varies based on the quality (grade) of bricks. Grade 1 bricks sell at Rs 1300–1400. The production cost, on the other hand, varies – and was reported to be around Rs 1000–1200 for 1000 bricks. Some entrepreneurs did say that their production costs were Rs 1400 and they were selling at a slight loss – however, it was difficult to verify this. Many said that the trend was cyclical (good seasons followed by bad ones) which eves out.
264 It is believed that the quality of the brick is associated with its colour (though not necessarily true): the redder the brick, the better its quality – so entrepreneurs prefer to manufacture red bricks and not use fly ash which renders the bricks paler.
PSCST, CBRI, etc.). However, there is still no adequate know-how especially with regard to management and operational practices, no demonstrated technology or benchmarking of technologies in the region, which the PSCST or AIBTMF can promote as an efficient or model technology.

Though technical knowledge has improved it still remains limited among the entrepreneurs “when they themselves are not trained, how will they train others – particularly their workers”. The association members point out that there is lack of dedicated, practical and need-based training. “Rudimentary training has been provided (e.g. PSCST and SIDBI), but what is needed is at least a week-long training on site and under supervision”. “PSCST provides training like it is required by secondary-school students – but in reality training should be provided as that for the kindergarten”. “We need either demonstrated technology or focused training on our site for at least a week”. PSCST, on the other hand, points out that even if training is provided, the problem is the mindsets – not just of the entrepreneurs but also of the workers. It is difficult to change worker mindsets – “they are convinced that more smoke out of the chimney implies that the combustion is better”. However, awareness has increased and concern for working conditions and efficiency is there, laying the foundations for technical changes in the future.265

8.4.5 Social factors

Some stakeholders (other than the policy makers) feel – in the same light as the entrepreneurs themselves – that the procedures to be followed by a unit owner are very stringent and time-consuming (like paying income tax, sales tax and royalty, and getting a no-objective certificate). There is no single window – and the entrepreneurs have to go through 20 or so departments (and the issue of middlemen becomes important). Forms – such as that for consent to operate – are difficult to fill. “Forms are made so that no one can fill them”.266 The need is to change the procedures – make them transparent and user-friendly, and also to create awareness among the entrepreneurs (develop effective training mechanisms at all three levels – owner, worker and policy).

The associations at the district levels in general have been weak and there is little interaction between the entrepreneurs. However, at the higher levels, initiatives have been undertaken – for instance, AIBTMF advising on technical issues and organizing training programmes, etc. The involvement of the younger generation is also bringing in new information, awareness and ideas.

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265 Some changes have already begun, for instance, sheds over the kilns is now talked about to avoid weather wrath; one entrepreneur has even installed a portable shed, and another has set up a 24-hour canteen for the workers to get (hygienic) food at affordable price.

266 Interview no. 9. PSCST 2002.
8.5 Brick clusters in and around Pune

The above sections focused on the Chandigarh cluster. As the production methods in the zone 1 are quite different from those in the other parts of India, this section presents the observations and findings of a study undertaken in Pune, Maharashtra in zone 2. Pune district is a fast-growing industrial area in Maharashtra, which is the largest brick-producing state in zone 2. The comparison is important as the technologies here are quite different from those in Chandigarh and the implications of the environmental policy is almost negligible. This also provides a case for performance of local associations in addressing the problems of the entrepreneurs.267

8.5.1 SSI–environment interaction

There are around thirteen brick-making clusters in and around Pune, of which four important clusters were covered in the mini case study (Table 8.7).268

Table 8.7: Clusters around Pune included in the study

<table>
<thead>
<tr>
<th>Cluster</th>
<th>District</th>
<th>Approximate number of units</th>
<th>Number of units surveyed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vittalwadi</td>
<td>Pune</td>
<td>80</td>
<td>5</td>
</tr>
<tr>
<td>Daund</td>
<td>Pune</td>
<td>80</td>
<td>3</td>
</tr>
<tr>
<td>Sangamner</td>
<td>Ahmednagar</td>
<td>140</td>
<td>3</td>
</tr>
<tr>
<td>Thergaon and others</td>
<td>Pune</td>
<td>50</td>
<td>5</td>
</tr>
</tbody>
</table>

Like in Punjab, these are family-owned businesses269 catering to the local markets.270 However, these are larger clusters comprising of small sized units with average production of around 0.6 million bricks per unit per season. Table 8.8 brings out the contrasts in the characteristics of the units in Pune and Chandigarh.

The main technology used is open clamps, and the main fuel used is coal (with low calorific value). The VSBK has been introduced in the region (two VSBK units are

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267 The cooperative society movement in Maharashtra – initially confined to agricultural credit but then spread to other areas – has played an important role in its development, particularly in the rural areas.

268 The Vittalwadi cluster is closest to Pune city, and comprises very small units with production ranging from 100,000–400,000 bricks per annum. On the other hand, the units in Daund cluster are larger with production in some of them being more than 1 million per annum. Sangamner cluster is farthest from Pune city and falls in another district (Ahmednagar).

269 In Daund, the situation was slightly different. In the earlier years, many were employed as railway staff, but with those jobs declining, the next generation had to shift to other activities (e.g. agriculture, brick making).

270 There are two kinds of bricks made in Pune – the conventional bricks (size 9” x 4” x 3”) and the double bricks (size 9” x 6” x 4”). The double bricks, popular in Maharashtra, account for 60% of the production and are sold mostly to building companies.
Energy efficiency in the clusters is very low, and the working conditions very poor. These can be improved by use of more efficient operating practices, use of internal fuel such as fly ash, and switching to more efficient technologies (Box 8.2) including efficiently designed clamps (like multi-chamber kilns can improve efficiency by 25%) and VSBK (can improve efficiency by 50–70%). The cost of VSBK is quite high compared to the clamps (which are famous for their zero costs), and therefore, it is referred to as a “five star technology” (viable for bigger entrepreneurs only) by a consultant active in the region. And, the information about the multi-chamber kilns is also very limited (setting up of demonstration projects has been proposed in the proposal to UNDP–GEF, contingent on its acceptance). Fly ash is also not very popular. On their own initiative, two units in Sangamner were using fly ash. However, one of them had closed down and the other was facing difficulties –

Table 8.8: Comparisons between brick units around Chandigarh and Pune

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Chandigarh</th>
<th>Pune</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone</td>
<td>Zone 1</td>
<td>Zone 2</td>
</tr>
<tr>
<td>No. of operational units</td>
<td>100</td>
<td>350</td>
</tr>
<tr>
<td>Average age of units</td>
<td>15 years</td>
<td>23 years</td>
</tr>
<tr>
<td>Product</td>
<td>Bricks (conventional) and brick tiles</td>
<td>Bricks (conventional and double bricks)</td>
</tr>
<tr>
<td>Production season</td>
<td>September to June</td>
<td>November to May</td>
</tr>
<tr>
<td>Production capacity/size</td>
<td>Medium and large</td>
<td>Small and medium</td>
</tr>
<tr>
<td>Number of workers</td>
<td>150–200</td>
<td>25–100</td>
</tr>
<tr>
<td>Main technology</td>
<td>BTK fixed chimney</td>
<td>Open clamps</td>
</tr>
<tr>
<td>Main fuel</td>
<td>Coal</td>
<td>Coal</td>
</tr>
<tr>
<td>Other technologies</td>
<td>HD kiln</td>
<td>VSBK</td>
</tr>
<tr>
<td>Policy implication</td>
<td>Significant</td>
<td>Limited</td>
</tr>
<tr>
<td>Main contextual factor</td>
<td>Organizational (reliance on workers)</td>
<td>Technological (appropriate technology, know-how, raw material)</td>
</tr>
</tbody>
</table>

Based on survey information.

Footnotes:

271 There was also a BTK owner who has now closed his unit as it was not viable. The main reasons that he gave for closing it were: (i) soil is more suited for clamps, (ii) production was much more in BTK than could be marketed, and (iii) labour problems, as the workers were trained for clamps and not BTKs.

272 In many of these clusters, entrepreneurs use all kinds of material available — some also reported using rubber shoes and tyres some years back but have now stopped using them.

273 For instance, firing in case of clamps, the workers have to carry loads of bricks (12-14 bricks at a time) usually on their heads, to stack them.
technical and marketing (there are few buyers for “white” bricks – implying limited marketing skills).

8.5.2 National policy and policy implications

Unlike the situation for the Chandigarh cluster, the ban on BTKs with moving chimneys under the MoEF notification (1996) does not include clamps, so it does not affect the units in Pune. On its own initiative, however, the Maharashtra Pollution Control Board, vide its letter dated 18 February 1997 to all District Collectors, included clamps under the purview of the said Regulation. However, this has not been followed up with concurrent extensions and efforts towards its enforcement have also been absent (Damle 2002). Thus, there is hardly any policy incentive towards use of cleaner technologies. A meeting with a senior official at the MPCB branch at Pune, also gave the impression that dealing with the brick units is not an area of concern for the Board.

Box 8.2. Technological options for the Pune cluster

Cleaner technologies

• Operational practices and housekeeping
• Use of efficient kilns (e.g. VSBK, multichamber kilns)
• Modifications in design of existing kilns (e.g. efficient clamps)
• Use of better quality or cleaner fuels (better-quality coal, renewables)
• Use of internal fuel (e.g. fly ash)

The location or sitting policy of industrial units has some implications for the clusters around Pune, which prohibits the setting up of the units within the city/residential areas. The Vittalwadi cluster faces the threat of closure as it is situated very close to Pune city, however, the entrepreneurs are not so concerned as land prices are very high – “we will see when the time comes, right now we are all rich due to our lands”. On the other hand, the threat of relocation or closure for the Daund cluster – where the units are situated mainly on agricultural land – has entrepreneurs living with the fear that some day a court order will be issued asking them to shut down.

8.5.3 Contextual factors

The main contextual factors that constrain diffusion of cleaner technologies are the lack of motivation and appropriate technologies. The clamps are popular for two main reasons. Firstly, the cost of the kiln is almost “zero” – as no permanent structure is needed and most entrepreneurs work on leased land there is hardly any fixed capital involved in the production. Secondly, it allows complete flexibility in terms of capacity and fuel used – it is accepted that when the demand rises, production of bricks can be increased by increasing contractual manpower and arranging more clamps on the land available, and vice versa. In addition to this, there is little policy pressure. Thus, there is little motivation or need for small entrepreneurs to change over or invest in a new technology.
There are also a number of problems faced by the entrepreneurs that make it more difficult to invest in change. These include:

- **Availability of clay:** There is scarcity of clay/sand, and it is usually got from quite distant areas. Royalty and transportation add to the costs. The “Prajapati” community (traditional brick makers) is exempt from paying royalty on providing evidence that they belong to the particular caste. However, in this case also there are lengthy procedures involved (in proving eligibility for exemption).

- **Bureaucratic procedures:** An entrepreneur has to spend a lot of time in meeting the requirements of different government departments (sales tax, royalty, etc). There is no single-window facility for them. There is also no real platform in the state or districts to put forth their concerns. “Government does not harass – it does not know”.

- **Coal availability and quality:** Coal is mostly bought from middlemen, as it is required in small quantities.

- **Labour problems –** The workers are migratory in nature and shift to different units if their demands are not met.

- **Payments –** Most transactions are based on credit, and marketing skills are limited.

- **Other problems –** These include finance and technological know-how (access and affordability). The KVIC does provide loans at a concessional rate, however, very few have availed of this option.

Associations in some of the micro-clusters are addressing many of these problems making a case for collective action. These exist only at the local levels; and the two which have made a significant difference are the Navjeevan Society at Sangamner and the society at Vittalwadi (see Box 8.3). The rest are relatively weak (the weakest is in Daund).

However, quite a few entrepreneurs are even interested in cleaner technologies which can be cost-saving. Some factors that have contributed to this have been: (a) increasing awareness as well as capacity building under the IBP under which the VSBK has been set up and the work of private consultants; (b) involvement of the younger generation. Maharashtra has a high literacy rate, and the introduction of information technology has brought in awareness about technologies, experiences of other countries and financial institutions among the internet users in the younger generation who want to bring about a change (this was seen in Sangamner which is about 70 km from Pune city, and among a couple of owners at Vittalwadi – but not much in other clusters). One entrepreneur who has set up a VSBK commented – “earlier my son (a graduate in business management) did not want to join my brick business, but now

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274 Government usually will process a requirement of a minimum of 1000 tonnes of coal, which is a large quantity for individual brick makers.

275 The association at the Daund cluster that has been formed relatively recently. There are currently 150 members from Daund and nearby areas. However, almost 90% of the members failed to pay the nominal membership fee due to which it remains extremely weak (interview with member). None of the three units surveyed in this area is a member of this association.
with this new technology he too has got involved and enjoys the work". The entrepreneurs in general are not ready to talk about new (and expensive) technologies like the VSBK, but they are interested in knowing about efficient ways and operating practices which could make their production more cost-effective.

Entrepreneurs are thereby searching for ‘appropriate’ technologies (that are cheap, applicable to a small scale and simple) which are not available to them. On the other hand, the main barrier still remains technology and information (both about technologies and financial and policy options), and the major problem is availability of quality clay.

**Box 8.3: Main activities of the two successful associations**

**Vittalwadi:** The Vittalwadi association has been formed relatively recently in 1997, and is based on the Navjeevan model discussed below. There are about 80 small units in Vittalwadi and all are members of this association. The main reason for the creation of the association was to deal with problems related to coal. The association makes a bulk purchase of coal ensuring better quality, price and delivery for the entrepreneurs. It also deals with issues relating to royalty (to deposit group royalty instead of individual payments) and help in marketing of the products. The association also plans to organize training programmes to help improve the existing production practices. And, it also provides a platform for interaction among the entrepreneurs (there was little interaction before).

**Sangamner:** In Sangamner, there are two societies co-existing – Navjeevan and Amritvahini, together with a credit society for the brick units. Navjeevan has about 136 members, all belonging to a particular caste – Prajapatis (Jhorwekars), and is the most successful. Amritvahini, on the other hand, has 50 members who are all non-Jhorwekars. The Navjeevan Society was started in 1963 with 25 members. It was actually established in 1956 as the Sant Gorba Society. However, in 1963, there was a split in the Sant Gorba Society and the Jhorwekars separated and formed the Navjeevan Society. The motivation for formation of the society was to obtain special privileges that were available to a registered society like tax exemption, waivers and preference in government tenders.

The success of the Navjeevan Society may be attributed to the common interests of a particular caste of people and that it has been presided over only by representatives of one family. Its activities are: to procure coal and distribute it among the members at a reasonable price, announce labour rates so that shifting of workers between units is limited (most workers do not shift between units – and many have been working in one unit for 10–15 years), help in the marketing of products (the units not possessing a sales tax number can use the society’s number), and collective payment of royalty. This kind of a close-knit and open system does provide an avenue for ‘demonstration and ripple effect’. Although the members are competitors the association provides a platform for exchange of ideas.

8.6 **Conclusions**

This case study presents the case of a traditional SSI where a regulatory incentive is combined with an opportunity for technical support. The case study brings out the importance of the role associations can play not only in motivating their members and sending petitions regarding their concerns to the requisite authorities, but also arranging opportunities for technical advice. In addition, it provided evidence of indigenous development of a technology (HD kiln) as well as technology adaptation of an imported technology (in case of the VSBK).
The environmental policy has been diffusion-forcing for the Chandigarh cluster – there has been strong enforcement of the policy provisions and it provided added incentives in terms of availability of approved technological options, reduced bureaucratic hassle in obtaining licenses (indirect impact), accessibility to consultancy package and increasing awareness. However, it does not provide direct incentives for further improvements (though there is indirect incentive owing to increased awareness) or at improving the operational practices across the units. The technological capacities in terms of operations and firing practices have not changed, mainly due to contextual factors such as limited technical knowledge and reliance on workers by the entrepreneurs. This has resulted in under-achievement of the technological and energy-efficiency potential of the diffused technology (and policy objectives), and thereby scope for improvement. In the current policy scenario though awareness has increased, the exploitation of the energy efficiency potential is not going to happen.

One would think that with installation of the currently available and installed technologies across the cluster, there may be no options for bringing in cleaner technologies. However, as pointed out there does exist potential for energy efficiency improvements by improving the operational practices, as well as by introducing new designs. This may happen as information is increasing and the associations as well as the entrepreneurs are becoming more aware not only in terms of the technologies but also various incentives available to them. However, arguing that this cluster has already shown a change, it also makes a case for replication of the efforts made here across other clusters in the country. Steps towards this have been undertaken in terms of capacity-building efforts, and an increasing number of consultants and organizations becoming involved. However, given the magnitude of the number of units that are there, this requires much greater effort which may be taken as an extension of the current efforts as well as new initiatives and using the climate change instruments.

The Pune case does give an example of a cluster where action may be undertaken. The environmental policy here is weak and does not provide an incentive for change. This is mainly due to their small size, limited resources, benefits of existing technology (cost, flexibility), and absence of comparable appropriate technology. However, the Pune case has shown that even in an unorganized set-up entrepreneurs have come together to form associations in order to meet their requirements.
9. Current paradigm: Is small beautiful and clean?

9.1 Introduction

This chapter presents a comparative analysis of the three case studies and adds additional elements based on desk research and interviews with select relevant stakeholders, in order to draw insights for the Indian SSI sector as a whole. It follows a bottom-up approach in examining the link between CCIs and SSIs by assessing the influence of local circumstances on SSI–environment interactions. It therefore helps in addressing the third research question: What are the main drivers and barriers related to diffusion of cleaner technologies in the SSIs in India?

Section 9.2 discusses the SSI–environment interaction holistically. Section 9.3 examines the local situation including the role of national policies and the contextual factors to bring out the context and the reasons why SSIs are constrained in adopting cleaner technologies in the present situation. This brings to the fore the gaps in the current paradigm, and presents a base for a shift towards a more sustainable paradigm for the SSIs, as is detailed in Section 9.4. The last section draws the main conclusions related to the policy options that can be used for inducing such a transition, and whether a role for CCIs can be envisaged in this regard.

9.2 SSI–environment interaction

The case studies highlight the relevance of the SSI sector from a sustainable development perspective. They provide empirical evidence for local (environmental and developmental) and global (GHG emissions) impacts of the SSI activities.

The SSIs make a notable contribution to the value added and exports of the country and help build upon the local skills and expertise (e.g. local handicrafts as in the case of glass). Being labour intensive, they are a source of livelihood to many (including skilled as well as unskilled and migrant workers), and lead to indirect benefits such as local self-sufficiency, improved standards of living and poverty alleviation. However, there are social concerns pertaining to SSIs as well including health impacts and labour issues involving contract and bonded labour. Although, there are policy provisions addressing these concerns, they are not always adhered to (for example, field observations children reveal that work in the brick and informal household glass units despite a ban on child labour). The working conditions are especially poor in most of the units surveyed. For instance, the workers work in high temperatures and handle material – mixing raw material in glass units, sieving coal in clamp brick units and pouring molten metal in foundries – without proper protection and at times in small covered areas (as in glass and foundry units).

Evidence shows that in most SSI units energy is used inefficiently and comes from different sources (fossil fuels including inferior quality fuels like low grade coke,
biomass and electricity). Even when relatively cleaner fuels like natural gas and superior coke is used, little attention is paid to efficiency. This contributes to the negative environmental impact and poor working conditions. The environmental impact, though small at the unit level, is quite relevant collectively at cluster and SSI levels, as shown for all the three clusters studied. Their GHG contribution too is not as prominent as large-scale industries, but the collective degree of energy inefficiency is a matter of concern for environmentalists as well as for developmental agencies.

The use of traditional technologies in SSIs provides significant potential for cleaner technologies, both hardware and software technologies. Evidence shows that diffusion of select cleaner technologies brings down energy consumption and GHG emissions in the sector, along with other socio-economic and environmental benefits. For example, use of natural-gas furnaces in glass units reduces production costs and improves working conditions and product quality. There is still significant potential for further efficiency improvement in all SSIs, including glass which has already experienced change. These include options ranging from simple modification in operating practices to adoption of modern technologies, and from indigenously developed (e.g. HD kilns) to those based on technologies used in other countries (e.g. VSBK).

### 9.3 Why do SSIs not adopt cleaner technologies?

The case studies help in drawing lessons about what encourages or hinders the SSIs from adopting cleaner technologies.

#### 9.3.1 National policies

The theoretical literature suggests that appropriate policy instruments can encourage diffusion of cleaner technologies in the SSIs (Section 2.2). An examination of the national policies (in Chapter 5) reveals that national policies can be drivers as well as barriers to change.

SSIs in India have for long enjoyed a protective national policy environment. This, in effect, has created perverse incentives for them to remain small and brought in complacency. Gradually, the policy focus is shifting from protection to promotion in line with the broader macro policies advocating reforms, liberalization and globalization of the economy. Units now face increasing market opportunities as well as competition (Section 5.2). While these provide a motivation for SSIs to adopt cleaner technologies; uncertainties regarding market and policy scenarios also constrain them, particularly the small units, from doing so. The SSI policy continues to provide, although reduced, preferential treatment, incentives in terms of subsides, and opportunities for training, marketing and technical assistance. The cluster development programme in particular is targeting clusters rather than individual units. This has positive implications but is also limited in not recognizing the heterogeneity among the units. Though several SSI units and clusters have benefited, the reach of policy incentives is narrow given their large numbers. In the ‘case study’ clusters, there are
only a few units that have effectively used these opportunities (research shows that only 10–15% of the units in the three clusters have availed of policy incentives).

The emphasis of the environmental policy is particularly on regulatory instruments, supplemented by suasive and at times economic instruments. The policy exerts some pressure on SSIs to adopt cleaner technologies, but it is limited. This is because, first, there are few policy provisions related to energy efficiency in the SSIs. The environmental issues are either ignored or given concessional treatment (Section 5.3). Often they get incorporated in the overall policy making primarily for reasons other than concern for inefficient use of energy; such as protection of the national heritage and cleaning of the river Ganges. Second, the policy thrust is on end-of-pipe solutions or on fuel-switching; efficiency aspects in terms of design or hardware and operating practices or software have largely been ignored. Even in the case of the glass cluster, though the focus is on switch to cleaner fuel, energy efficiency has not been given due attention (Section 7.4). Third, the focus has been on local pollution and not global environment issues. There are no standards for CO₂ or other main GHGs as of 2006. Fourth, the enforcement of the policy provisions is ad hoc and generally weak. Among other reasons, the fact that the sector constitutes a large vote bank makes political will towards active enforcement weaker. For example, the closure notice for polluting industries in Delhi has not been successfully implemented.

This provides evidence that there is significant potential for efficiency improvement in the SSIs, and energy efficiency is still not a priority for the national SSI policy. Overall, there exists a gap between the promotional and environmental objectives of the SSI policy, and there is little coordination between the concerned departments. Though there are support policies and programmes (such as fiscal benefits, UPTECH programme) that help the SSIs comply with the environmental regulations, they are limited and inadequate. In the case of foundry units, a regulation supplemented by a subsidy provided an impetus for an initiative that brought together small units and increased compliance in the cluster. For cleaner technologies, the emphasis of the promotional policy has been only on capacity building and demonstration projects.

It is important to also point out that SSI representation in the policy-setting process is little or almost negligible. In most cases, uniform standards are set across industrial units that do not consider the ‘special needs’ of small units and at times are not backed with adequate infrastructure (for example, natural gas supply for muffle glass units). In this event, these units are threatened with closure or relocation. In other cases, the scientific basis for setting the standards is unclear or they are adopted based on international standards which may or may not be relevant in domestic situations. For instance, why was the emission standard for the Howrah foundries set at the particular level (based on notification of Environmental Protection Agency) and later revised to another level for all units? In addition, why is it that while the environmental policy has been relaxed for SSIs in general, it has been made stringent for some units? An example is the insufficient reasoning for including glass units in Firozabad under the ban of coal in the TTZ and excluding some nearby brick units also falling within the zone. The question that arises is that are these instruments dis-
guised ways of closing down some ‘dirty’ units? Uncertainty regarding policies (revisions of standards, etc.) poses a constraint for the entrepreneurs for proper planning.

9.3.2 Contextual factors

This section examines the drivers and barriers for diffusion of cleaner technologies. According to the standard economic theory, the main motivation for entrepreneurs is profit-making and they are likely to adopt cleaner technologies that make economic sense. However, the case studies show that it is not economic factors alone but an interplay of several contextual factors that impact policy effectiveness at the local level and shape the existing technological paradigm for the SSIs (Table 9.1).

Internal/organizational: The internal factors emerge due to specific characteristics and the behavioural and contractual structure of the SSIs such as small size and unorganized nature. Though significant inter- and intra-cluster differences exist, in general entrepreneurs are lacking in awareness, environmental consciousness, technical knowledge as well as managerial skills. The foundry cluster is relatively more modern than others in terms of operations, management and information. Within each cluster also there are a few units that are relatively more ‘progressive’. In general, there are three types of units within a cluster. The big (and export-oriented units if present) are relatively technically advanced. The smaller units (catering to the local market) have relatively less technological and financial capabilities, are most vulnerable to external pressures be it policy or otherwise, and most of them are ‘survivalist’ units. The middle-sized units are generally more stable than the smallest units but less advanced compared to the bigger ones. In Chandigarh, the units were more or less similar; however, there were marked differences between these micro-clusters, and contrasts were also evident when compared to traditional units in Pune.

For many entrepreneurs, the SSI activity is only a secondary activity, and they rely on their workers for production processes. For example, brick clamps may be located on rented land and depend on raw material bought on credit and contract workers, which highlights the informality in some SSI units. The workers do build on local expertise and knowledge; but due to lack of capacity building, they tend to continue with the traditional methods. These factors contribute to the low environmental consciousness and motivation for change as well. In addition, the marketing skills of the entrepreneurs are limited. There is little systematic monitoring or any kind of process or product certification (only observed in Howrah cluster where the big export-oriented units have ISO certification). Product differentiation is also not evident as the same kinds of products are produced within a cluster; this was observed even in the case of glass decorative items which allows for creativity in terms of design.

Environmental: Working conditions, safety and local pollution are all drivers for diffusion of cleaner technologies. Proximity with environmentally sensitive areas, as in the case of glass and foundries, has led to social awareness or increased monitoring by regulatory authorities to lower pollution. Overall environmental
<table>
<thead>
<tr>
<th>Type</th>
<th>Driver</th>
<th>Barrier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental</td>
<td>• Local pollution</td>
<td>• Environmental concern low among various actors</td>
</tr>
<tr>
<td></td>
<td>- Proximity with environmentally sensitive area (e.g. Howrah; Firozabad in the Taj Trapezium Zone)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Civil society involvement (and public interest litigation)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Safety, working conditions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Increasing awareness, even regarding climate change (CCI projects in place, e.g. in steel re-rolling, brick, pottery units)</td>
<td></td>
</tr>
<tr>
<td>Organizational</td>
<td>• Availability of skilled workers with local expertise</td>
<td>• Low awareness (Traditional units, informal nature)</td>
</tr>
<tr>
<td></td>
<td>• Contract workers act as ‘knowledge carriers’ (e.g. glass)</td>
<td>• Flexibility in working (may be seasonal or secondary occupation; e.g. brick)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Limited managerial &amp; marketing skills</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Limited product differentiation, innovation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Dependence on contract workers ? no incentive for training (e.g. brick)</td>
</tr>
<tr>
<td>Economic</td>
<td>• Economic capability of some entrepreneurs high</td>
<td>• Economic capability low for many units (low capital, profits)</td>
</tr>
<tr>
<td></td>
<td>• Market conditions and competition</td>
<td>• Market conditions and competition</td>
</tr>
<tr>
<td></td>
<td>- Market niches for select products (sanitary castings, bangles, bricks)</td>
<td>- Fixed market (lack of competition)</td>
</tr>
<tr>
<td></td>
<td>- Rising competition ? need to improve efficiency, competitiveness</td>
<td>- Market uncertainty (due to competition)</td>
</tr>
<tr>
<td></td>
<td>• Financial options available</td>
<td>- No market premium on ‘clean’ products (e.g. fly ash bricks) or even quality products (e.g. better quality bangles)</td>
</tr>
<tr>
<td></td>
<td>- Under national development and SSI programmes and policies (e.g. subsidy for power, PCD)</td>
<td>• Limited financial support for cleaner technologies</td>
</tr>
<tr>
<td></td>
<td>- External support, esp. with interest of international and local agencies in some cases (e.g. to protect Taj Mahal)</td>
<td>- Options for cleaner technology and their reach limited, procedures and transactions costs, suppliers’ attitude</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Limited awareness, hesitancy to approach or declare financial position ? preference for local/informal sources</td>
</tr>
<tr>
<td>Technological</td>
<td>• Perceived benefits of cleaner technologies (e.g. reduce production costs, improve product quality, etc.)</td>
<td>• Limited technological access, know-how</td>
</tr>
<tr>
<td></td>
<td>• Lack of appropriate technologies</td>
<td>• Limited technological access, know-how</td>
</tr>
<tr>
<td></td>
<td>- Technology-specific (e.g. upfront and operating cost, power and la-</td>
<td></td>
</tr>
<tr>
<td>Technical support</td>
<td>Limited technical support</td>
<td></td>
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<tr>
<td>-------------------</td>
<td>--------------------------</td>
<td></td>
</tr>
<tr>
<td>• Some, but few, units innovate</td>
<td>- Little in-house R&amp;D, awareness or reach of programmes</td>
<td></td>
</tr>
<tr>
<td>• Under programmes and policy of government (e.g. tool rooms) and specialized technical institutes (CDGI, CBRI, etc.)</td>
<td>- Limited benefits of technical institutes (e.g. CDGI)</td>
<td></td>
</tr>
<tr>
<td>• Demonstration projects</td>
<td>- Captive demonstration projects (e.g. glass) hardly any technology ‘demonstration’ (e.g. foundry, glass)</td>
<td></td>
</tr>
<tr>
<td>• Consultants (e.g. brick, foundry)</td>
<td>- Consultants are expensive</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Infrastructure</th>
<th>Raw material/fuel availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Improving infrastructure (e.g. natural gas pipeline to Firozabad)</td>
<td>- non-availability of cleaner fuels (quality coke for foundry, natural gas for muffle units),</td>
</tr>
<tr>
<td>• Infrastructure</td>
<td>- Erratic power supply, poor connectivity by roads (?) breakages)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Raw material/fuel availability</th>
<th>Raw material/fuel availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Availability of raw material (e.g. pig iron for foundry) and fuels (e.g. cheap low-quality coke/coal, fly ash for brick units near power station)</td>
<td>- Non-availability or high price of raw material (e.g. clay for bricks), quality (e.g. high grade coal/coke) and alternate fuels</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social</th>
<th>Motivation</th>
<th>Motivation, attitudes, mindsets</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Culture, entrepreneurial spirit: willingness to innovate and experiment to move business forward (e.g. in Punjab)</td>
<td>- Fixed mindsets (of entrepreneurs, workers, policy makers, etc.)</td>
<td></td>
</tr>
<tr>
<td>• Joint action (e.g. formation of cooperatives in Firozabad for natural gas connection; societies in Pune dealing with issues of coal availability, price, labour, etc.)</td>
<td>- Culture and entrepreneurial spirit: complacency, ‘wait-and-see attitude’ (e.g. in Howrah)</td>
<td></td>
</tr>
<tr>
<td>• Networking by associations (e.g. AIBTMF, PBMF)</td>
<td>- Entrepreneurs suspicious of government</td>
<td></td>
</tr>
<tr>
<td>• Linkages (e.g. subletting gas-based glass muffle furnaces)</td>
<td><strong>Limited networking</strong></td>
<td></td>
</tr>
<tr>
<td>• Involvement of younger generation</td>
<td>- Weak associations (only a few active members normally)</td>
<td></td>
</tr>
<tr>
<td>• New ideas, information technology, motivate (e.g. brick)</td>
<td>- Competitors considered threats</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Collective efficiency</th>
<th>Limited networking</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Joint action (e.g. formation of cooperatives in Firozabad for natural gas connection; societies in Pune dealing with issues of coal availability, price, labour, etc.)</td>
<td>- Little interaction between government departments, entrepreneurs (delays, bureaucracy), and within departments (inconsistency at times, industry and environment departments work independently)</td>
</tr>
<tr>
<td>• Networking by associations (e.g. AIBTMF, PBMF)</td>
<td><strong>Limited networking</strong></td>
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<td>• Linkages (e.g. subletting gas-based glass muffle furnaces)</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Social</th>
<th>Involvement of younger generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Disinterest (e.g. foundry)</td>
<td><strong>Involvement of younger generation</strong></td>
</tr>
<tr>
<td>• Social status of the industry (e.g. foundry)</td>
<td>- Disinterest (e.g. foundry)</td>
</tr>
</tbody>
</table>
consciousness, including climate-related (for example, a UNDP and MoEF initiative is targeted at improving awareness regarding climate change and CDM in SSIs), is increasing; however, it is not a priority for entrepreneurs. Their concern is mainly to adhere to policy requirements and not environmental protection in itself. Entrepreneurs remain wary of any questions about environmental issues and consider them as conflicting with their economic priorities. The interest in any cleaner technology is largely because of business considerations such as reduced production costs (as in glass units).

**Economic:** The economic factors include financial positions and market conditions. These are most relevant from the business perspective and therefore are focussed on in the economic literature as well as in SSI policy debates in India.

Financial: Most SSIs have limited economic capabilities. Firstly, they operate on low profit margins and finances (some units do have financial capability yet deliberately remain small). Secondly, financial incentive is offered under support policy and programmes and by other organizations (financial, developmental, technical). These are mainly for setting up new units and capacity addition in existing units, as well as for technology development for existing units. However, financial support for cleaner technologies, in particular, is limited. Thirdly, the formal support available is associated with procedural and transactions costs. Owing to lack of awareness among entrepreneurs coupled with a hesitant attitude and the “hidden” economic motive not to display their assets, most SSIs prefer informal forms of credit from local lenders, family or friends, where they get credit in less time and without many questions asked or forms to fill. It is only very few SSIs that manage to avail formal financing and government-driven incentives.

Market: Market conditions play a crucial role in diffusion of cleaner technologies. With liberalization becoming a integral part of in the national development strategy and a policy shift away from protection for the SSI sector, competition from within and outside the clusters (other clusters, large-scale industries, other countries) as well from alternative goods and materials (e.g. plastic in case of iron or glass items) is increasing and poses a challenge to the entrepreneurs. On the one hand, this may act as a driver for change, as in the case of the glass industry where entrepreneurs are interested in shifting to natural gas in order to be competitive (coal-based production is more expensive). On the other hand, it acts as a constraint as the entrepreneurs, especially of smaller units, would not like to invest in a new technology until the market situation is likely to be favourable.

In addition, as many SSIs have fixed markets, they do not have enough motivation to upgrade their technologies. At least as of now, the local market does not pay a premium on cleaner products and processes, nor is it aware of these products. For example, though fly ash bricks are cleaner (as they address fly ash disposal and top soil erosion issues) and a better quality product, the manufacturers’ in Pune could not sell them. One reason was that the colour of fly ash bricks was not the bright red associated with well-baked (and hence tough) clay bricks and thereby could not find ac-
ceptability in the market. In the bangle industry too, quality is not an issue as the price of bangles is fixed for all bangles and no proper grading is done.

**Technological**: In general, technological access and know-how is limited among the SSIs. There is little in-house R&D, expect in a few big units, and most innovations are due to efforts of local workers (again not out of concern for the environment). Technical support remains limited, in spite of organizations and assistance programmes of government and other organizations; due to reasons including:

a. Qualified consultants are few and expensive.

b. Associations are weak and generally do not undertake technical assistance activities. There are instances when associations have played a significant role (for example, for brick at the all-India level, in approaching technical institutions to develop technical options; and in foundry, in motivating and assisting small units to set up PCDs), but that again was because of external forces like regulatory pressures.

c. Training programmes organized by the government or other organizations are either not well attended or are not useful or needs-based. They are mostly targeted at entrepreneurs; whereas those targeting workers, usually the main players in the production processes, have been negligible. In cases where they have been context-specific (as in some programmes for brick unit owners under the SDC’s brick project) the programmes were found to be more useful.

d. Demonstration projects for energy-efficient and cleaner technology are important tools for diffusion, but in most cases they have not been replicated or in some cases not even ‘seen’ by the entrepreneurs. The demonstrated projects are normally housed in selected units with assured financial and technical support, and which may not be available to others. For example, in the case of foundry and glass, TERI in collaboration with SDC, has set up demonstration projects which have failed mainly on account of: high costs of demonstrated technology, and insufficient information dissemination and even misinformation.

e. Most technical institutes take a top-down rather than a need-based approach. The case of Firozabad is a classic example where a specialized technical institute, the CDGI, with good infrastructure, research facilities and highly technical staff has failed to meet the needs of the glass units. The CDGI has not been able to replicate its designs in the cluster, and has basically emerged as a ‘white elephant’.

The case studies also highlight the significance of technology-specific factors in diffusion of cleaner technologies. These include technology costs, availability of raw material and fuel. For example, the relative technology costs, the upfront and operating costs are all important (even with short payback period, high upfront costs are a deterrent) and the SSIs need affordable and applicable options. This is clearly reflected in the Pune brick cluster, where clamps provide a flexible and low-cost technology option, and any high capital-cost technology like VSBK, which is no doubt cleaner (improves productivity, quality and working conditions), is not a viable op-
tion for most unit owners. In addition, infrastructure support, such as power supply and access to natural gas, is also important.

**Social:** Social factors include culture (entrepreneurial spirit), workers’ attitude (as carriers of information, in resisting change), level of bureaucracy (procedures, delays, red tape) and mindsets of various stakeholders (short-term perspectives). Networking is an important tool in keeping abreast of developments in the sector, but in general interaction is low between the entrepreneurs themselves, and between them and government and other departments. Involvement of the younger generation and introduction of information technology also plays an important role, either positive or negative. There is evidence that the younger generation brings information technology and fresh ideas (as observed in the glass cluster); in some cases reluctance of the younger generation to join the family SSI units has motivated parents to adopt improved technology (as in case of VSBK in Pune). In other cases they give the older generation no reason to change or lead them to closing down their businesses (as in the foundry cluster).

All these factors influence SSI–environment interaction and indicate a complex scenario for policy intervention. There is a need for an integrated approach in addressing the needs of the sector. Before discussing an alternative paradigm that facilitates diffusion of cleaner technologies across clusters, however, the next section addresses the question whether environmental policy is a driver and why environmental policy works in some cases as in the three case-study clusters?

### 9.3.3 Why does environmental policy work in some cases?

#### 9.3.3.1 Triggering the change

In each case study cluster, policy intervention brought in technological change in the 1990s (Table 9.2). The issue is: what has been the main driver or the triggering factor(s) for bringing about the change? Was it the environmental policy or any other factor(s)? It was primarily reasons beyond the concern for environment or inefficient use of energy that triggered the change. Basically, it was judicial intervention in response to public litigations and civil society concern that played a critical role.

**Foundry industry, Howrah:** Compliance with the specified emission standard in the cluster with a niche market for low-grade castings was limited, until the intervention of the Supreme Court. A judicial order issued by the Court increased enforcement measures of the regulatory bodies (PCBs) and led to almost all the units installing PCDs in order to comply with the emission standard (some units closed down). It however did not lead to sustained enforcement (many PCDs are inefficient and not properly maintained; some operate only during inspections; entrepreneurs perceive cleaning technology a liability). The regulatory standard was supplemented for a fixed period with a partial subsidy for PCDs. This led to a joint initiative between a local industry association, a technical institute and a financial institution for assisting in PCD installation in select small units and recommending better technology design.
Glass industry, Firozabad: Fuel switching in this large cluster occurred following the Supreme Court’s order to ban use of coal and recommending a shift to natural gas in the Taj Trapezium Zone (TTZ). The Court’s order was in response to a PIL for protection of the Taj Mahal, a heritage monument. This illustrates a case of a strong policy provision, but without focus on efficiency considerations and inadequate infrastructure. After initial resistance and stringent enforcement measures by local authorities (including radical measures such as forcing shut-down of furnaces by pouring water), many units initiated a switch to natural-gas furnaces, while some coal-based units also closed down. The economic benefits of natural gas (reduced production costs) in addition to the regulatory pressure led to more units making the switch and even smaller units exploring this option. The larger units that receive natural gas supply are even subletting their space and infrastructure to units that have been unable to access natural gas supply. However, coal is still being used in several units. In addition, technical support was offered by setting up a technical institute specifically for

Table 9.2: Environmental policy and implications

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Foundry (Howrah)</th>
<th>Glass (Firozabad)</th>
<th>Brick (Chandigarh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Policy focus</td>
<td>End-of-pipe technology</td>
<td>Fuel-switching</td>
<td>Technology forcing</td>
</tr>
<tr>
<td>Main policy instrument</td>
<td>Emission standard</td>
<td>Ban</td>
<td>Emission standard, technology standard (incl. ban), rule (fly ash use)</td>
</tr>
<tr>
<td>Recommended action</td>
<td>Install pollution control device (PCD)</td>
<td>Shift from coal to natural gas use</td>
<td>• Switch from moving to fixed chimney BTK</td>
</tr>
<tr>
<td></td>
<td>• Regulatory (threat of penal action)</td>
<td></td>
<td>• Use fly ash (for units near power station)</td>
</tr>
<tr>
<td></td>
<td>- No-objection certificate from state Pollution Control Board (PCB) required</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Periodic revisions in the standard</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Economic: Subsidy for PCD (for a fixed time period)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main incentive</td>
<td>• Regulatory (threat of penal action)</td>
<td>• Supreme Court order to ban coal in Taj Trapezium Zone (TTZ)</td>
<td>• Regulatory (threat of penal action)</td>
</tr>
<tr>
<td></td>
<td>• Supreme Court order to ban coal in Taj Trapezium Zone (TTZ)</td>
<td>• Commencement of natural gas supply</td>
<td>• Technical consultancy package offered by government-approved department (not subsidized)</td>
</tr>
<tr>
<td></td>
<td>• Technology institute for the cluster</td>
<td>• Technology institute for the cluster</td>
<td>• Approved technology provided easier access to license and enforcement by local authorities</td>
</tr>
<tr>
<td>Main effect</td>
<td>• PCD in all units (may/may not operate efficiently, or may be operated only during inspections)</td>
<td>• Fuel switch in many units (without focus on efficiency). Others face relocation/closure threat</td>
<td>• Prescribed technology in all units</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Coal still being used in many units (including unregistered small units)</td>
<td>• Hardly any change in operating practices</td>
</tr>
</tbody>
</table>


the glass industry. With little interaction with entrepreneurs however it has failed to meet the needs of the cluster and is often referred to as the ‘white elephant’.

**Brick industry, Chandigarh:** Technology-forcing in this SSI was brought about by introducing an emission standard which included a ban on the conventional form of brick kiln technology. The enforcement of a standard was pushed following the Supreme Court’s response to a PIL that highlighted the adverse impacts of coal use in the SSI. However, compliance was achieved in the cluster largely because an alternative technology (not too expensive compared to the conventional one) was provided as a consultancy package (not subsidized) by a technical institute. This technology was approved by the local authorities and helped the units in getting required licenses. The regulatory pressure (reinforced due to the close proximity of the units to the state capital), however, did not encourage improvement in operational practices, in spite of increasing awareness and technical levels of the entrepreneurs.

9.3.3.2 So, is environmental policy a driver?

The evidence indicates that environmental policy is ‘diffusion forcing’ provided there is effective enforcement of the policy provisions in the SSIs. Thus, it is the enforcement of environmental policy that is diffusion forcing, and not the policy in itself. In the case study SSIs, policy instruments were introduced long before a change was brought about essentially through strict enforcement measures. These measures included increased inspections by regulatory authorities and threat of closure of the units. In the case of the brick SSI, reduced bureaucratic procedures for obtaining licenses once the recommended technology was in place was an added incentive. The enforcement itself is triggered by external factors; here, it was judicial intervention.

9.4 Gaps in the current paradigm

The above sections indicate that there are no off-the-shelf or blanket solutions in dealing with the different SSIs. Stand-alone incentives and top-down initiatives (for example, a high-profile technology institute for the glass industry) are less likely to work and an integrated approach may be necessary based on the existing circumstances. The contextual factors shape the activities and influence the impact that policies have on the SSI–environment interactions. There is, therefore, a need to move beyond the current capacity-building and regulatory measures to (i) increase focus on energy efficiency and cleaner technologies, (ii) strengthen the incentives for motivating and providing easy access to finance and appropriate technologies, and (iii) take steps to integrate environmental and promotional policy objectives, the former including global environmental considerations as well (Table 9.2). In addition, a greater ‘policy push’ together with social awareness (and judicial watch) in terms of effective enforcement of regulatory provisions is required.

A critical need is ‘effective’ capacity building; in terms of awareness, environmental consciousness, marketing and managerial skills, technologies, etc. Capacity-building programmes are organized by various organizations (SSI associations, government departments, technical institutes, NGOs, financial organizations and even private
Table 9.3: Towards a sustainable paradigm for SSIs

<table>
<thead>
<tr>
<th>Contextual factors/issues*</th>
<th>Current paradigm</th>
<th>New paradigm</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal (and environmental)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Traditional, informal set-ups</td>
<td>Low energy efficiency and environmental concerns</td>
<td>Effective capacity building:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Awareness and skills: Technical, management, marketing, etc.</td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Support available, but for cleaner technologies in particular it is limited</td>
<td>Limited finance for cleaner technogies</td>
<td>Easier and increased access to finance for cleaner technologies</td>
</tr>
<tr>
<td>• Reliance mainly on family or informal sources</td>
<td></td>
<td>• Increase support options</td>
</tr>
<tr>
<td>• Limited marketing skills, access</td>
<td></td>
<td>• Increase awareness, capacities</td>
</tr>
<tr>
<td>• Increased market competition</td>
<td></td>
<td>• Reduce transaction costs</td>
</tr>
<tr>
<td>• No market premium on cleaner products/processes</td>
<td>Fixed markets and products</td>
<td>Avail market opportunities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Build on market opportunities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Incentives for cleaner products, processes (economic or regulatory)</td>
</tr>
<tr>
<td><strong>Technological</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Limited technical support and access to appropriate technology</td>
<td>Dependence local capacity (lock-in)</td>
<td>Context-specific, targeted technical solutions building on existing capacities</td>
</tr>
<tr>
<td>• Infrastructural factors (availability of raw material, cleaner fuels, basic infrastructure)</td>
<td></td>
<td>• Access to information</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Access to appropriate technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Capacity building (entrepreneurs and workers)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Better infrastructure</td>
</tr>
<tr>
<td><strong>Social</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Attitudes and mindsets</td>
<td>Limited awareness and networking</td>
<td>Target collective efficiency</td>
</tr>
<tr>
<td>• Limited networking</td>
<td></td>
<td>• Motivate and strengthen associations, nodal agencies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improve networking among stakeholders</td>
</tr>
<tr>
<td><strong>Policy specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Concessions for SSIs (including political motivations)</td>
<td>Weak incentives: Limited regulatory policy push and motivation</td>
<td>Increased policy incentive for cleaner technology</td>
</tr>
<tr>
<td>• Enforcement is weak</td>
<td></td>
<td>• Better information and awareness among stakeholders</td>
</tr>
<tr>
<td>• Focus on end-of-pipe technolgy (extreme cases relocation, closure)</td>
<td></td>
<td>• Effective enforcement</td>
</tr>
<tr>
<td>• Focus on local pollution</td>
<td></td>
<td>• Focus on energy efficiency and cleaner technology</td>
</tr>
<tr>
<td>• Promotional and environmental policy objectives distinct</td>
<td></td>
<td>• Integration of promotional and environmental goals</td>
</tr>
</tbody>
</table>

Notes: * For detailed discussions of the contextual factors and policy specific issues see 9.2

bodies); however, more often these are top-centric and not needs-driven. A policy response will be to modify the existing programmes and develop context-specific and needs-based ‘capability enhancing’ approaches with focus on cleaner technologies.
and targeting various stakeholders (entrepreneurs, workers, technology suppliers, financial institutions, policy makers, etc.). The programmes may be geared towards increasing environmental consciousness and awareness regarding policies, benefits of cleaner technologies and market opportunities.

Another angle is awareness and information of other stakeholders regarding the SSIs. At present, the official database on energy usage and environmental impacts of SSIs is insufficient (Section 3.3). The information base has to be built and will be useful in policy formulation and implementation. In addition, an essential pre-requisite for effective policy enforcement will be building capacities of the PCBs and relevant authorities in terms of scientific, technical as well as administrative matters.

Access to finance has been the focus of national SSI policy since the initial formulation of the policy. Significant incentives are provided, but those for cleaner technologies are still limited. The finance may be provided by local, national or international sources. Given that private and informal funds are already being used and government funding is available (with focus on SSI promotion rather than environmental impact), there is still a large demand–supply gap. An option could be to merge technology and environmental funds to focus on cleaner technologies. Additional and targeted funds are clearly needed, and one option could be through CCIs. However, considering that SSIs prefer informal sources of funding, these funds will have to be made accessible to SSIs; for example, by increasing awareness regarding these opportunities and reducing the transactions costs.

Another way of providing economic incentives is by assisting in utilizing market opportunities. Increasing competition is creating market opportunities, but many SSIs perceive this as a threat and uncertainty for the future (several SSIs are closing down as toy manufacturing units facing competition from China). The sector would have to be geared towards facing competition, wherever applicable, and availing the opportunities. The current efforts in this regard need to be strengthened and use of cleaner production emphasized. Incentives may also be provided by facilitating a ‘market premium’ on cleaner products and processes or at least ensure that they are not at any disadvantage. This may be, for example, in the form of a mark-up on the market price or even a certification (e.g. the eco-mark). However, producer and consumer awareness and consciousness will be critical in making such a scheme effective.

Improved access to appropriate technologies, which are affordable, efficient and suitable for local conditions, is needed along with effective technical support and proper infrastructure. One of the main reasons for most demonstrated technologies not being replicated in practice (such as CDGI designs, TERI–SDC design for DBC and efficient pot furnace) is their costs especially the initial costs relative to other existing technologies. For instance, a small clamp owner will find it difficult to change over to a VSBK for reasons including high upfront costs, little flexibility, and the need for fixed land and workers. On the other hand, the PSCST brick design has been replicated, not only due to regulatory pressure but also its affordability.
It is also observed that though there exist opportunities for technical support, most innovations have come in by building local capacities and by local actors (workers or entrepreneurs). For example, CDGI was set up before the ban on coke was recommended by the Supreme Court but it played an almost negligible role in the fuel shift across the cluster. Thus, efficient technical support is required in line with the needs of the SSIs. In addition to this, another basic requirement of any industrial unit is the infrastructure, not only in terms of basic amenities (power supply, roads, etc) but also availability of raw material and fuels.

Evidence indicates that a few units gain from the support, service and opportunities, and thereby highlights the need to target collective efficiency and facilitate networking. The existing networks (such as SSI associations, unions, NGO networks) may be strengthened and developed so that they provide an interactive platform for exchange of ideas and taking proactive steps for meeting technological needs. Strong associations enhance the entrepreneurs’ confidence in the measures being implemented and thereby their success rates (as in the case of AIBMF for brick SSI, and HFA for the foundry cluster). Greater interaction is needed among entrepreneurs as well as different stakeholders including financial organization, technical institutes, government departments, regulatory authorities and NGOs. Representation of SSIs in relevant policy-making and review forums, which has been missing till now, is especially required to bring transparency and encourage cooperation.

9.5 In conclusion

The discussions in this chapter indicate that there has been very little technological change in the SSIs over a long period of time. One of the reasons has been the perverse incentive created by the national policy characterized by regulatory instruments focusing on end-of-pipe solutions and a protective approach due to social and political motivations. The other has been the SSIs’ own limited technological capabilities (production, innovative and investment capabilities) coupled with social (attitudes and culture) and techno-economic (including lack of market demand and access to technology and finances) deterrents. Initiatives to change the status quo have been successful only in some cases wherein the push has come from external sources; more often the piece-meal approaches benefit only a select few. A transition to the new paradigm therefore requires an integrated approach, under which increased regulatory push, effective capacity building, adequate financial and technological support, possible market incentives and networking are facilitated. However, the question remains: how can this be done?

Theory lists various pathways or levers for change, including private (SSI-unit level), community (networks, associations) and policy-driven initiatives. Owing to the prevailing contextual factors (such as low capabilities, intra-cluster competition and limited networking for community initiatives), it is difficult to envisage that the SSIs themselves would undertake concerted efforts for cleaner technology diffusion. Though networks and associations have proactively or collaboratively brought a
change in some cases, they usually do not really focus on cleaner technologies diffusion. The national policy provides but limited incentives for cleaner technologies.

In addition to these, the CCIs provide incentives for cleaner technologies by offering opportunities for capacity building and increased access to additional funding, technologies and market avenues (for GHG credits). Mapping SSI needs with the CCI objectives indicates that in principle the CCIs can assist in the transition as can the national policies. For example, they could facilitate targeted capacity-building activities, address the issue of putting a premium on cleaner products and processes, support programmes for improving basic infrastructure and access to cleaner fuels, and also assist in developing the existing initiatives further. The issue is: can CCIs help the SSIs, and whether SSIs can make use of the CCIs and in turn contribute to GHG reduction efforts. This CCI–SSI link is addressed in the next chapter.
10. Towards a new paradigm

10.1 Introduction

Climate change is a global problem that calls for internationally negotiated global solutions to address rising GHG emissions in the atmosphere. Although the institutional and legal framework to address the problem is determined basically at the international level, the human activities that impact the climate occur at the national and, more specifically, at the local levels. Therefore, while the broad environmental policy issues are coordinated at the highest level of governance, the struggle for ecological sustainability must ultimately be won at the local level (Costanza et al. 1997). It is in this regard that this thesis has looked at the link between the global climate change policy (with focus on CCIs) and a local-level SSI activity.

The research essentially deals with this link at three levels, the international, national and the local. Thereby, it examines the role of CCIs in shaping SSI–environment interaction by looking into the implications of the international and national climate change policies and the (local) contextual factors. The initial proposition was that the CCIs will not focus on the SSIs, unless appropriate measures are applied (Section 1.2). This chapter revisits this proposition, and concludes that, in the present scenario, the link between CCIs and SSIs is weak (10.2). Further, it provides recommendations for possible policy responses for strengthening the link (10.3) and how these recommendations may be operationalized. The chapter and the thesis conclude with discussion on practical lessons and theoretical insights (10.4).

10.2 The CCI–SSI link

The rationale for examining the CCIs–SSIs link was discussed in Chapter 1: can CCIs act as a lever for sustainable development and efficiency improvement in local industries? Chapter 2 brings out the complexities while dealing with international policy instruments designed to protect a global public good in a political setting, with scientific uncertainty and several heterogeneous actors involved at different levels of social organization. The number of actors in any case complicates the design and effectiveness of policy instruments (Section 2.2.3). It is further maintained that SSIs form a diverse group of small industrial units, often located in clusters, and having significant relevance for sustainable development. The issue here is whether the link between CCIs and SSIs exists.

A broad mapping of CCIs’ objectives and the SSIs’ needs does indicate synergies between them. CCIs can facilitate sustainability in SSIs, and SSIs can help in the global efforts for addressing climate change (Section 9.4 and 9.5). However, in the current scenario it is difficult to envisage a strong link between CCIs and SSIs. This section
provides a further examination of the link using arguments and counter-arguments to determine whether it is a ‘\textit{weak link}’ and, if so, then why.

10.2.1 Climate change instruments

The climate change policies and policy instruments are based on the economic theory of environmental protection (Section 2.2). The CCIs relevant for developing countries have dual objectives of facilitating sustainable development at the global (GHG reductions) and the national/local levels (additional economic, social and environmental benefits). While the initial focus of the climate change regime was on a subsidy-based financial mechanism, the emphasis over the last decade has been on market-based economic instruments (Section 4.2). The main argument (A) for the use of CCIs is that they promote diffusion of cleaner technologies across various sectors including the SSIs. However, the counter-argument (C) is that the CCIs tend to focus on specific sectors and SSIs are generally ignored.

10.2.1.1 Arguments

The main argument (A) underlying the CCIs is that they are designed to provide incentives for undertaking climate-relevant activities. Recognizing the needs of developing countries, they offer solutions that are cost-effective on a global basis and facilitate additional sustainable development benefits. These could include or be extended to SSIs in India as well. The argument is based on the incentives they provide \textit{per se} as solutions to the global problem of climate change.

The first sub-argument (SA1) is that the CCIs provide incentives including economic opportunities for additional finance (grants, concessions, incremental costs and credit pricing), cleaner technologies (including through technology transfer) and suasive capacity building. As the focus is on sustainable development and ‘additional’ global environmental benefits, they have a broader agenda than other environmental policy instruments. With the market-based instruments becoming increasingly important, the CCIs are geared to encourage not only government but also private-sector investments and a large market for climate-relevant activities is envisaged. The energy-intensive SSIs, in light of their energy-saving potential, may make use of the incentives to improve sustainability in their sectors. For instance, the CCIs could address SSI needs by facilitating targeted capacity-building, address the issue of putting a premium on cleaner products and processes, support programmes for improving the basic infrastructure and access to cleaner fuels for the SSIs (Sections 9.4 and 9.5). SSIs, in effect, fare strongly on two accounts: ‘additionality’ and national sustainability benefits. SSIs constitute a sector where very little happens on its own in terms of pollution control and climate change, and needs an external impetus. SSI development is also a national priority, especially as SSIs will continue to provide economic and livelihood opportunities to significant proportions of its rising population.

The second sub-argument (SA2) pertains to the inclusion of small projects under CCIs. The main deterrent for inclusion of small projects in normal circumstances is the associated transactions costs, which are higher for the smaller projects on a rela-
tive basis. Recognizing the need for special consideration, initiatives have been undertaken to bring smaller projects within the purview of CCIs. These include simplification of procedures and streamlining methodologies aimed at lowering the transactions costs, platforms such as the Small Grants Programme and Project Development Funds (PDF) under the GEF, and introduction of the small-scale CDM allowing for bundling of projects and other initiatives such as the CDCF and those targeted at intermediates that facilitate interventions in the SSIs (Section 4.3.1). They bring down the transactions costs and provide added incentive for inclusion of smaller projects including those in the SSI sector.

The third sub-argument (SA3) pertains to national policies in India and how they address climate change issues. As a signatory to the FCCC, India is committed to incorporating climate-change considerations in its development policies and strategies. It is undertaking several initiatives under its economic and energy policies that are also climate-relevant, such as increasingly emphasizing energy efficiency under the energy policy (Section 4.4.1). These have implications for the SSIs as well. With significant GHG emissions, India offers a range of potential mitigation options including those in the SSI sector. In order to tap these opportunities it provides a conducive policy environment by institutionalizing a basic framework for approvals, and is perceived as a key host nation for undertaking CCI-relevant activities. For instance, India is among the leading countries having a large pipeline of potential CDM projects. The government is also slowly shifting towards a more active role along with other stakeholders including the private sector.

10.2.1.2 Counter-arguments

The counter-argument (CA) is based on experience and current trends related to the climate change policy. The CAs highlight the key issues influencing potential CCI incentives, which are the basis for the first sub-argument (SA1). Chapter 2 has highlighted these issues as uncertainty, transactions costs and market biases. These are reinforced based on practical experience. The various climate change portfolios, international and in India, comprise a large number of projects. However, only a few of these projects are in the SSI sector, with a focus on capacity building. This indicates that the CCIs, especially the market-based instruments, tend to focus on specific sectors such as renewable energy, and in the process SSIs are generally ignored.

The first sub-counter-argument (SC1) relates to the incentives provided by CCIs in the context in which they are designed and implemented. In principle, CCIs bring in opportunities for financial, technological and capacity-building inputs for developing countries. Analysis of the policy instruments has shown that the focus of CCIs has been on financial inputs with cost-effectiveness among the main criteria and not on technology transfer. The financial resources made available in terms of direct international transfers and subsidies are significant, but small compared to magnitude of the climate change problem (IPCC 2000). The carbon market, especially under CDM, creates financial opportunities; however, its evolution has been speculative in light of uncertainties pertaining to the future of the climate change regime and mo-
dalities related to the instruments. The size of the market for carbon credits from developing countries is increasing rapidly since the ratification of the Kyoto Protocol, modalities becoming clearer and as the first commitment period draws closer. The price of carbon credits offered (generally just a mark-up price as discussed in Section 4.3) however, normally does not reflect the ‘real costs’ of carbon credit based on marginal costs of GHG mitigation (principle on which the JI concept is based), and may be termed as just ‘icing on the cake’ for developing countries.

The other factor conducive for inclusion of SSIs is the dual objectives of the CCIs. However, experience shows that the activities are often driven by motivations of different actors rather than the sustainable development objectives, be it direct international transfers, subsidy-based mechanisms or market-based instruments. For example, in the case of market-based instruments the foremost investor focus is non-risky and cheap carbon credits with many a time other criteria not adequately addressed. The carbon markets being largely investor-driven (the buyers are far less compared to the sellers) and often the projects consultant-driven, brings in biases. Developing countries, including India, do not display a proactive stance, and there is no concrete ‘host country-driven CCI programme’. Given all this, the ‘top-down’ approaches and cost-effectiveness criterion tend to undermine the importance of additional national and local level benefits, which make a case for the SSIs.

The next sub-counter-argument (SC2) is that the initiatives for inclusion of small-scale projects do not imply that SSI projects are being undertaken. In the current climate change portfolios, there are but a few cases of SSI-relevant activities (e.g. GEF-IFC SME project, fly ash bricks project under the CDCF, steel projects under GEF and CDM in India); however, these are geared more towards capacity building (awareness, demonstration projects) rather than towards actual implementation of cleaner technologies in the SSI units. There is no contention that the ongoing initiatives raise the probability of SSI inclusion. However, sustained efforts are required before a more level-playing field exists for SSI-related activities. For example, the transactions costs for the small-scale CDM projects, though reduced by an estimated 50–65% relative to transactions costs of regular CDM, still remain as high as up to several hundred dollars. SSIs in developing countries including India generally lack economic capabilities to meet these costs.

The third sub-counter-argument (SC3) deals with the climate change activities and related policies in India. In the current scenario, there is international interest in India (and China) as it is a significant contributor to GHG emissions, and the large number of projects being developed also indicates the attractiveness of the nation from the point of view of climate-relevant activities. However, the focus has not been on the SSIs. For instance, take the case of the CDM – India has the largest number of CDM projects that are being developed, but the point is how many of them involve energy efficiency improvements in the SSI sector? Considering that the investors are looking for cheap and non-risky carbon credits, and that most of these projects are unilateral projects pushed by consultants or the private sector, the investors’ interest and emphasis on the SSIs is low (Section 4.4.2). In several international multilateral or bi-
lateral meets and conferences related to climate change, there is representation of Indian industry, but within that the SSIs are practically absent. Thus, in the international arena, the SSIs do not emerge as dominant or even average players.

10.2.2 Diffusion of cleaner technologies in the SSIs

The main argument (A) for SSIs assisting in the global efforts towards addressing climate change is that diffusion of cleaner technologies within the sector can be encouraged with the help of CCIs. However, the counter-argument (CA) is that although the energy usage patterns in the SSIs do provide a lot of scope for energy saving and thereby GHG emissions reductions, it is difficult for them to make use of the incentives that CCIs provide.

10.2.2.1 Arguments

The main argument (A) is based on the local context and the circumstances within which the SSIs operate. While the prevailing practices and the energy usage pattern have led to inefficiencies in the production system, the social organizational factors have resulted in a lock-in situation in many SSI units. The overall macro-economic (and sectoral) policy environment in the country poses significant challenges for the sector and induces the need for efficiency improvements.

The first sub-argument (SA1) pertains to the SSI–environment interaction, specifically the environmental impact of the existing energy-use patterns in the SSIs. Evidence indicates a significant potential for efficiency improvements and adoption of cleaner technologies. For instance, the energy-saving potential in many units surveyed was around 50%. These may not appear to be ‘climate relevant’ at the face of it; however, aggregation of emissions across several units in geographical clusters reflects a significant emission contribution (a case for collective efficiency or externalities) as has been illustrated by the case studies (Section 9.2). The relevance is even greater for national sustainable development benefits, particularly in terms of local environmental or pollution problem as well as working conditions.

The second sub-argument (SA2) stems from the current national policy environment in India and the incentives they provide to SSIs to adopt cleaner technologies. The macro-policies aimed at liberalization and globalization of the economy is reflected in the sectoral policies as well. While SSIs still enjoy special consideration due to their social and economic relevance (SSI policy recognizes equity as the guiding principle), the national SSI policy is gradually shifting from a protective to a promotional focus (Section 5.5). These pose a challenge for SSIs to increase their efficiency in light of increasing competition from within India and from other countries.

In addition, it is projected that the national environmental policy is going to become stringent. The overall global landscape is also shifting towards increased environ-

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276 The recent Central Budget (2004) of the Government of India also acknowledges this by announcing de-reservation of 85 projects of the SSI sector.
mental consciousness, including climate change concerns. As a signatory to the FCCC, India is committed to incorporate climate change considerations in its development policies and strategies, and is undertaking initiatives under its economic and energy policies that are also climate relevant such as promotion of energy efficiency and renewables. The Tenth Five Year Plan of the Government of India as well the Approach Paper to the Eleventh Five Year Plan recognizes the link between economic development and environmental degradation. In this scenario, and given that the technological and economic capabilities of many SSI units are limited (Sections 9.4 and 9.5), there is a need for external stimulus for cleaner technology diffusion, including CCIs as possible options.

The third sub-argument (SA3) pertains to the national policies relevant from the perspective of climate change and CCIs. There is substantial interest in the CCIs in India, especially related to the market-based instruments, which is relevant across sectors (Section 4.4). The government is also slowly shifting towards a more active role (DNA for CDM, NATCOM process for developing national inventories, listing the approval criteria for CCI projects, etc.), and several other stakeholders (private sector, financial organizations, consultants, NGOs etc.) are getting involved. Industrial organizations and the private sector view these as an opportunity for technology upgradation, and consultants and organizations are offering services in terms of scientific and technical assistance in developing CCI-relevant projects. There are several projects developed or in the pipeline under the CCI platforms, which also include select initiatives in the SSI sector (for example in brick and steel re-rolling units, and capacity building for small-scale CDM projects). Thus, the overall framework is conducive for developing CCI projects for the SSI sector.

10.2.2.2 Counter-arguments

The counter-argument (CA) pertains to the conditions that constrain the SSIs in availing the incentives under the CCIs. These stem basically from the policies and contextual factors or the circumstances (internal and external) that surround SSIs. These impact the SSIs and their ability (in spite of them being important candidates for CCI) to leverage opportunities offered by climate change policies. The SSI sector in general is associated with low awareness and transactions costs.

The first sub-counter-argument (CA1) is based on energy usage in the SSIs. Energy inefficient practices offer options leading to GHG reductions and national and local sustainable development benefits. However, attractiveness of these options depends on the contextual factors as well. Aggregation of units or a cluster approach brings in collective efficiency and provides the GHG benefits that CCIs look towards, especially in the context that the SSIs operate on an informal and dispersed manner which increases the transaction cost. Since there is hardly any monitoring of energy usage in SSIs which is essential under CCIs, the transaction cost will further increase. The task is to bundle units with common characteristics but yet quite heterogeneous for undertaking climate-relevant activities. At the same time, most of the SSIs are unaware of the emerging opportunities and associated procedures under emerging envi-
ronmental negotiations. Owing particularly to socio-political and economic factors the SSIs are also not motivated enough to introduce clean technologies unless some external impetus such as regulations and judicial orders are made mandatory. Networking among the units as well as with other relevant organizations (financial and technical organizations, NGOs) is also limited, and the linkages with the state and government departments are inadequate. While the current energy usage pattern in SSIs do provide potential, however, there are greater challenges related to input and transaction cost which make it difficult for GHG mitigation options in the SSIs be taken up by the CCIs, especially under the existing market-based instruments.

The second sub-counter-argument (CA2) pertains to the current and emerging challenges faced by the SSIs that provide an incentive for them to adopt cleaner technologies. The challenges include increasing competition in face of a liberalized policy environment, and the threat of stringency of environmental policy in the future. However, SSIs still enjoy, though reduced, preferential treatment under the national SSI policy, which weakens this incentive. The largely regulatory environmental policy for SSIs provides concessions and is constrained in terms of enforcement (including at times lack of political will to enforce the policy provisions). The SSIs also lack experience related to market-based instruments or formal incentives as those provided by the CCIs. The emphasis of national policy is on end-of-pipe solutions and there are no standards for CO$_2$. Thus, the focus on energy efficiency improvements in SSIs and on global environmental concerns has been limited. Environmental consciousness in the sector and the urgency for environmental improvement is low, except in some cases for reasons other energy efficiency concerns (Section 9.3.1).

In addition, there exists a gap between the promotional and environmental policy objectives related to SSIs. There are SSI-policy provisions aimed at technology upgradation and cluster development, but within these the provisions for cleaner technologies are limited in number and reach. Evidence has shown that more than 85% of the energy-intensive SSIs surveyed have not benefited from the incentives provided under national policies. Filling in this gap by diffusion of cleaner technologies is clearly an additional activity option for the CCIs. However, additionality aspects are not always adhered to as has been the experience with CCIs until now.

The third sub-counter-argument (CA3) deals with the national policy and perceptions with regard to climate change. The government is now slowly shifting towards a more active role in terms of CCIs and there is considerable interest among various actors, especially related to market-based instruments. However, there are still uncertainties and lack of a comprehensive policy, and many of these activities have remained top-centric though efforts are being made to take them to 'lower levels' as well (Section 4.5). The approval processes are associated with transactions costs. In climate change-related debates and activities, normally representation of SSIs is low or even non-existent. Information about the potential GHG-reduction options and needs of the SSIs therefore do not adequately reach higher levels. There are cases where consultants and relevant players are involving the SSI sector; but again com-
pared to the involvement of the other sectors this is quite limited. Therefore, it will be fair to say that SSIs are low in priority within the national climate change policy.

10.3 Policy responses to strengthen the CCI–SSI link

10.3.1 It is a weak link!

The arguments and counter-arguments presented in the previous section and summarized in table 10.1, indicate that the CCI–SSI link exists; however, in the present circumstances, it is a “weak link”. The ‘weakness’ in the link is based on the analysis of the policies and policy instruments at different levels of social organization and their interaction. At the local SSI level, there is low environmental consciousness and significant contextual barriers. At the national level, the SSIs are low on the priority list within the national environmental and climate change policies. In terms of CCIs, at the national and international levels, the incentives for SSIs are associated with uncertainties, transactions costs and market biases. In effect, the SSIs are not able to effectively utilize the emerging opportunities, and CCIs are unable to effectively target the GHG-reduction potentials of the SSIs. The weakness, therefore, also stems from the inadequate transmission of CCIs and the intentions they reflect. The ‘CCI-signals’, their objectives and incentives offered, somehow do not reach the local SSI performance and the local needs are not adequately comprehended or represented at higher levels. This, among other reasons, is due to a lack of fit at the different levels in terms of corresponding policies and instruments.

10.3.2 Potential policy responses

The CCI–SSI link may be strengthened to influence SSI–environment interaction, and to facilitate a transition to a new and more sustainable paradigm across the sector and globally. While policy intervention in this direction is a necessary step, perhaps it is not a sufficient one in practice. The organizations and agencies that connect the policies On the one hand and the SSIs on the other also need to be strengthened, such that they may operate towards enforcing the CCI–SSI link. Going back to the research framework (Figure 10.1), potential policy responses may be to: (a) strengthen the incentives that the policies and policy instruments provide, and (b) address the contextual factors by removing the barriers and reinforcing the drivers for diffusion of cleaner technologies in the SSIs. Additionally, response may be to (c) strengthen the synergies between policies and policy instruments at international and national (including state, industry, local) levels.

10.3.2.1 Strengthening policy incentives

The climate change policy implications for any sector may be significant, provided the incentives they offer are strong and are communicated accordingly. The strength of CCIs lies in their dual objectives. Following the “ideology of efficiency” (Bromley 1990), the policies that focus on cost-effectiveness and use economic instruments,
especially market-based ones, tend to ignore evolutionary characteristics of the climate change regime. Top-down assessments of the policy instruments in general do not capture the sectoral details and dynamic complexities of human actions especially at the local level. SSIs have a high potential to contribute to sustainability, but lack the ability to attract investments in a pure market situation.

Table 10.1: The CCI–SSI link

<table>
<thead>
<tr>
<th>Arguments</th>
<th>Counter-arguments</th>
<th>Potential policy response</th>
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</thead>
<tbody>
<tr>
<td><strong>Link between CCIs and SSIs: CCIs as levers for sustainability in SSIs</strong></td>
<td></td>
<td></td>
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<tr>
<td>(SA1) Incentives</td>
<td>(CA1) Issues (not technology transfer)</td>
<td>• Build focus on sustainable development benefits</td>
</tr>
<tr>
<td>• Opportunity for finance, technology, capacity building</td>
<td>• Focus on cost-effectiveness (not national sustainable development benefits)</td>
<td>• Address market biases</td>
</tr>
<tr>
<td>• Dual objectives: global and national/local sustainable development</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(SA2) Incentives for inclusion of small-scale projects under CCIs</td>
<td>(CA2) Transactions costs are high</td>
<td>• Further reduce transactions costs</td>
</tr>
<tr>
<td>(SA3) Climate change considerations in India’s national policy</td>
<td>(CA3) Focus on few sectors and investor and/or consultant-driven projects</td>
<td>• Build focus on sustainable development benefits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reduce (national level) transactions costs</td>
</tr>
</tbody>
</table>

| **Link between SSIs and CCIs: SSIs as candidates for GHG reduction by using CCIs** |
| (SA1) SSIs offer GHG reduction potential and sustainable development benefits | (CA1) Low environmental concern and policy pressure (not technology transfer) | • Reduce (local level) transactions costs (build on collective efficiency) |
| • Transactions costs at SSI cluster level are high | | |
| (SA2) SSIs face challenges under national policy (macro: liberalization, globalization; SSI: shift from protection; environmental: stricter instruments) | (CA2) Contextual factors including concessions, weak enforcement and disjointed policy objectives leading to technology lock-in | • Address relevant contextual factors |
| • Integrative development and environmental objectives | | |
| (SA3) Position regarding CCIs | (CA3) Involvement (not a priority) | • Adopt a clear and proactive approach |
| • Basic structure for CCIs in place | • SSIs are low in priority in climate change policy | • Facilitate inclusion of SSIs |
| • Stakeholders interest (including some initiatives for SSIs) | | |

This necessitates a greater focus towards host-driven projects, integrating sustainable development and climate change benefits, and developing clear indicators of sustainable development benefits. Research shows that the SSIs fail to effectively make use of incentives which come with complicated procedures and transactions costs. Efforts to reduce transactions costs and uncertainties (such as clear and transparent modalities and methodologies) will have to be built in as a policy response. In purely economic terms, this would push the abatement costs down and make the SSI-specific activities more attractive in the global carbon market. The initiatives to in-
clude small projects in the CCIs are useful but these are still limited in their implications for the SSIs, and may be accentuated. Some specific recommendations include:

**Fig 10.1: Strengthening the CCI-SSI link**
Reducing policy uncertainties: For a conducive and inclusive scenario, greater clarity regarding (a) direction of the international climate change regime, (b) approach of national policies to climate change and (c) modalities of the CCIs from the SSI perspective is needed. Scientific backing, technical knowledge and in particular political consensus are important in this regard. Initiatives are being undertaken, but the process may be accelerated through greater transparency, information dissemination, interactions and clear guidelines for CCIs at different levels.

In this direction, suasive measures for effective capacity building and increasing the knowledge base at all policy levels may be required. The knowledge base of those involved with climate change activities may be enhanced regarding the potential of the SSIs. At the same time, information related to climate change policies and the current and emerging opportunities including CCIs needs to be disseminated down to the SSIs. This implies building capacities not only at the macro policy-making levels, but also of decentralized entities such as district level authorities and local departments. In this regard, SSI participation may be facilitated in the different national and international environmental policy and climate change forums. As several CCI activities tend to be top-down, it may be important to have SSI representation, active involvement and understanding of their needs not only during project implementation but also during project identification and development. Specialized bodies or agencies may also be set up for disseminating information and also for developing SSI projects, helping in host–investor negotiations, and providing policy and technical advice.

In addition, a coherent national policy (with incentives for compliance) based on national priorities can be communicated to all stakeholders for greater clarity, which may draw and provide guidance on country priority listing of mitigation options that lend themselves to the CCI criteria. Given the importance of SSIs for national sustainable development, SSIs could figure high in this list.

Highlighting sustainability and additionality aspects related to the climate change activities: to address market biases, and provide stronger incentives for undertaking climate-relevant SSI projects. This may be done for the existing instruments through suasion and greater transparency. The national government in particular can play a proactive role by translating international CCI incentives and developing national CCIs, under which a sectoral or cluster-level emphasis may be provided. Innovative methods may also be introduced in this regard; for example, through

a. An additional incentive in the form of a “sustainable development premium” may be offered on projects with clear sustainable development and additionality benefits, as in the case of SSIs. This may be a direct incentive through a higher mark-up price (such as for CDCF) or just by giving a priority status to SSI projects.277

b. An international ‘sustainable development fund’ may be set up as a separate entity or a subset of an already existing mechanism (such as small-scale CDM or CDCF) to deal with SSI projects that have direct sustainable development bene-

277 For instance, small projects are already being encouraged by providing greater flexibility and reduced administration/certification costs.
This may also be done at the national level, as a national sustainable development fund. The government can also build such a national level fund by imposing a tax on each CER or project approved by the national authorities. This may be on an absolute or a regressive basis, and is relevant particularly for market-based instruments. The fund in turn can generate revenue for the government, which may be used for SSI promotion or developing climate-relevant SSI projects.

c. A National Carbon Fund may be formed wherein unilateral projects in the sectors including, or exclusively for the SSI sector are undertaken and the GHG credits offered in the carbon market. Till now, the investor countries have had their CCI programmes outlining their priorities, but no ‘real’ developing country programme has actually been put in place. This national-level carbon fund or a sectoral approach may be extremely useful in pushing SSI projects. Such a fund may also be developed by a group or a ‘cartel’ of developing countries.

Reducing transactions costs: This may be through: (a) clear guidelines, indicators and criteria for approval of proposals, (b) further simplification and streamlining of procedures for SSI-related projects at the international and national levels (for project development, approval, verification and certification processes, etc), and (c) greater transparency in all processes. This is especially useful for activities in SSIs.

In this regard, nodal agencies or intermediaries may be empowered for developing SSI projects. Schemes to build on existing networks and associations may be introduced and new partnerships developed by strengthening nodal agencies. This is highly recommended for the success of any climate-relevant CCI project and making the SSI–CCI link stronger. As illustrated by the case studies, national environmental policies have brought about greater diffusion of cleaner technologies when associations or nodal agencies are involved. Nodal agencies can act as an interface between the local level SSIs and the higher levels relevant for CCIs. They can provide a single-point contact for negotiations and reporting, be responsible for aggregation or bundling, and work towards bringing CCI signals to the clusters and communicating SSI needs to the higher levels. As SSI units are associated with low capacities, these agencies could function on their behalf to develop, negotiate and implement CCI projects. This all would in fact reduce the transactions costs at the local levels. Separate fund(s) may also be set up to help meet the existing transactions costs which may be

\[278\] The fund may be set up, for example, in addition to the three additional funds under the Kyoto Protocol; by collecting the proceeds by certification of CERs as the adaptation levy; based on the non-compliance fine principle, etc. The developing countries may even push these activities through a common position at the negotiations or under the market-based instruments forming a cartel for doing so; however, there are issues related to heterogeneity of countries and their political motives and stands.

\[279\] However, this can raise the costs of CDM vis-à-vis other policy instruments (including JI and GEF).
through specialized funds for only SSIs, or as *subset of existing instruments* (e.g. small-scale CDM with even lower transactions costs for SSI projects).

### 10.3.2.2 Addressing barriers to cleaner technology diffusion in SSIs

Contextual factors may be addressed by reducing barriers and reinforcing drivers for cleaner technology diffusion in SSIs and enable their participation in the CCI activities. While focusing on the micro details, however, the wider picture regarding the macro-context, and the complexities related to implementation of the policy instruments at higher levels of social organization (which are taken as given) may be left out. Thus, the contextual factors need to be addressed within the overall macro milieu. It is not just the techno-economic factors but an interplay of different factors that provide the overall context. In this regard, effective capacity-building and appropriate policy responses (Section 9.4) may be instrumental in making a difference. It is important however to move beyond piece-meal approaches to an integrated approach for overall development while addressing the climate change issue. In this regard, some recommendations include:

**Strong national policy incentives:** For this, the national policies may be designed for integrating environmental and development goals. They may also reflect global environmental goals to encourage policy-driven change for cleaner technology diffusion in the SSIs.

In effect, greater *policy push* in terms of effective enforcement of regulatory provisions and increased awareness, as well as their relevance for the SSI (Section 9.3) is required. The use of market forces and other economic instruments may also be useful in this regard. The policy may be structured so as to focus more on energy efficiency and cleaner technologies rather than end-of-pipe solutions, and even with clear incentives for addressing climate change which is missing in the current scenario. The *judicial system and the civil society* has been successful in some cases to bring about a change and may be further charged to do so, not in terms of local environmental issues but also those related to climate change. At present, however, official information regarding energy usage and environmental impacts of SSIs is insufficient (Section 3.3). This *information base* has to be built up, and *capacity-building* of all stakeholders will be useful in this regard. In addition, an essential requirement towards effective enforcement of policy provisions would be building capacities of the state PCB in terms of scientific, technical as well as administrative matters.

**Effective increasing awareness and building local capacity:** Since directly influencing the characteristics and operational practices of the SSIs is difficult; *effective capacity-building for the entrepreneurs and other stakeholders may be undertaken to reduce organizational and social barriers, either by targeting individual units or clusters through associations or agencies*. This is in terms of awareness and understanding, especially environmental concerns, energy-efficiency potentials, cost–benefits of cleaner technologies, and issues and opportunities related to CCIs. For SSIs to avail the available national policy and CCI incentives, they have to be made aware as well as capacitated and motivated. In addition, capacity-building in terms of marketing
and managerial skills, monitoring operations, and cleaner technological options, etc. may also be required. Monitoring, managerial and negotiating skills are especially needed for any CCI activities, which need to be built upon.

**Reducing other contextual barriers and building capabilities:** The other factors including techno-economic and political also impact SSI operations and practice, their technological capabilities (Section 2.3.4.1), and thereby the CCI–SSI link. The SSIs generally prefer informal sources of funding; however, capacities may be developed through integrated awareness and skill-enhancement approaches so that they are able to avail economic incentives under national policies as well as through CCIs. Local stakeholders such as financial intermediaries, local authorities and associations may also play a proactive role in providing training and assistance, and providing additional financing for such activities. Efficient technical support may be provided regarding technological options that are affordable, efficient and suitable for local conditions. Existing traditional expertise and knowledge may be tapped and built upon. Information related to design, costs, operations and maintenance of technologies; and adequate infrastructure including basic amenities, raw material and quality fuels may be made more available. Monitoring stations and tool rooms are already supporting SSIs (chapter 4), but may be made more accessible along with information technology, which may be useful for availing potential CCI incentives. The idea is provide an impetus for a technological shift not only in developing appropriate technologies and demonstration projects or laboratory technology but in their dissemination as well.

**Facilitate networking and strengthening intermediaries** for ensuring that more SSIs gain directly from the available and potential support and opportunities. As mentioned above, existing networks and local organizations may be strengthened and specialized agencies established, such that they may play a proactive role in diffusion of cleaner technology as well as in developing climate-specific activities in line with the industry needs. Routing support through an association also enhances confidence in the measures and thereby their success rates. These could provide targeted training and also facilitate bundling and assist in developing and implementing energy efficiency and climate-relevant projects in the SSIs. Entrepreneurs’ confidence in these bodies is important, which can also provide an interactive platform for exchange of ideas as well as taking proactive steps in meeting their other needs (including hiring consultants, technical help and negotiations).

However, it is also for the SSIs to learn and avail the opportunities that the climate-change policies provide. As the saying goes “you can take the horse to the river, but you cannot make it drink”. The entrepreneurs’ motivation and mindsets play an important role by which they can organize themselves. One such community-driven innovative method is by organizing a GHG cooperative, which is a good option for the SSIs to come together in a mutually beneficial way. For instance, if an SSI cluster organizes itself as a cooperative to undertake an activity under a specific, particularly market-based CCI; the cooperative can take care of the administrative aspects and
develop the project and also market their GHG credits, whereas the SSIs individually undertake climate-relevant activity and share the benefits amongst themselves.

10.3.2.3  

**Strengthen synergies between policies at different scales**

In order for the CCI signals from the international policies to reach local levels, it is important to mainstream global environmental goals into national SSI policies. In addition, national considerations and aspirations have to be taken into account while negotiating and implementing the global policy instruments. These need to be supported by *political consensus* at all levels as well as scientific knowledge. In addition, while the national SSI policy focuses on regulatory instruments, CCIs concentrate more on economic incentives. Therefore, synergies between institutions are as important as the institutions themselves. The international institutions, which operate on ‘governance without a government’ basis and essentially through national policies, need to recognize these synergies at the local levels for them to be effective.

At the international level, the national policy objectives may be integrated into the broader climate goals. The emphasis on ‘sustainable development’ benefits is a key, but actually implementing the climate activities, which are in congruence with the national objective, is also important. The international instruments may be used not only to develop but also to *facilitate new, or support the existing, national (and sectoral) programmes for SSI development* that also contribute to GHG reduction efforts. This may be either by direct intervention like financing a programme for technology dissemination in a particular cluster or by indirect intervention such as infrastructural development (providing delivery mechanisms for access of cleaner fuels, technology development for the SSI sector, e.g. under the cluster development programmes) that impact the SSIs in cleaner technology diffusion.

At the national level, international policy instruments may be translated into national and sectoral policy instruments. This has been missing till now. In addition, national and sectoral programmes may be developed to reflect global environmental objectives and the latter transmitted at the lower levels. Thereby, political willingness, SSI acceptability as well as institutional linkages and policy guidance at various levels need to be enhanced for catalysing CCI projects at the local levels such as SSI clusters. The current scenario also calls for a *greater interaction* between different stakeholders including financial organization, technical institutes, government departments, regulatory authorities and NGOs at various levels. Representation of SSIs in relevant policy-making and review forums is especially needed to bring in greater transparency and encourage cooperation. In addition, the coordination of all climate-relevant policies has to be made more effective.

In order to strengthen the linkages between institutions and human actions at different scales, there will have to be a convergence of interests, change in mindsets, as well as initiatives taken to address the issues and for using climate change instruments to address global problems as well as local sustainability needs.
10.4 In conclusion

Global environmental problems can be aggravated by large as well as small-scale human activities. Given the spread of SSI activities in the developing countries, ignoring them would lead to not addressing an important segment of the problem. The study was therefore initiated with the objective of developing an understanding on how the global climate change policy instruments can be effective at local levels. Clearly, this involves a broader institutional approach than what is offered by (but inclusive of) the standard environmental economics theory, which concentrates on the cost-effectiveness of the CCIs.

10.4.1 Revisiting the research questions

The Research Framework and the set of five (overlapping) research questions have been useful in addressing the central research question.

*Research question 1:* How do CCIs create incentives for diffusion of cleaner technologies in the small-scale sector in developing countries? How do the national policies address climate change in India? What are the policy implications of climate change policies and policy instruments for the SSIs in India?

The climate change policies and policy instruments: provide significant incentives for developing countries to undertake climate-relevant activities through opportunities for *additional* finance, technology, and capacity building. These are supplemented by increased opportunities for small projects under CCIs. As a signatory to the FCCC, India is committed to incorporate climate change considerations in its development policies and strategies. There are a number of issues related to the design and implementation of the CCIs that influence their policy implications. India at present is undertaking several initiatives under its economic and energy policies that are also climate-relevant, such as increasing emphasis on energy efficiency and renewable energy. With significant GHG emissions, India offers a range of potential mitigation options, including those in the SSI sector. The policy scenario is generally conducive for CCIs, as India is emerging as an important player at the international negotiations and has in place the basic institutional framework for approval processes for CCIs. The government is slowly shifting towards a more active role in terms of CCIs, along with other actors such as industry associations, NGOs, civil societies, and research organizations. However, much of the debate is on international policy instruments, and there is no attempt yet to translate the incentives into domestic instruments.

*Research question 2:* Which national policies address the small-scale industrial sector in India? What are the implications of the national policies for the diffusion of cleaner technologies in the SSIs in India?

The national policies for SSIs in India include particularly the promotional or support and the environmental policies. The former have for long provided SSIs with a protective environment. Providing suitable conditions for growth created perverse incentives for the units to remain small. Macro level liberalization and globalization poli-
cies since 1990s are resulting in a shift in SSI policy towards promotion, which in turn leads to increasing market opportunities and market competition (domestic and external) for SSIs. The SSIs still enjoy, though reduced, preferential treatment including credit benefits and marketing and technical support. These, as well as the cluster development programme for SSIs, have positive implications for technological change. Though several SSI units have benefited, there is a large number which remain beyond the reach of the policy incentives. More than 85 per cent of the energy-intensive SSIs studied in this thesis fall under the latter category.

The emphasis of the environmental policy is on regulatory instruments (standards, bans), supplemented by suasive and economic instruments (subsidies). It provides, though limited, policy pressure to adopt cleaner technologies. Community pressure and the judiciary have also been important players in the enforcement of environmental policy specifications for the sector. It is observed that:

• Energy efficiency is still not a priority for the SSI policy, and the thrust is on end-of-pipe solutions or fuel-switching,

• The focus is also limited to local pollution and not on global environment issues,

• Policy enforcement is generally been weak given the large number of SSIs and constraints of the regulatory bodies,

• There exists a gap between promotional and environmental objectives of the SSI policy, though there are some support policies and programmes that may help SSI comply with the environmental regulations; and

• SSI representation during the policy-setting process is limited.

Research question 3: What are the main drivers and barriers related to diffusion of cleaner technologies in the small-scale industries in India?

The research shows that it is the interplay of contextual factors that impact the effectiveness of policies at the local level and shape the technological paradigm for SSIs. The major contextual factors include:

• Organizational: Though significant inter- and intra-cluster differences exist, in general entrepreneurs have low awareness, environmental consciousness, technical knowledge, and marketing and managerial skills. Many SSIs operate on an informal basis, and there is limited systematic monitoring or certification.

• Economic (financial): Most SSIs have limited economic capabilities. Financial support for cleaner technologies in particular is limited, and is associated with procedural and transactions costs. Owing to limited awareness, hesitant attitude and ‘hidden’ motivations, entrepreneurs prefer informal forms of credit. Only few units manage to avail formal finance and government-driven incentives.

• Economic (market): Competition acts as a driver for improving competitiveness or a barrier for change on account of uncertainty or fixed markets for some SSIs. In addition, the local markets at present do not pay a premium on cleaner products and processes.
• Technological: There is in general limited awareness and technological access among the SSIs. There is little in-house R&D, and technical support remains limited due to few qualified technical experts, weak associations, limited training and demonstration of cleaner technologies.

• Social: These include culture (entrepreneurial spirit), attitude of workers (as carriers of information or in resisting change) and other actors, bureaucracy (procedural delay, political motive), limited networking and involvement of younger generation.

The case studies also illustrate instances where national policies have played an important role in cleaner technology diffusion to some extent. These cases show that the environmental policy can be ‘diffusion forcing’ only if there is effective enforcement, and the policy signals from the policy-making levels reach the local levels. Judicial intervention and civil society concerns play a critical role. However, there are no off-the-shelf or blanket solutions in dealing with different SSIs. Transition to a more sustainable paradigm for SSIs requires an integrated approach, under which increased regulatory push, effective capacity building, adequate financial and technological support, possible market incentives and networking are facilitated. The question is how can this be done? Theory lists various pathways or levers for change: private (at enterprise level), community (by networks) and institution-driven initiatives which may include national policies and CCIs.

Research question 4: How can SSIs benefit from CCIs and contribute towards a reduction in greenhouse gas emissions? How can CCIs affect small-scale industries–environment interactions?

In principle, the CCIs along with national policies can assist the SSIs in India. CCIs could facilitate targeted capacity-building activities, address the issue of putting a premium on cleaner products and processes, support programmes for improving basic infrastructure and access to cleaner fuels, and also assist in developing the existing initiatives for cleaner technologies diffusion in SSIs further. The SSIs also can benefit from the CCIs and contribute towards GHG reduction. They fare strongly on account of their national and local sustainability benefits, as well as on additionality. SSIs constitute a sector where there is inactivity on its own in terms of pollution control and climate change, and needs an external impetus. The development of SSIs is of national priority, especially because they will continue to provide economic and livelihood opportunities to India’s significant proportions of population.

Research question 5: What lessons can be drawn from the Indian SSIs sector for the design and implementation of policy instruments under the international climate change negotiations?

The thesis argues that the CCI–SSI link exists; however, in the present paradigm this is a ‘weak link’. At the local SSI level there is low environmental consciousness and a set of contextual barriers. At the national level, the SSIs are low in priority within the national environmental and climate change policies. In terms of CCIs, at the national and international levels, the incentives are weak for SSIs due to uncertainties,
transactions costs and market biases. The ‘CCI-signals’ regarding incentives offered somehow do not reach the local levels and the potential of CCIs is restricted to the higher levels, due to a lack of corresponding policies and instruments.

It has been thus suggested in this thesis that the existing ‘weak link’ can be strengthened by adequate policy responses to: (a) strengthen the incentives provided by the climate change policies and policy instruments, (b) work on the contextual factors by addressing the barriers and reinforcing the drivers, and (c) strengthen the synergies between policies at international and national, including state, industry, local levels. At the national level, the international policy instruments may be translated into national instruments, and programmes built to reflect global environmental objectives as well. At the international levels, the national policy objectives may be integrated into the broader climate goals, and instruments may be used to also support ongoing programmes and organization related to activities in the SSI sector that lend themselves to the global GHG reduction efforts. The design of the CCIs for them to be effective cannot be analysed in isolation but the context in which these will be used need to considered during their formulation and implementation stages.

10.4.2 On a concluding note

At the *theoretical level*, the research has provided insights on the macro–micro linkages of a global environmental concern and a local-level human activity. A multi-disciplinary ecological economics approach allowed examining the interplay of institutions, particularly the policies, at different levels; while the evolutionary approach reiterated the need to look beyond just the human activity in itself while addressing the diffusion of cleaner technology issues and also focus upon the broader contextual environment around it (Section 2.4). The research framework provides the flexibility of combing these two approaches, and dealing with the complexities of scale as well as various stakeholders’ perspectives. The case study approach has been especially important in understanding the practical experiences related to SSIs. The framework highlights the synergies between various levels and the need for an effective transmission of the intentions of the global policies to the micro-levels and vice versa. It thus helps provide recommendations towards strengthening the currently weak CCI–SSI link by adequate policy responses.

As a further field of study, investigations may be required to develop the modalities and establish a workable system in trying to operationalize some of the recommendations of the research. While the framework provides a lot of flexibility in dealing with multi-disciplinary perspectives, it has not really used concrete quantitative models or tools for the analysis. This was justified, since the focus was more to get a broad range of perspectives and integrate them to identify the drivers and barriers for the sector and then analyse their linkages with national and international climate change policies. This emphasis was basically on policy research, and not to get involved in the technical analysis, such as the cost–benefit assessments and financial analysis, or the economics of technological options in addressing diffusion issues for
the sector. However, this is an area for further research, to use some of these tools in order to theoretically substantiate the conclusions that have emerged out of the study.

At a practical level, it may be said that SSIs remain the engines of growth in India’s economic development as in many other developing countries. The development of SSIs is of national priority, especially since they will continue to provide economic and livelihood opportunities to rising populations. As India grows along its development path and sees itself as a developed country by the year 2020 (Abdul Kalam and Rajan 1998), it needs, along with agriculture, a substantial role of the industrial and the services sectors. Within this, the SSIs will have a crucial role. SSIs need to emerge out of the protectionist regime, avail market opportunities (including financial investments for the industrial and SSIs sectors) and efficiently compete in the markets. A developed India cannot afford to build an industrial base that is polluting and causes environmental degradation. SSIs too must see environmental instruments not as a limitation and barrier to their development but as an opportunity to access technology, finance and know-how. The role of climate change policies and policy instruments lies herein that they are designed to provide access to technology, finance and capacity building. However, the climate change policies cannot achieve these objectives only by supporting greenfield projects and targeting only a few sectors while ignoring the SSIs, which also provide them a platform to implement climate change projects. The challenge for CCIs is not just to avoid emissions but also to reduce emissions at source. Greenfield projects are a virtual trading of GHG benefits, where the problem may not actually be solved but it may just be circumventing the problem. SSIs provide an opportunity for reducing emissions by correcting inefficient practices, and at the same time providing sustainable development benefits.

SSIs fare strongly on two accounts, their sustainability benefits and on additionality. They constitute a sector where not much is happening in terms of pollution control and climate change, and needs an external impetus. However, SSIs tend to get ignored. The developing countries have been unable to organize themselves or put forth effective host-driven programmes, whereby their priorities get the importance they deserve. The host priorities have to get reflected in the CCI projects, or at least there has to be greater transparency to ensure that the broader objectives and principles of the climate change polices and CCIs are kept in mind. Convergence of interests among different stakeholders is also needed to make the CCI–SSI link stronger. A number of people point out that CCIs are not a ‘solution for everything’, and all kinds of projects and sectors cannot be included under these options. The idea however, is to use the CCIs for genuinely ‘additional’ projects in energy-relevant sectors for betterment of the environment and achieving national sustainable development benefits at the same time. This is where the CCI–SSI link becomes relevant.

Possible policy responses as put forth in this thesis include four key propositions to make the link stronger:

- Effective capacity-building and increasing the knowledge base of SSIs and various stakeholders, and facilitate interaction between them. SSI representation may
be encouraged in different climate change forums, overall policy making and implementation related to cleaner technologies in the country.

- Strengthen national and international policy incentives. In particular, highlight sustainability and ‘additionality’ of SSI projects. This may be done by a ‘host-driven’ emphasis or by providing a ‘sustainable development premium’ on projects with clear additionality and high sustainable development benefits.

- Lower uncertainties, including those related to direction of the international regime, national climate change policies, and CCI modalities. This may be done by setting up agencies for developing SSI projects, helping in host-investor negotiations; and introducing innovative methods like a tax for approving CCI projects which may used for SSI promotion, providing a sectoral emphasis and a national carbon fund with focus on sectoral or cluster-level baselines for SSI projects.

- Reduce transactions costs at each level for SSIs and bringing in greater transparency in the process. This may be done by setting up a separate CCI for SSIs, or a subset of the existing CCIs with lower transactions cost and streamlined procedures. Targeting the collective efficiency of SSI clusters may also reduce transactions costs. Schemes could be developed to built on existing networks and associations, and also develop new partnerships by strengthening nodal agencies.

While these provide the necessary conditions, they may not be sufficient in bringing in sustainability in the sector via GHG-reducing CCI activities. In the case of climate change, as the options to address the problem are embedded in specific human activities, their interaction with the national and local-level institutions and policies is critical for their intentions to be transmitted at these levels and vice versa. It is also critical in assessing that they have been meeting the environmental objectives and do not get limited as tools for political and economic ends. This research is only one such analysis, as an attempt to understanding the macro-micro linkages in a theoretical as well as practical context.

When the research was initiated, the attention given to SSIs or even small projects within the climate change discussions and literature was very limited. As the study progressed, the emphasis on small projects has increased significantly. However, the involvement of SSIs still remains small. It is hoped that the recommendations presented in this thesis will encourage greater focus on the SSI sectors which have a direct relevance for sustainable development, but may not attract the attention of many international-level players involved in climate change activities.
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Summary

Over a decade of international climate change negotiations has led to the introduction of climate change instruments (CCIs) that offer incentives for undertaking activities climate-relevant and facilitating sustainable development at global and national levels. The question is whether these instruments will have any impact on the small scale industries (SSIs) which are significant contributors to both socio-economic growth and greenhouse gas (GHG) emissions in developing countries. Given the spread of SSI activities in the developing countries, leaving them out would lead to not addressing an important segment of the climate change problem. It is in this regard that this thesis examines the link between the CCIs and the SSIs. Beginning with the proposition that the CCIs will not focus on SSIs, unless appropriate measures are applied; the thesis has examined the role of CCIs in shaping SSI-environment interaction.

The main objective is: To determine whether the climate change instruments can facilitate the diffusion of cleaner technologies in the small-scale industries in developing countries leading to sustainable development benefits, by examining the synergies and conflicts between these instruments and national policies in India.

The central research question is: Under what circumstances can climate change instruments induce the small-scale industries sectors in developing countries to contribute towards the global efforts for addressing climate change and at the same time assist the process of sustainable development at the national level?

In order to address the central research question, the thesis uses theoretical perspectives related to: (a) ecological economics for assessing the climate change policies and instruments for diffusion of cleaner technologies at various levels, and (b) evolutionary theory of technological change for providing insights into the complexity of factors influencing cleaner technology diffusion in the SSIs. Thereby, the macro approach (with a focus on policy implications) is reinforced by the feedback from conditions and actions of actors at the micro level, and visa versa. The co-evolution of the two approaches provide a better understanding of the issues in each in order to acquire insights regarding their linkages (especially in terms of how micro level can respond to macro level policies, and in turn how these policies may be built to have the desired impact on the micro level).

The research framework has been developed to assist in analysing the role the international policy instruments may play in shaping SSI-environment interactions by focusing on the interplay between the policy implications and the contextual factors. The methodology used is largely qualitative, including literature survey, primary interviews and multiple case studies (involving primary survey and interviews). The central research question is sub-divided into more focused research questions.
**Research question 1:** How do climate change instruments create incentives for diffusion of cleaner technologies in the small-scale sector in developing countries? How do the national policies address climate change in India? What are the policy implications of climate change policies and policy instruments for the small-scale industries in India?

**Research question 2:** Which national policies address the small-scale industrial sector in India? What are the implications of the national policies for the diffusion of cleaner technologies in the small-scale industries in India?

**Research question 3:** What are the main drivers and barriers related to diffusion of cleaner technologies in the small-scale industries in India?

**Research question 4:** How can small-scale industries benefit from climate change instruments and contribute towards a reduction in greenhouse gas emissions? How can climate change instruments affect small-scale industries–environment interactions?

**Research question 5:** What lessons can be drawn from the Indian small-scale industries sector for the design and implementation of policy instruments under the international climate change negotiations?

The analysis of the institutional framework at international level focuses on the instruments developed in the climate change regime. The CCIs on the one hand promote public awareness of climate change issues and, on the other hand, provide additional opportunities for finance, technology and/or capacity-building for addressing climate change (although focus has largely been on financing). India, with a significant GHG mitigation potential, is a key host for these climate relevant and sustainable development initiatives. While the climate change policy incentives are significant, they are also associated with uncertainties, transactions costs and market biases. These issues are especially relevant for small-size and low-capital SSIs. SSIs are low on the priority list in international and national climate change policies. The situation is slowly evolving and there are indications of the diversification of CCI portfolios with SSI projects being considered under GEF and CDM in India. However, these are still only a few and are mainly for capacity-building. It thus appears that the top-down approaches though relevant will remain constrained unless the associated issues are resolved or addressed.

A follow-up analysis of national SSI policies in India reveals that although these have been motivated by social and equity concerns, energy efficiency considerations have played a minor role and there has been little integration between the diverse policies focusing on this sector. Until the late 1980s, the SSIs were protected; but this inadvertently implied that the sector also stagnated. Following the Bhopal gas tragedy, environmental reform was prioritised, but progress has been slow. Community pressure and public interest litigation (PIL) combined with a proactive judiciary have promoted the opportunities for enforcing environmental policies. In the current scenario, two challenges emerge as especially relevant for the SSIs; one, with processes of liberalization and globalization, the SSIs face the threat of increased competition,
both from within and outside the country, and two, the regulations addressing at least local pollution and their enforcement are projected to become stringent. In addition, the increasing concerns for the global environment and relevant international policies are likely to have direct or indirect implications for the SSIs. The SSIs, therefore, will have to improve their processes and adopt cleaner technologies to be more competitive. A transition of the SSI sector towards more sustainable developmental paths is needed. Given the large number of these industries, and other national concerns, government support available for technology upgrading in SSIs will be limited. Hence, innovative strategies for the diffusion of cleaner technologies are required if the SSIs are to survive and grow in a sustainable manner.

The research focuses on three SSIs clusters in India, where national environmental policies have brought about a change in terms of cleaner technology diffusion, and in that sense, have been ‘diffusion forcing’. This not only helps to draw lessons for drafting international environmental policies, but also to examine the barriers and drivers that exist that may influence these policies (and thereby also address RQ 3).

The case study of the iron foundry cluster in Howrah shows that compliance with the specified emission standard in the cluster with a niche market for low-grade castings was limited, until the intervention of the Supreme Court. A judicial order issued by the Court increased enforcement measures by local authorities, leading to almost all units installing the required pollution control devices (PCDs) in order to comply with the standard. It however did not lead to sustained enforcement. Many PCDs are inefficient, are not properly maintained, and operate only during inspections. The regulatory instrument was supplemented with a partial subsidy for PCDs. This led to a joint initiative between a local industry association, a technical institute and a financial institution for technology improvements in select small units.

The case study of the glass cluster in Firozabad reveals that fuel switching in this large cluster was triggered following the Supreme Court’s order to ban use of coal and recommending a shift to natural gas in the Taj Trapezium Zone (TTZ), in response to a Public Interest Litigation (PIL) for protection of the Taj Mahal. Stringent enforcement measures by local authorities forced many glass units to switch to natural gas furnaces. Subsequently, however, financial benefits of natural gas led to more units opting for the switch. The larger units with access to natural gas have started subletting their space and infrastructure to units without natural gas access. However, coal is still being used in the cluster. Technical support was also provided by setting up a technical institute specifically for the industry; however, with little interaction with entrepreneurs it has not really met the needs of the cluster and among local industries is called a white elephant.

The third case study of the brick cluster in Chandigarh shows that technology forcing was encouraged through an emission standard, which included a ban on the conventionally used technology. The enforcement of the standard was pushed following a Supreme Court’s response to the PIL highlighting the adverse impacts of coal use in the SSI. However, compliance by the cluster was achieved largely because technical institutions provided the alternative technology as a consultancy package. This tech-
...technology was approved by the local authorities and helped SSIs in getting the required licenses. It could not however improve operational practices in the units despite increasing the awareness and technical levels of the entrepreneurs.

A comparative analysis of the case studies shows that there has been very little technological change in the SSIs over a long period of time. One of the reasons has been the perverse incentive created by the national policy characterized by regulatory instruments focusing on end-of-pipe solutions and a protective approach due to social and political motivations. The other has been the SSIs’ own limited technological capabilities (production, innovative and investment capabilities) coupled with social (attitudes and culture) and techno-economic (including lack of market demand and access to technology and finances) deterrents. It is the interplay of contextual factors that impact the effectiveness of policies at the local level and shape the technological paradigm for SSIs. Initiatives to change the status quo have been successful only in some cases where the push has come from external sources; more often the piecemeal approaches benefit only a select few. A transition to a new and sustainable paradigm therefore requires an integrated approach, under which increased regulatory push, effective capacity building, adequate financial and technological support, possible market incentives and networking are facilitated.

Theory lists various pathways or levers for change, including private (SSI-unit level), community (networks, associations) and policy-driven initiatives. Owing to the prevailing contextual factors, it is difficult to envisage that the SSIs themselves would undertake concerted efforts for cleaner technology diffusion. Though networks and associations have proactively or collaboratively brought a change in some cases, they usually do not really focus on cleaner technologies diffusion. The national policy provides but limited incentives for cleaner technologies. In addition, the CCIs provide incentives for cleaner technologies by offering opportunities for capacity building and increased access to additional funding, technologies and market avenues. Mapping SSI needs with the CCI objectives indicates that, in principle, the CCIs can assist in the transition as can the national policies. The question is: Can CCIs help the SSIs, and whether SSIs can make use of the CCIs and in turn contribute to GHG reduction efforts?

In principle, the CCIs along with national policies can assist the SSIs in India. CCIs could facilitate targeted capacity-building activities, address the issue of putting a premium on cleaner products and processes, support programmes for improving basic infrastructure and access to cleaner fuels, and also assist in developing the existing initiatives for cleaner technologies diffusion in SSIs further. SSIs fare strongly on account of their national and local sustainability benefits, as well as on additionality, wherein the SSIs constitute a sector where there is inactivity on its own in terms of pollution control and climate change, and needs an external impetus. The development of SSIs is of national priority, especially because they will continue to provide economic and livelihood opportunities to India’s significant proportions of population. Even though the GHG contribution of the SSIs is not as prominent as the large-scale industries, their large numbers and degree of energy inefficiency are a matter of
concern from environmental and developmental perspectives (the energy-saving potential in case study SSIs was found to be more than 50 per cent). Diffusion of select cleaner technologies ranging of options from simple modification in operating practices to modern technologies can bring down energy consumption and thereby GHG emissions from the sector, along with other economic (increase competitiveness), environmental (reduce pollution) and social benefits (better working conditions), and also help meet the environmental norms.

However, there are some counterarguments as well. At present, there are only a few cases of SSI-relevant activities undertaken. These are mainly geared towards capacity building rather than actual implementation of cleaner technologies in the SSI units. In international and national debates and discussions related to climate change, there is representation from the Indian industry, but within that the SSIs are practically absent. At the local SSI level there is low environmental consciousness and a set of contextual barriers. At the national level, the SSIs are low in priority within the national environmental and climate change policies. In terms of CCIs, at the national and international levels, the incentives are weak for SSIs due to uncertainties, transactions costs and market biases. Based on these, the research concludes that the CCI–SSI link clearly exists; however, in the present paradigm this is a ‘weak link’. The ‘CCI-signals’ regarding incentives offered somehow do not reach the local levels and the potential of CCIs is restricted to the higher levels due to a lack of corresponding policies and instruments.

It has been suggested that the existing ‘weak link’ can be strengthened by adequate policy responses to: (a) strengthen the incentives provided by the climate change policies and policy instruments, (b) work on the contextual factors by addressing the barriers and reinforcing the drivers, and (c) strengthen the synergies between policies at international and national, including state, industry, local levels. At the national level, the international policy instruments may be translated into national instruments, and programmes built to reflect global environmental objectives as well. At the international levels, the national policy objectives may be integrated into the broader climate goals, and instruments may be used to also support ongoing programmes and organization related to activities in the SSI sector that lend themselves to the global GHG reduction efforts. Possible policy responses as put forth in this thesis include four propositions:

- **Effective capacity building** and increasing the knowledge base of SSIs and various stakeholders, and facilitating interaction between them. SSI representation may be encouraged in the different climate change fora for overall policy making and implementation related to cleaner technologies in the country.

- Strengthen policy incentives – in particular, highlight sustainability and ‘additionality’ of SSIs projects. This may be done by a ‘host-driven’ emphasis or providing a ‘sustainable development premium’ on projects and products with clear additionality and high sustainable development benefits.
• Lower policy uncertainties, including those related to the international regime, national climate change policies and CCI modalities. This may be done by setting agencies for developing SSI projects; helping in host–investor negotiations; and introducing innovative methods like a tax for approving CCI projects which may used for SSI promotion, providing a sectoral emphasis and a national carbon fund with focus on sectoral or cluster-level baselines for SSI projects.

• Reduce transactions costs at each level for SSIs and bringing in greater transparency in the process. This may be done by setting up a separate CCI for SSIs, or a sub-set of the existing CCIs with lower transactions costs and streamlined procedures. Targeting the collective efficiency of SSI clusters may also reduce transactions costs. Schemes could be developed to build on existing networks and associations, and also develop new partnerships by strengthening nodal agencies.

While these provide the necessary conditions, they may not be sufficient in bringing in sustainability in the sector via GHG-reducing CCI activities. In the case of climate change, as the options to address the problem are embedded in specific human activities, their interaction with the national and local-level institutions and policies is critical for their intentions to be transmitted at these levels and vice versa. It is also critical in assessing that they have been meeting the environmental objectives and do not get limited as tools for political and economic ends. This research is only one such analysis, as an attempt to understanding the macro-micro linkages in a theoretical as well as practical context. It takes a broader approach than what is offered by, but inclusive of, the standard environmental theory in order to provide a holistic assessment of the linkages between international institutions and local actions.
De nu meer dan tien jaren van internationale onderhandelingen op het gebied van klimaatverandering die achter ons liggen, hebben geleid tot de introductie van klimaatveranderinggerichte beleidsinstrumenten (CCIs) die het ontplooien van klimaatrelevante activiteiten stimuleren en duurzame ontwikkeling op wereld en nationaal niveau vergemakkelijken. De vraag is of deze instrumenten effect zullen hebben op de kleinschalige industriële bedrijven (SSIs) die significant bijdragen aan zowel socio-economische groei als aan de uitstoot van broeikasgassen in ontwikkelingslanden. Gegeven de ruime verspreiding van activiteiten van SSIs in ontwikkelingslanden, zou het niet in beschouwing nemen hiervan leiden tot het veronachtzamen van een belangrijk segment van het probleem van de klimaatverandering. Vanuit deze gedachte wordt in dit proefschrift de verbinding bestudeerd tussen CCIs en SSIs, te beginnen met de stelling dat de CCIs zich niet richten op SSIs tenzij passende maatregelen worden toegepast. In het proefschrift wordt de betekenis van CCIs bestudeerd als onderdeel van de interactie tussen SSIs en het milieu.

Het voornaamste onderzoekdoel is: te bepalen of de instrumenten voor klimaatverandering de verspreiding van schone technologieën in de kleinschalige industrieën in ontwikkelingslanden kunnen vergemakkelijken, daarmee leidend tot voordelen in termen van duurzame ontwikkeling, door het bestuderen van synergieën en conflicten tussen deze instrumenten en nationale beleidsmaatregelen in India.

De centrale onderzoeksvraag is: onder welke omstandigheden kunnen instrumenten voor klimaatverandering de sector van de kleinschalige industrie in ontwikkelingslanden bewegen bij te dragen aan de wereldwijde inspanningen om klimaatverandering aan te pakken en tegelijkertijd bij te dragen tot het proces van duurzame ontwikkeling op nationaal niveau?

Om de centrale onderzoeksvraag aan te pakken, worden theoretische perspectieven gebruikt gerelateerd aan: (a) ecologisch- economische theorie ter vaststelling van het beleid ten aanzien van klimaatverandering en instrumenten voor verspreiding van schone technologieën op verschillende niveaus, en (b) evolutionaire theorie van technologische verandering om inzicht te verschaffen in de complexiteit van factoren die de verspreiding van schone technologie in SSIs beïnvloeden. Aldus wordt de macrobenadering (met een nadruk op beleidsimplicaties) versterkt door de teruggreep van condities en acties van actoren op het microniveau en omgekeerd. De co-evolutie van beide benaderingen verschaf een beter begrip van de ontwikkelingen in iedere benadering afzonderlijk en verschaf inzicht betreffende hun verbindingen (vooral in termen van hoe het microniveau kan reageren op beleid op macroniveau, en op zijn beurt hoe dit beleid ontworpen kan worden om de gewenste uitwerking op het microniveau te bewerkstelligen).
Voor dit onderzoek is een conceptueel raamwerk ontwikkeld ten behoeve van de analyse van de rol die de internationale beleidsinstrumenten zouden kunnen spelen in het beïnvloeden van de interacties tussen SSIs en het milieu, door zich te richten op de interactie tussen de beleidsimplicaties en een reeks ‘contextuele’ factoren. De gebruikte methodologie is in hoge mate kwalitatief en omvat literatuuronderzoek, primaire interviews en een aantal ‘case’-beschrijvingen (inclusief primair onderzoek en interviews). De centrale onderzoeksvraag is ondervolgd in meerdere, duidelijk toegesneden onderzoekvragen.

**Onderzoeksvraag 1**: Hoe verschaffen instrumenten voor klimaatverandering prikkels ter verspreiding van schonere technologieën in de kleinschalige sector in ontwikkelingslanden? Hoe houdt het nationale beleid in India zich bezig met klimaatverandering? Wat zijn de beleidsimplicaties van klimaatbeleid en klimaatbeleidsinstrumenten voor de kleinschalige industrieën in India?

**Onderzoeksvraag 2**: Welk nationaal beleid richt zich op de kleinschalige industriële sector in India? Wat zijn de implicaties van het nationale beleid voor het verspreiden van schonere technologieën in de kleinschalige industrieën in India?

**Onderzoeksvraag 3**: Wat zijn de voornaamste drijfveren en hindernissen gerelateerd aan verspreiding van schonere technologieën in de kleinschalige industrieën in India?

**Onderzoeksvraag 4**: Hoe kunnen kleinschalige industrieën baat hebben bij instrumenten voor klimaatverandering en bijdragen aan reductie van de broeikasgasemissies? Hoe kunnen instrumenten voor klimaatverandering de interacties tussen kleinschalige industrieën en milieu beïnvloeden?

**Onderzoeksvraag 5**: Welke lees kan getrokken worden uit de Indiase sector van kleinschalige industrieën voor het ontwerpen en implementeren van beleidsinstrumenten zoals vastgelegd in de internationale klimaatveranderingsonderhandelingen (het Kyoto Protocol)?

De analyse van het institutionele raamwerk op internationaal niveau richt zich op de instrumenten die zich ontwikkeld hebben onder het regime van klimaatverandering. De CCIs bevorderen de publieke bewustwording van zaken die met klimaatverandering te maken hebben en verschaffen aanvullende gelegenheden voor de financiering van technologie en/of capaciteitsontwikkeling om klimaatverandering aan te pakken (waarbij de nadruk op financiering ligt). India, met een significant potentieel voor broeikasgas mitigatie, bekleedt een sleutelpositie bij deze klimaatrelevantie en duurzame ontwikkelingsinitiatieven. Terwijl de prikkels van beleid voor klimaatverandering significant zijn, worden ze ook geassocieerd met onzekerheden, transactiekosten en markt-ambivalenties. Deze zaken zijn met name relevant voor kleinschalige SSIs met een klein werkkapitaal. SSIs staan laag op de prioriteitenlijst in internationaal en nationaal beleid op het gebied van klimaatverandering. Deze situatie ontwikkelde zich langzaam en er zijn aanwijzingen dat, onder auspiciën van de GEF en het CDM in India, de verscheidenheid in CCIs voor SSI-projecten toeneemt. Dit zijn er echter nog maar een paar en dan
voornamelijk voor 'capacity-building'. Het lijkt er op dat de 'top-down'
benaderingen, hoewel relevant, aan beperkingen onderhevig blijven, tenzij de
daarmee samenhangende zaken opgelost zijn of aangepakt worden.

Een vervolg-analyse van het nationale SSI-beleid in India laat zien dat dit is
ingegeven door zorgen betreffende sociale (on)gelijkheid; overwegingen inzake
energie efficiëntie hebben een kleinere rol gespeeld en er is weinig integratie tussen
de diverse vormen van beleid die zich op SSIs richten. Tot ver in de jaren 1980
werden de SSIs beschermd, maar dit bracht onopzettelijk met zich mee dat de sector
ook stagneerde. Na de Bhopal tragedie kreeg milieuvervorming prioriteit, maar de
vooruitgang ging langzaam. Druk vanuit de gemeenschap en processen voortkomend
uit publieke belangstelling ('public interest litigation' - PIL) gecombineerd met een
pro-actieve rechterlijke macht hebben de mogelijkheden bevorderd om milieubeleid
te implementeren. In de huidige situatie komen twee uitdagingen naar voren die met
name relevant zijn voor SSIs; een met elementen van liberalisering en globalisering
waarin de SSIs geconfronteerd worden met de dreiging van toenemende competitie,
zowel van binnen als van buiten het land, en als tweede meer stringente regelgeving
die in ieder geval plaatselijke vervuiling effectief aanpakt. Daarenboven heeft de
toenemende bezorgdheid voor het wereldmilieu en daarbij behorend internationaal
beleid waarschijnlijk directe en indirecte implicaties voor de SSIs. De SSIs moeten
darom hun processen verbeteren en schonere technologieën overnemen om
competatieve to zijn. Een overgang van de SSI-sector naar meer duurzame
ontwikkelingspaden is nodig. Gegeven de grote aantallen van deze industrieën en
ook wegens andere nationale belangen, zal de overheidssteun beschikbaar voor
technologische verbetering in de SSIs beperkt zijn. Vandaar dat innovatieve
strategieën voor de verspreiding van schone technologieën benodigd zijn om de
kleinschalige industriëën te laten overleven en groeien op een duurzame wijze.

Het hier samengevatte onderzoek richt zich op drie clusters van SSI in India, waar
nationaal milieubeleid verandering teweeg heeft gebracht in termen van de
verspreiding van schonere technologie, en in die zin `verspreiding afdwingend ' zijn.
Dit helpt bij het leren trekken ten behoeve van het opstellen van internationaal
milieubeleid en ook bij de bestudering van belemmeringen en aanjagers die dit beleid
zouden kunnen beïnvloeden. Zo wordt ook de derde onderzoeks vraag benaderd.

De case study van de metaalgietijerij cluster in Howrah laat zien dat naleving van de
gespecificeerde emissienorm in het cluster beperkt was totdat een gerechtelijk bevel,
uitgevaardigd door de Hoge Raad van India, leidde tot versterkte krachtige
uitvoering door locale autoriteiten en tot het door bijna alle eenheden installeren van
de vereiste installaties voor beperking van emissies . Het leidde echter niet tot
duurzame krachtige uitvoering. Veel emissiebeperkende installaties zijn inefficiënt,
niet goed onderhouden en werken slechts gedurende de inspecties.

De case study van het glas cluster in Firozabad laat zien dat het overstappen op
andere brandstof in de cluster uitgelokt was door een uitspraak van de Hoge Raad om
het gebruik van kolen te verbieden en de overstap op aardgas aan te bevelen, in
antwoord op een proces voortkomend uit een PIL gericht op de bescherming van de
Taj Mahal. Stringente uitvoering van maatregelen door locale autoriteiten dwong menige glasfabriek over te stappen op aardgasovens. Vervolgens brachten de financiële voordelen van het gebruik van aardgas meer eenheden ertoe die overstap te maken. Echter, kolen worden nog steeds gebruikt in het cluster. Ook werd technische ondersteuning geboden in de vorm van het opzetten van een technisch instituut voor de bedrijfstak; door de geringe interactie met ondernemers heeft dit niet voldaan aan de behoeften van de cluster.

De *case study* van de baksteencluster in Chandigarh laat zien dat het afdwingen van technologische vernieuwing aangemoedigd werd door een emissienorm die uitbanning inhield van de conventionele technologie. De aanmoediging van de norm werd kracht bijgezet door een uitspraak van de Hoge Raad in antwoord op een PIL die de nadelige invloeden van het gebruik van kolen in deze SSI naar voren bracht. Echter, nakoming werd voornamelijk bereikt doordat technische instituten de alternatieve technologie aanboden als pakket. Deze technologie was geaccordeerd door lokale autoriteiten en hielp de SSIs in het verkrijgen van de benodigde vergunningen. Toch konden de operationele praktijken in de eenheden niet voldoende verbeterd worden, ondanks de bewustwording onder de ondernemers.

Een vergelijkende analyse van de *case studies* laat zien dat er gedurende een lange periode weinig technologische verandering binnen de SSIs heeft plaatsgevonden. Een van de redenen is gelegen in de tegengestelde prikkels gecreëerd door het nationale beleid, gekenmerkt door regulerende instrumenten gericht op 'end-of-pipe' oplossingen en een beschermende benadering vanwege sociaal-politieke motivaties. De andere reden was de eigen beperkte technologische vaardigheden van de SSIs (productie, vermogen tot innoveren en investeren), gekoppeld aan sociale (houding en cultuur) en technisch-economische ontkomendiging (inclusief gebrek aan vraag uit de markt en toegang tot technologie en financiën). Het is het samenspel van contextuele factoren dat de effectiviteit van beleid op locaal niveau beïnvloedt en de technologische context vormt voor SSIs. Initiatieven om de status quo te veranderen zijn slechts in enkele gevallen succesvol geweest, daar waar de druk kwam van externe bronnen; vaker had de gevolgde stap-voor-stap benadering slechts voordeel voor een selectief groepje bedrijven. Een overgang naar een nieuw en duurzaam paradigma vereist daarom een geïntegreerde benadering, waarin verhoogde regulerende druk, effectieve capaciteitsopbouw, adequate financiële en technologische ondersteuning, mogelijke marktprikkels en netwerken worden bevorderd.

De theorie biedt verschillende paden of handvatten voor verandering, inclusief private (per SSI-eenheid), gemeenschaps- (netwerken, verenigingen) en beleidsbedreven initiatieven. Ten gevolge van de heersende contextuele factoren is het moeilijk voor te stellen dat de kleinschalige industrieën zelf gezamenlijke pogingen zullen ondernemen voor verspreiding van schonere technologie. Alhoewel netwerken en verenigingen pro-actief of samenwerkend in sommige gevallen een verandering tot stand hebben gebracht, richten ze zich meestal niet op verspreiding van schonere technologieën. Het nationale beleid verschafte slechts beperkte prikkels
voor schonere technologieën. Daarbij verschaffen de CCIs prikkels voor schonere technologieën door het aanbieden van mogelijkheden voor opbouw van capaciteitsontwikkeling en toenemende toegang tot aanvullende fondsen, technologieën en markten. Het in kaart brengen van relaties tussen de behoeften van SSI met de doelstellingen van CCIs geeft aan dat de CCIs in principe bij kunnen dragen in de transitie, net als het nationale beleid. De vraag is, of CCIs de SSIs kunnen helpen en of de SSIs gebruik kunnen maken van de instrumenten voor CCIs en zo op hun beurt bijdragen aan de pogingen tot reductie van broeikasgasemissies. In principe kunnen de CCIs samen met nationaal beleid SSI in India ondersteunen. CCIs kunnen doelgerichte capaciteitsopbouw vergemakkelijken, een premie zetten op schonere producten en processen, programma’s ondersteunen om de basis infrastructuur te verbeteren en toegang te verschaffen tot schonere brandstoffen en ook bijdragen in het ontwikkelen van de bestaande initiatieven voor het verder verspreiden van schonere technologieën in SSIs. SSIs profiteren sterk van nationale en lokale duurzaamheidsvoordelen, evenals van additionele financiële impulsen, waar de sector op eigen kracht alleen inactief zou blijven in termen van beheersing van vervuiling en klimaatverandering. De ontwikkeling van SSIs is een nationale prioriteit, vooral omdat ze blijvend economische en bestaansmogelijkheden bieden aan een belangrijk deel van de Indiase bevolking. Zelfs wanneer het aandeel van SSIs in broeikasgasemissies niet zo duidelijk is als dat van de grootschalige industrieën, zijn hun grote aantallen en hun energie-inefficiëntie vanuit milieu- en ontwikkelingsperspectieven een zaak van zorg (de mogelijkheid tot energiebesparing gevonden in de case studie was meer dan 50%). Verspreiding van bepaalde schonere technologieën, van eenvoudige veranderingen in operationele praktijken tot moderne technologieën die energieconsumptie en daardoor broeikasgasemissies van de sector verlagen, samen met baten van economische aard (concurrentieverhoging), of milieukundige (verontreiniging reduceren) en sociale (betere werkomstandigheden), helpen mee te voldoen aan de milieunormen.

Er zijn echter ook tegenargumenten. Momenteel zijn er slechts een paar voorbeelden van relevante activiteiten op het gebied van SSIs ondernomen. Deze richten zich voornamelijk op capaciteitsopbouw en minder op werkelijke implementatie van schonere technologieën in de SSI-eenheden. In internationale en nationale debatten en discussies over klimaatverandering is vertegenwoordiging vanuit de Indiase industrie, maar daarbinnen zijn de SSIs praktisch afwezig. Op lokaal kleinschalig industrienniveau is weinig milieubewustzijn en bestaat een reeks van samenhangende hindernissen. Op nationaal niveau, hebben de SSIs weinig prioriteit binnen het milieu- en klimaatbeleid. Bekeken vanuit het oogpunt van de CCIs zijn de prikkels, op nationaal en internationaal niveau, zwak voor kleinschalige industrieën vanwege onzekerheden, transactiekosten en markeffecten. Hierop baserend, wordt in het onderzoek geconcludeerd dat de relatie tussen CCIs en SSIs duidelijk bestaat; echter, in het huidige voorbeeld is dit een ‘zwakke relatie’. De ‘CCI-signalen’ in termen van aangeboden prikkels bereiken de lokale niveaus op de een of andere manier niet, en het potentieel van CCIs is voorbehouden voor de hogere niveaus van bedrijvigheid, door een gebrek aan adequate beleidsmaatregelen en instrumenten.
Er is gesuggereerd dat de bestaande ‘zwakke relatie’ versterkt kan worden door adequate beleidsantwoorden in de vorm van: (a) versterken van de prikkel aangeleverd door de klimaatbeleidsmaatregelen en beleidsinstrumenten, (b) verbeteren van de contextuele factoren door de hindernissen aan te pakken en de aandrijvende factoren te versterken, en (c) versterken van de synergie tussen beleidsmaatregelen op internationale, nationale (inclusief staat, industrie) en locale niveaus. Op nationaal niveau, mogen de internationale beleidsinstrumenten vertaald worden in nationale instrumenten en mogen programma’s opgesteld worden om wereldwijde milieudoelen in overweging te nemen. Op internationaal niveau, kunnen nationale beleidsdoelen geïntegreerd worden in bredere klimaatdoelen en instrumenten kunnen ook gebruikt worden om activiteiten in lopende programma’s en organisaties te ondersteunen in de SSI-sector die zich inzetten voor broeikasgasreductie. Denkbare beleidsantwoorden zoals naar voren gebracht in dit proefschrift, omvatten vier stellingen:

- **Effectieve capaciteitsopbouw** en verhogen van de **kennisbasis** van SSIs en verschillende belanghebbenden, en het vergemakkelijken van de interactie tussen hen. Participatie van SSIs in de verschillende fora voor klimaatverandering kan worden bevorderd ten behoeve van het maken van algemeen beleid voor schonere technologieën en uitvoering daarvan in het land.

- **Versterk beleidsprikkels** – breng met name **duurzaamheid** en ‘**additionaliteit**’ van SSI projecten naar voren. Dit kan via het leggen van de nadruk op ‘host-driven’. Een andere mogelijkheid is het verstrekken van een ‘**premie op duurzame ontwikkeling**’ voor projecten en producten met duidelijk “additionaliteit” en hoge score op duurzame ontwikkeling.

- **Verklein beleidsonzekerheden**, inclusief de onzekerheden die gerelateerd zijn aan het internationale regime, het nationaal klimaatbeleid en CCI modaliteiten. Dit kan bereikt worden door het opzetten van vertegenwoordigingen (agentschappen) voor het ontwikkelen van SSI-projecten; hulp bij onderhandelingen over investeringen; en het introduceren van innovatieve methoden zoals een belasting op het goe deuren van CCI projecten die gebruikt worden voor SSI promotie, daarmee nadruk leggend op de sector en op een nationaal koolstoffonds gericht op SSI projecten op sectoraal of clusterniveau.

- **Verlaag transactiekosten** voor SSIs op elk niveau en maak het hele proces transparanter. Dit kan door het opzetten van een apart CCI voor SSIs, of door het opzetten van een deel-CCI met lagere transactiekosten en gestroomlijnde procedures. Versterking van de collectieve efficiëntie van SSI clusters kan ook de transactiekosten verlagen. Procedures en trajecten kunnen worden ontwikkeld door bestaande netwerken en sectorale belangenverenigingen verder te ontwikkelen en tevens nieuwe verbanden te ontwikkelen door het versterken van netwerkorganisaties.

Hoewel deze beleidsmaatregelen de noodzakelijke voorwaarden scheppen, is het mogelijk dat ze onvoldoende zijn om duurzaamheid en broeikasemissiereductie
stevig te verankeren in de sectoren. In geval van klimaatverandering, waarbij de
opties om het probleem te benaderen sterk zijn ingebed in specifiek menselijke
activiteiten, is de interactie met de instituten en het beleid op nationaal en locaal
niveau bepalend voor het succes in het overbrengen van intenties tussen de sector en
beleid en vice versa. Het is ook van groot belang dat de door de sector gehaalde
milieudoelen gezamenlijk worden vastgesteld en dat de rol van de sector niet beperkt
wordt tot die van werktuig voor politieke en economische doeleinden. Dit onderzoek
is een van de analyses waarbij een poging wordt gedaan de macro-micro
verbindingen te begrijpen, zowel vanuit een theoretische als vanuit een praktische
context. Uiteindelijk is een bredere benadering nodig dan wordt geboden door de
standaard milieuthorie, hoewel wel noodzakelijk om mee te beginnen, om een
holistisch inzicht te krijgen in de verbindingen tussen internationale instituten en
locale acties.
Annexure 1: SSI case studies – technical details

I.1 Iron foundry industry

I.1.1 Production process
The production process in the foundry units involves five major steps for production of iron castings. These include:

a. Pattern making: Making a replica of the desired casting.

b. Mould preparation: Preparing a mould into which the molten metal will be poured to create the casting.

c. Furnace charge preparation, melting and pouring: The proper mix of metal is prepared and melted in the furnace at very high temperatures. The molten metal is then poured into the moulds manually or by machines.

d. Cooling, quenching and sand handling: The metal is allowed to cool and solidify as the casting and removed from the mould, while the mould materials are recovered for reuse.

e. Fettling, finishing and cleaning: The excess material is removed from the casting, and finished to polish and protect the surfaces.

![Diagram of the melting process in a conventional cupola](image_url)

**Fig. A:** Melting process in a conventional cupola

I.1.2 Furnace technologies
The main technology for melting of metal in the foundries in Howrah and in India is the (coke/coal based) cupola. The cupola is the oldest and dominant technology in

*The details are compiled based on the relevant references as mentioned in the text above.*
the world as well. It involves feeding the charge (raw materials) and fuel in alternate layers into the cylinder of the cupola (figure A). Combustion occurs in the presence of air entering through its tuyeres. This prepares the molten metal, while giving rise to residue and pollutants such as SPM, SO₂, CO, and CO₂.

The various technologies (for melting) for iron foundries in India are listed below.

a. **Single Blast Cupola (SBC) or the conventional cupola**: Coke-based. The SBC is the oldest technology for production of castings. The cost of the cupola varies according to size and design. The approximate capital cost of a SBC of 5 ton per hour capacity is approximately Rs 0.4–0.6 million.

b. **Divided Blast Cupola (DBC)**: Coke-based. The DBC has been modified from SBC to include tuyeres in two rows to enable better combustion of fuel and therefore improved efficiency. A properly designed DBC can result in significant increase in efficiency as compared to the SBC. The approximate capital cost of a DBC of 5 ton per hour capacity is approximately Rs 0.45–0.65 million. However, with better design and installation of PCDs, the cost increases.

c. **Induction Furnace (IF)**: Electricity-based. The energy consumption for an IF varies according to the capacity of the furnace and raw materials used. It may be between 550–2000 kWh/ton (TERI 2001). However, in a typical system it may be around 650–750 kWh/ton. It does not lead to any emissions of local pollutants, but in undertaking a life-cycle analysis (including generation of electricity) it may not be that environment friendly if grid-based electricity from coal-based power plants is being utilized. The approximate capital cost of an IF of 1 ton capacity is approximately Rs 1–1.2 million.

d. **Rotary Furnace (RF)**: Natural gas, diesel or oil based. Can provide continuous castings, and also improves thermal efficiency, reduces melting time and increases metal-pouring temperature. It reduces the emissions resulting in local pollution. These furnaces however are difficult to control. The approximate capital cost of a SBC of 100 ton per month capacity is approximately Rs 1.1 million.

e. **Coke-less Cupola (CC)**: Natural gas, LDO or LPG based. The CC is further modified from the DBC. In this system, the use of coke is replaced by fuel that is comparatively cleaner or environment friendly. It is the most recently developed technology, and is still very expensive. The National Metallurgical Laboratory (NML) in India has been actively involved in trying to develop this technology for Indian conditions, especially for Agra. Initial results have shown that the energy consumption is almost 40 per cent less than the conventional cupola. The melting efficiency is claimed to be at least 1.4 times more, and theoretically the CO₂ emissions will be reduced to just one-third of a coke-fired cupola (depending on the material charge). However, the initial cost of CC is high (even though the operating costs come down drastically). The approximate capital cost of a CC of 350 ton per month capacity is approximately Rs 6.5–7 million.

f. **Duplexing** – such that the primary melting is done in a coke based cupola, and is then transferred to an RF or an IF.
As the main product is low value castings, the cupola – properly designed and with an appropriate PCD – is the most economical technology for Howrah. However, temperature control is difficult and diversification to higher and other (S.G./ductile) castings may not be possible (however, a technical consultant did claim achieving these in properly designed DBC). For higher temperatures, and temperature (and therefore quality) control, and production of higher-grade castings such as ductile or S.G. iron, other technologies are more appropriate. However, CC and IF are more viable for larger production and are expensive. The RF may be economically viable for smaller units. However, temperature control is difficult in an RF. The operational costs of the IF are also high if based on grid electricity. An important option is duplexing which can help in quality improvement and diversification of the products (producing high-grade gray iron castings as well as others – S.G./ductile castings), with production costs lower than while undertaking the whole process in a single RF or IF. In many other countries, foundries that adopted the IF in the 1980s appear to be switching over to duplexing of DBC and IF, as it can be more economical and environment friendly compared to only using an IF.

As mentioned before, the main technology in the Howrah cluster is the cupola. Diffusion of other technologies such as RF, IF has been very limited across the units. There is no CC in the cluster as of now (although one foundry has planned to set it up). The performance of the cupolas depends on the combination of the design – the melting zone area, blast volume and pressure, and the maintenance of the cupola. By improving the design of the cupolas, significant reduction in the use of energy and thereby emissions of gases can be achieved.

1.2 Glass industry

1.2.1 Production process

The process of manufacturing of glass products in the glass units may be divided into five major processes:

a. Batch making
b. Melting
c. Shaping and forming
d. Annealing
e. Finishing

The most common type of glass produced in Firozabad is the soda lime.

1.2.2 Furnace technologies

There are three main types of furnaces used in Firozabad:

a. Melting furnace or sakai bhatti
i. *Tank furnace:* These furnaces are usually regenerative and used for large capacities. These can handle single-colour jobs.

ii. *Direct and indirect fired pot furnaces*
   
i. Locally made *circular pots/open pots:* These furnaces contain 6–12 pots each (in other countries, the furnaces may have up to 30 pots as well), use direct firing, and are used for producing mainly bangles and also glass items of different colours.

   ii. *Monkey mouth Japanese pots/closed pots:* This is similar to the closed pot, however the mouth is closed so that the glass does not come in contact with other material. It is particularly used for making glass items.

b. Bangle making (including slab reheating) furnace or *belan bhatti:* This furnace is found in bangle-making units and is used specifically for making glass spirals to be later converted as bangles. These may be manual or automated.

c. Muffle furnace or *pakai bhatti:* The furnace is used for baking, strengthening and finishing of the semi-finished glass bangles and products.

### I.3 Brick industry

#### I.3.1 Production process

The process of making bricks in the brick units may be divided into four main stages:

a. *Clay preparation or winning:* Suitable clay is excavated that is used to make bricks and is mixed with water after removal of stones and bigger particles (usually done manually). If necessary carbonaceous materials (e.g. coal dust, agricultural wastes, industrial wastes) may be added to the clay.

b. *Moulding of bricks:* The clay is shaped or moulded as ‘green’ bricks. This is usually done manually with the help of wooden or metallic moulds, or in some cases using extrusion machines (used only in a few units in India).

c. *Drying:* The green bricks are dried to remove moisture, usually naturally under the sun.

d. *Firing:* The green bricks are fired in a kiln at a temperature anywhere between 600 and 1000°C in order to make them strong.

#### I.3.2 Kiln technologies

The main types of brick kilns (for firing bricks) in India are detailed below. The choice of technology generally depends on factors such as scale of production, soil and fuel availability, market conditions and skills available. Therefore, the technology used in zone 1 (Indo-Gangetic) and zone 2 brick-producing regions in India are quite different from each other.
a. *Intermittent kilns or clamps*: are generally used in zone 2 when the volume of production is small – ranging from 5,000 to 2,00,000 bricks per firing. The main fuels range from coal, firewood, agricultural residues and dung cakes. In these kilns, the fire is allowed to die out after each firing and the kiln is emptied, re-filled and a new fire started for each load of bricks. Thus, most of the heat contained in the hot flue gases and fired bricks is lost to the surroundings. Therefore, these kilns have low energy efficiency as most of the heat contained in the flue gases, fired bricks and kiln structure remains unutilized. However, they remain popular due to almost ‘zero’ costs of kiln construction and flexibility in terms of production volume and use of a variety of fuels.

i. Clamps: Mainly open clamps are structured geometrical stacks of green bricks. The bricks are fired in situ using renewable fuels like wood, biomass and cowdung. Clamps are largely energy intensive, responsible for poor quality, and highly polluting.

ii. Scove clamp: Tunnels are built at the base of the kiln to fire wooden logs and the outer surface of the setting is plastered with mud (i.e. ‘scoved’).

iii. Scotch clamp: Tunnels and outer walls are permanently built with bricks.

b. *Continuous kilns*: are generally used in zone 1 where the volume of production is bigger – more than 15,000 bricks a day. These kilns are superior to intermittent kilns in terms of both the energy efficiency and quality of bricks produced. In these kilns, the fire is always kept alive and bricks are pre-heated, fired and cooled simultaneously in different parts of the kiln. Heat in the flue gas is utilized for pre-heating the green bricks while heat in fired bricks is used for pre-heating the air for combustion. Thus, the continuous kilns are generally more efficient than intermittent ones. Although they form a share of 65 per cent of the total number of brick manufacturing units in India, they account for only 26 per cent of the brick production. Large-scale savings are possible, about 30-50 per cent, by the replacement of intermittent kilns by continuous kilns.

i. Bull’s Trench Kiln (BTK): are of two types.

   i. BTK with moving metallic chimney is the most popular continuous kiln in India.

   ii. BTK with fixed masonry chimney is a more efficient version and is fast replacing moving chimney BTK due to regulatory pressure. Fixed chimney BTKs contribute for about 73 per cent of the total brick production.

ii. Other kilns are Hoffman and High Draught Kilns. However, the share of Hoffman and HD kilns is not significant (0.6 per cent). HD kilns have been developed by the Central Building Research Institute (CBRI) in India.

iii. Vertical Shaft Brick Kiln (VSBK): The VSBK has been recently introduced in India, based on the design originally developed and being used...
in China. It is more efficient and exhibits safer working conditions (and less pollution). However, it is more suitable for small and medium-capacity brick production (and therefore more so in zone 2). At present, there are about 27 VSBKs in operation in India (in Madhya Pradesh, Maharashtra, Orissa, Uttar Pradesh, Karnataka and Tamil Nadu).
Ph.D. study on "Climate Change policy instruments for diffusion of cleaner technologies in SSI in India"

Preliminary questions

1. What is the status of the industrial cluster – in general and vis-à-vis other clusters in the country, especially in terms of:
   - Number of units
   - Value added and employment
   - Technological status
   - Energy consumption
   - Working conditions and pollution levels
   - Quality certification

2. How can the units in this cluster be classified?

3. What are the kinds of technologies and fuels used in this cluster?

4. Which units in your classification are the most energy intensive?

5. Is there a potential for technological up-gradation for energy efficiency improvement?

6. Which technology would be more appropriate or efficient in the current situation?

7. What are the main reasons due to which this technology not being employed? What are the barriers to adoption of more efficient technologies in the region?

8. What are the current policies for adoption of cleaner any energy efficient technologies in the cluster? What are the financial options available for the entrepreneurs?

9. Have these policies have been effective in meeting their objective? Why/why not?

10. What are the additional steps needed for diffusion of efficient technology? What are the ways for providing accessible technical advice to the entrepreneurs?

11. Do you think the small-scale units face a disadvantage compared to the other sectors in attracting funds and technical advice? If yes, how?

12. What in your view is the future of this industry?