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Roadmap for Green Growth of Industry Sector in Punjab

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1 Introduction

The Indian industry is spread across the length and breadth of the country. However, sometimes there is concentration of a certain type of industries in a region/cluster which may be due factors such as availability of raw materials, markets for the products and so on. Punjab state has a high concentration of energy intensive industries – both large-scale industries and (MSMEs). The major energy-intensive industry sectors in Punjab are textiles, cement, iron and steel, pulp and paper and engineering. Some of these industries are large consumers of energy and are designated consumers (DCs) while most fall in the category of MSMEs and are located in clusters.

Industry is the second largest contributor to the state's economy after agriculture. Good connectivity by road, rail and air has contributed to the growth of industries in the state. Some of the major industries in the state include textile, iron & steel, machine tools, food processing, agricultural implements, engineering goods, bicycles, sports equipment and biotechnology. The industrial scene in the state is dominated by MSMEs which account for over 95% of the total industrial units. There is also clustering of the industrial units in some big cities (See Figure 1). The major industrial towns include Ludhiana (textiles, brick, engineering, bicycle, foundry), Mandi Gobindgarh (steel-rerolling), Jalandhar and Amritsar (forging, foundry, sports equipment) and Mohali (biotechnology, engineering).

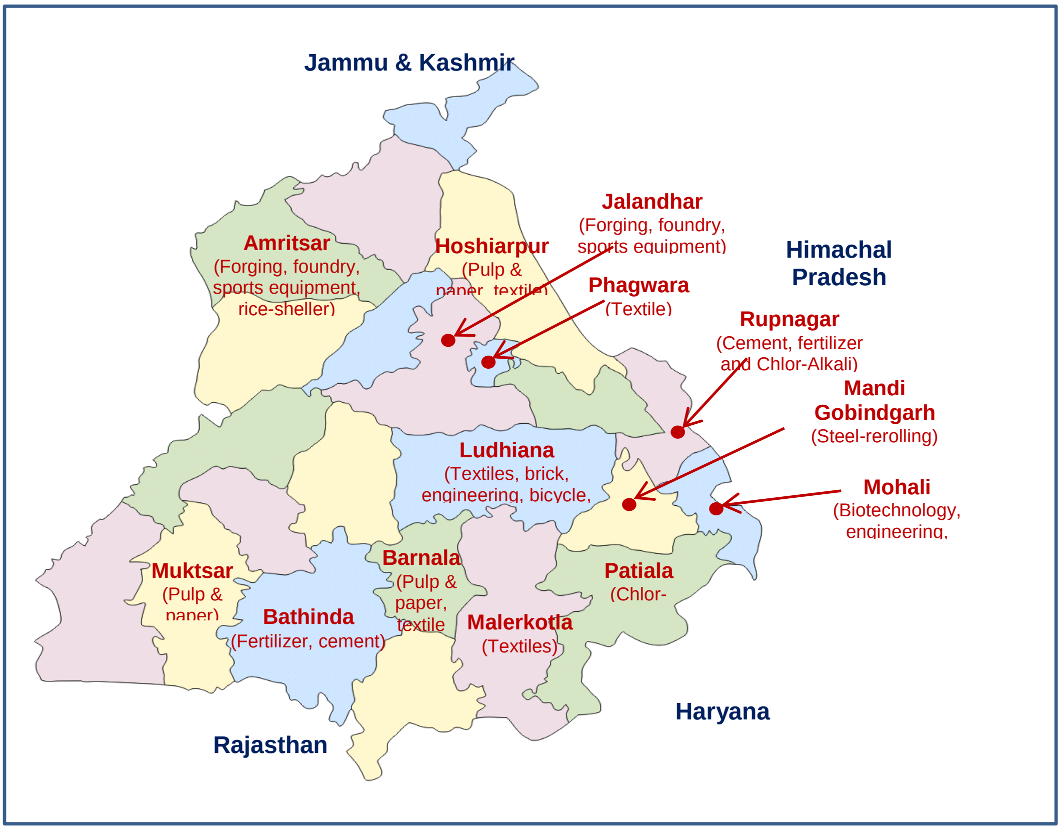


Figure 1: Industrial clusters in Punjab

Source: BEE, 2012 and TERI studies

With about 140 textile mills, the state has emerged as a key hub for all kinds of textile based industries including yarn, readymade garments and hosiery. Punjab has the largest number of small and medium scale steel rolling mill plants in India. Most of the steel rolling units are located in Mandi Gobindgarh. The secondary steel sector under which these manufacturing activities fall, contribute to around 30% to state's Gross Domestic Product (GoP 2013).

According to the Economic Survey report of the Punjab government (GoP 2013), there are about 475 large and medium scale industrial units in the state. These industries provide employment to over 0.28 million persons and have turn-over of Rs. 1,050 billion. There are 1,72,000 micro and small scale units in the state providing employment to over one million persons. These units have a turnover of Rs. 640 billion crores. Table 1 provides key statistics of the state's industrial sector.

Table 1: Key Industrial Statistics (2012-13)

S. No	Items	Units	Large and medium scale units	Small and micro scale units	Total
1	Working Units	Numbers	475	1,72,000	1,72,472
2	Fixed Investment	Rs. crores	50,000	9,400	59,400
3	No. of employees	Nos. (lakhs)	2.7	10.6	13.3
4	Production	Rs. crores	1,05,000	64,000	1,69,000

Source: GoP 2013

2 Energy intensive industries

Punjab has a high concentration of energy-intensive industries that includes a mix of DCs as well as SMEs. Of the total electrical energy sold in the state, 33.4% (13,170 million kWh) was sold to industry (GoP 2013).The state has a total of 19 DCs including eleven textile plants, one large-scale cement plant, two clinker grinding units, two chlor alkali units, two fertilizer plants, and three pulp and paper units (BEE 2012). The total energy consumption (in toe) by various industrial sectors under which these DCs fall is highlighted in Figure 2. These DCs together consume 1.09 MTOE of energy annually.

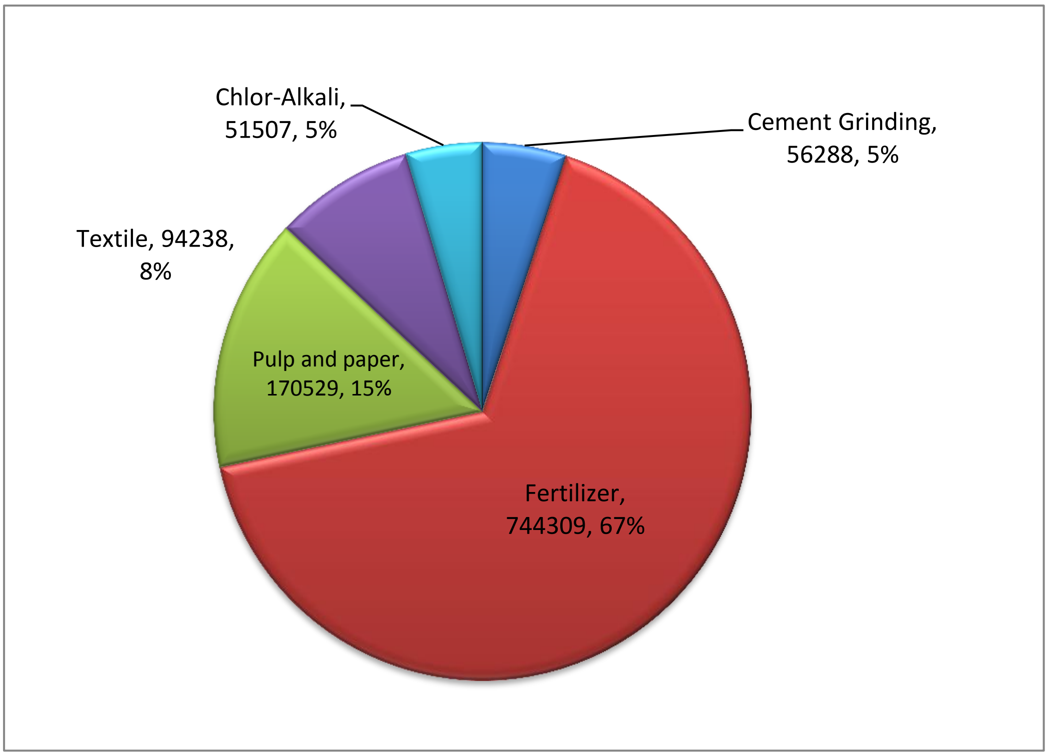


Figure 2: Energy consumption (TOE) by various large industrial sectors in Punjab

Source: BEE 2012

There are many energy-intensive MSMEs in the state. The major energy-intensive MSME clusters in the state are Mandi Gobindgarh (steel rolling; Ludhiana (textiles and brick-kilns), Jalandhar and Amritsar (forging & foundry). The Mandi Gobindgarh cluster has about 300 MSME steel re-rolling units. These units use coal and electricity. Mandi Gobindgarh has one of the worst air quality in the state and has been classified as a critically polluting town by MoEF. About four million tonne of steel is rolled per annum in the cluster. The total annual energy consumption of the cluster is estimated as 142,000 tonne of oil equivalent (toe). The equivalent emissions are estimated to be 753,000 tonne of CO_2. The Jalandhar hand tools cluster is also very energy intensive. About 950 MSMEs in the cluster produce over 50,000 tonne of hand tools per annum. The total amount of energy consumed in the cluster is about 19,901 toe annually which mainly includes electricity. The average SEC of a hand-tool unit is 16.7 GJ/tonne.

3 Why green growth?

In Punjab, the annual electricity sales to the industry sector, including low tension and high tension consumers, is 17.384 BU or about 37 % of the total electricity sold (GoP 2012). Studies estimate the electrical energy saving potential in Punjab's industrial sector to be between 7-10%. The energy savings potential of the sector is estimated to be 1.217 BU (GoP 2012). The energy-intensive MSMEs sub-sector in Punjab—namely foundry, hand tools, auto components and hosiery & dyeing offer significant energy savings potential as shown in Table 2. Together they consume 2891.3 MU of electricity and the energy saving potential is about 175.75 MU.

Table 2: Energy saving potential in Punjab's SME sector

Location	Product/cluster	Units	Estimated Total Energy Consumption MUs (TOE)	Energy savings potential, %	Annual energy saving potential
Batala	Foundry	300	**252.3 MU** 63075 TOE	10- 15	25.23 MU 9461 TOE
Jalandhar	Handtools	400	**1902.8 MU** 475700 TOE	5 -20	95.14 MU 95140 TOE
Ludhiana	Auto Components	400	**343.2 MU** 85800 TOE	7- 10	24.02 MU 8580 TOE
Ludhiana	Hosiery	530	**128.4 MU** 32100 TOE	10- 25	12.84 MU 8025 TOE
Ludhiana	Dyeing	150	**264.6 MU** 66150 TOE	7- 15	18.52 MU 9923 TOE
TOTAL			**2891.3 MU** **722825 TOE**		**175.75 MU** **131129 TOE**

Source: (NPC 2010)

The energy efficiency interventions in the industry sector will not only provide significant GHG reduction benefits, but also lead to important co-benefits and directly impact the well-being of the workforce. Some of the co-benefits include improved productivity/product quality, cleaner air, improved quality of life, waste reduction and social benefits. The co-benefits, as reported by the Working Group III of the Fourth Assessment Report of the IPCC are highlighted in Table 3.

Table 3: Co-benefits of GHG mitigation of energy-efficiency programmes of selected countries

Category of Co-benefit	Examples
Health	Better health of workers, Reduced medical expenses, reduced lost working days, reduced acute and chronic respiratory symptoms, increased life expectancy.
Emissions	Reduction of dust, CO, CO_2, NO_x and SO_x; reduced environmental compliance costs.
Waste	Reduced use of primary materials; reduction of waste water, hazardous waste, waste materials; reduced waste disposal costs; use of waste fuels, heat and gas.
Production	Increased yield; improved product quality or purity; improved equipment performance and capacity utilization; reduced process cycle times; increased production reliability
Operation and maintenance	Reduced wear on equipment; increased facility reliability; reduced need for engineering controls; lower cooling requirements; lower labour

Category of Co-benefit	Examples
	requirements.
Working environment	Improved lighting, temperature control and air quality; reduced noise levels; reduced need for personal protective equipment; increased worker safety.
Other	Decreased liability; improved public image; delayed or reduced capital expenditures; creation of additional space; improved worker morale.

Source: IPCC, 2007

Additionally, economy wide impact studies show that in a developing country, like India, adoption of energy efficient technology can lead to higher employment (particularly green jobs) and income generation (Sathaye et al., 2005; Phadke et al., 2005).

4 Initiatives for energy efficient practices

The state has taken various steps for promotion of energy efficiency in the industrial sector. As part of the Energy Conservation and Commercialization-II (ECO-II) project (a bilateral project between the Government of India and the United States agency USAID), Punjab has developed an Energy Conservation Action Plan (ECAP). The major objectives of the plan related to the industry sector are:

- To fulfill the mandates of EC act, in co-ordination with BEE, and other stakeholders.
- To promote energy efficiency addressing all commercial energy sources (coal, liquid petroleum gas, oil and electricity).
- Promote reduction of GHG emissions in the state.
- Promote use of Energy Efficient Technologies (EETs), equipment, processes, and appliances.
- Promote awareness in respect of EC Act, energy efficiency, standards, best practices, etc.

This action plan has a programmatic approach for implementation and focuses on energy reduction in the industry sector particularly in large Consumers, textile Industry and SMEs. A state level Energy Conservation Action Plan Team (ECAT) has been constituted under EC Act, 2001 to enable harmonization of energy conservation policy across different sectors in the state.

According to the Punjab State Action Plan on Climate Change (PSAPCC), the key achievements of the state towards energy conservation in the industry sector include (GoP 2012):

- Saving of 22 million kWh in large industries
- Conducted energy audits in 24 government/public buildings and a number of SMEs.
- Brought out notification for compulsory Solar Water Heaters, CFLs, ISI Marked Pumps.
- 10% energy saved in brick, cupola and rolling units through improved technological solutions.

The state however, needs to implement its own strategy in line with the action plan, prepared by Punjab Energy Development Agency (PEDA) as part of the ECO-III project of US-AID. The Punjab Mission for Enhanced Energy Efficiency (PMEEE) under its state action plan on climate change (PSAPCC) which is being implemented by PEDA aims to achieve EE in both large and MSMEs. It has the following objectives (GoP 2012):

- Achieve 3-7% improvement in energy efficiency in DCs through the PAT scheme
- Achieve 3-5% improvement in energy efficiency in large inductees other than DCs in sectors such as food processing, chemicals and ceramics. Around 7.5 crore has been earmarked under 12th plan to achieve this objective.
- Achieve 15-20% energy efficiency in energy intensive MSMEs. About 5 crore has been earmarked under 12th plan to achieve this objective.
- Create demand for energy efficient appliances, technologies and programs by educating the public and private sector on their options
- Through Bachat Lamp Yojana- replacing conventional lamp by CFL (around 40% savings in energy)

In order to achieve these objectives, PEDA organizes workshops in various industrial towns. It is also implementing many demonstrations projects of EETs. An estimate made by the BEE indicates that the total amount of energy that can be saved in this sector is equivalent to 4.76 BU (NPC 2010), representing 15.63% of the annual energy sold in the state

The Punjab Mission on Strategic Knowledge under PSAPCC aims to develop a centre for excellence in an existing R&D institution for clean technology developments and demonstrations. In addition to this, during 2011-12 to make the industries pollution free, air pollution control device was made available to 496 large and medium air polluting units and about 10,000 small scale units of the state. The state ensured that each large/medium water polluting unit had an in-house effluent treatment plant. In order to tackle the problem of effluent disposal, the state is assisting the dyeing industry of Ludhiana to set up two Common Effluent Treatment Plants (CETP) at Ludhiana.

5 Institutional framework

In order to implement energy efficiency programs and undertakes monitoring/evaluation of energy conservation activities implemented by BEE, each state has appointed statutory body—State Designated Agency (SDA). The SDA of Punjab is *PEDA*. PEDA is responsible for implementing and meeting the objectives of the PMEEE which includes the PAT mechanism. It also coordinated in the preparation of PSAPCC. The agency identifies, promotes and implements demonstration projects (especially related to renewal energy sources) in the industrial sector. It is the nodal agency for promotion of energy auditing in collaboration with BEE. Other key stakeholders who are active in promoting energy efficiency and sustainable development in the industrial sector in Punjab are:

Department of Science, Technology, and Environment & Non-Conventional Energy—The department deals in matters related to environment and coordinates with state and central Government authorities in this connection. The department also liaises with Central

Ministries of Environment and Forest, Science & Technology, Non-Conventional and Renewable Energy This department executes its activities through the following six authorities at State level:

1. Punjab State Council for Science & Technology
2. Punjab Pollution Control Board
3. Punjab Energy Development Agency
4. Punjab Biotechnology Incubator
5. Pushpa Gujral Science City
6. Punjab Biodiversity Board

Punjab State Council for Science & Technology (PSCST)—PSCST is responsible for promotion of sustainable development including conservation of natural resources, rural environment improvement and is the nodal agency for EE improvements in the MSME sector. It has implemented numerous projects for technology development and demonstration in MSMEs for industrial pollution control. Some of these include:

- Evolving a cost effective scrubbing technology for air pollution control in cupola furnaces
- Sustained efforts in the brick sector have resulted in development and demonstration of a number of energy efficient measures in brick kilns.
- A technology for controlling air pollution from pulverized coal fired re-rolling mills has been developed and demonstrated.

Punjab Pollution Control Board (PPCB) — It is responsible for implementation of Water Act (1974), Air Act (1981) & Environment Protection Act (1986) in the state. The Board implements comprehensive programs for prevention control and abatement of pollution in the industrial sector, advises state govt. on pollution prevention and conservation issues, collects and disseminates information on environmental quality and participates in investigations.

Punjab State Industrial Development Corporation Ltd. (PSIDC)—PSIDC, a Punjab Govt. undertaking is engaged in industrial development in Punjab as an institutional promoter and also acts as State level financial institution. PSIDC in the past has played a pivotal role in the overall industrial development of the state.

Punjab Small Industries and Export Corporation (PSIEC)—PSIEC works for the development and promotion of the MSME sector in Punjab. It has so far developed 27 industrial focal points in the state.

Besides these government agencies, there are various national and cluster level industry associations that play a major role in implementing energy efficiency in the industrial sector. Confederation of Indian Industry has its northern India headquarters based in Chandigarh. It has a centre of excellence for SMEs which is implementing many EE projects in the state. PHD Chamber has a regional office in Chandigarh.

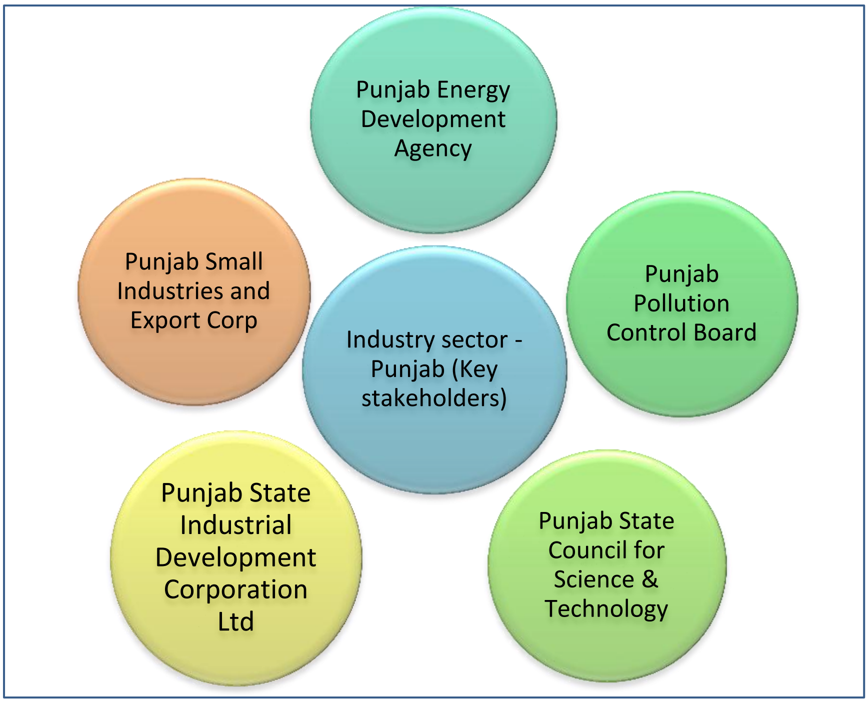


Figure 3: Key Regulatory Institutions- Punjab industrial sector

Source: TERI Analysis

6 Ways forward

Energy efficiency improvements can yield huge technical and economic benefits to bring about reductions in GHG emissions in the industry sector in Punjab. Adoption of best available technologies (BATs) and best operating practices (BOPs) would significantly reduce the energy consumption and CO_2 emissions in the industrial sector in the short and the medium term. In the long run, the state government cam focus on development of new energy efficient technologies could address the dual problems of growing resource scarcity and environmental degradation. New and emerging technologies that consume resources more efficiently, such as low temperature waste heat recovery and high energy efficient electric motors, promises to further boost the energy efficiency of the industrial sector in the long run.

Some of the key strategies that could be adopted (in the short, medium and long term) towards improving the energy efficiency and greening the Punjab's industry sector are mentioned below (see Figure 4):

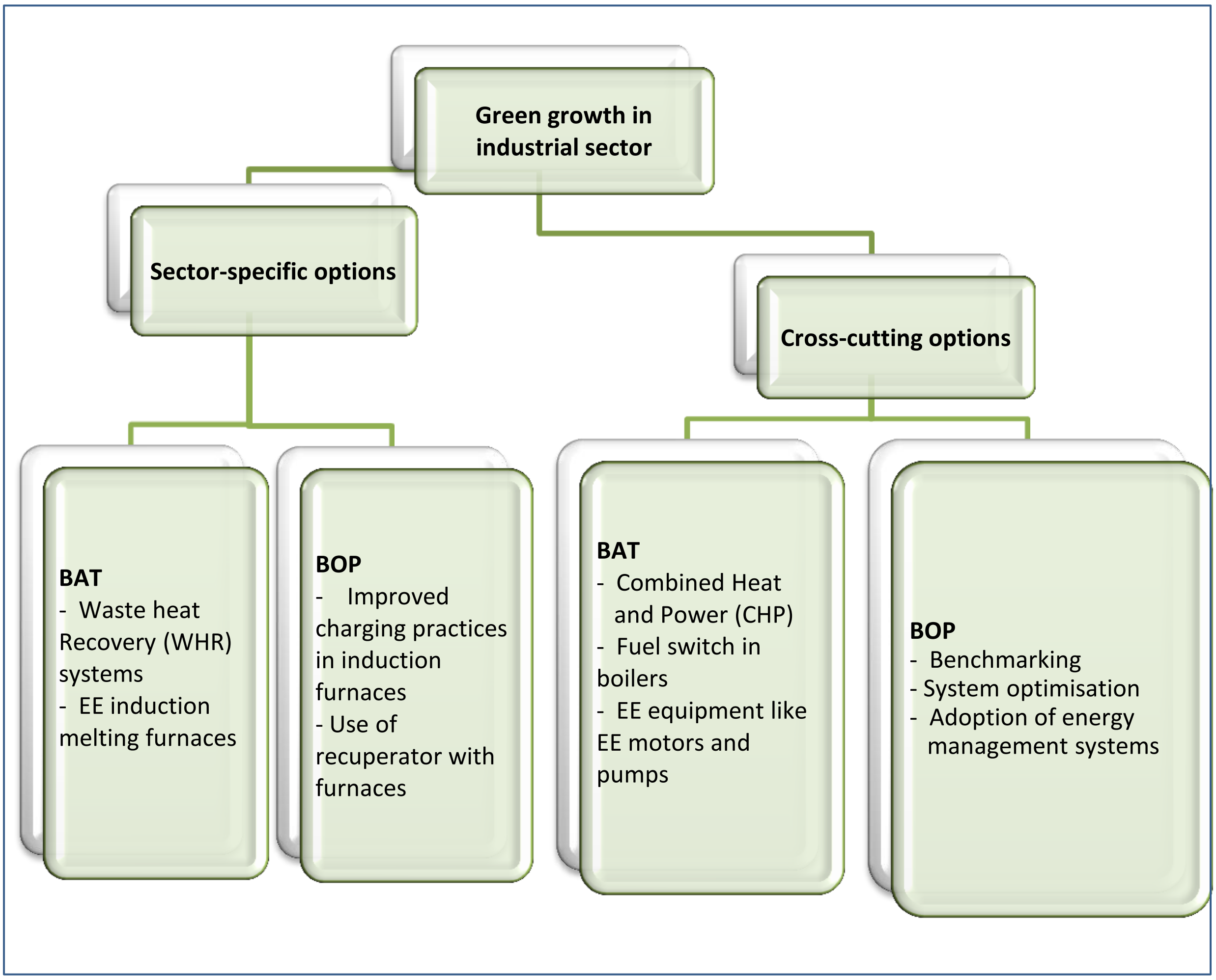


Figure 4: GHG mitigation options in Punjab's industry sector

Source: TERI studies

Short-term

- **Promote Energy Audits**

Effective management of energy-consuming systems can lead to significant cost and energy savings as well as lower maintenance costs, and extended equipment life, all in a short span of time. A successful energy management program begins with a thorough energy audit. In order to improve the energy efficiency of an industry, it is necessary first to examine the existing industrial process and identify the patterns of energy use in various stages. This exercise, known as energy audit is beneficial in the following ways

- Helps identify the areas where energy saving measures might be taken
- Provides the basis on which energy-efficient technological options can be developed for the industry concerned. Typically, an energy audit examines major energy-consuming systems and equipment such as motors, furnaces, boilers, pumps and blowers, HVAC (heating, ventilation and air cooling) systems, and the load and

demand management of the plant. PEDA can formulate and implement a program to conduct energy audits at a large scale in the industry sector. The audits could be followed up by implementation support to the industries (particularly the SMEs) to enable them to adopt the identified energy saving measures can be adopted by them.

- **Support financing of EE technologies**

Energy efficiency in any industry has two dimensions i.e. Technology and Financing. Technologies are available in different stages of commercialization (Pre commercial, Semi commercial and Fully commercial). Financing has to adapt itself to meet the requirement at each stage for scaling-up energy efficiency among the industries, given that energy efficient technologies are more expensive in comparison to conventional technologies. Therefore, energy efficiency financing models need to be customized to the specific financing needs of technologies in different stages of commercialization. State level financial institutions can play an important role in this regard.

Public finance through the state government and low cost finance from bilateral /multilateral agencies has a crucial role in supporting R&D and innovation of new technological solutions for pre commercial technologies, especially in the MSME sector in context of climate change. Supported bank finance is important for developing the market for commercially available technologies. It is important to note that most new technologies are more efficient compared to existing ones, and it is essential to ensure that the financial assistance for energy efficiency promotion gets channelized properly for correct technologies. One such criterion which has been adopted internationally is to calculate the financial returns (e.g. payback period, IRR) on capital investment fully from energy saving only. The energy saved from the technology needs to be estimated by certified energy professionals or from clearly defined Measurement & Verification (M & V) techniques. The financing can then be made flexible to decide on the amount and terms of lending for such technologies.

- **Benchmarking**

Benchmarking of specific energy consumption (SEC) is an important tool to access and compare present status of performance, technologies and processes in selected industrial sectors with those of others, to industry average and to best technologies and practices world-wide. This can help industries to compare with their peers and determine the potential of energy efficiency improvement within their plant.

Utility technologies such as boilers, pumps and compressors are large energy guzzlers and those produced in India offer immense scope for improvement in energy efficiency when compared to those manufactured in more advanced economies. However, no comprehensive benchmarking studies have been carried out for industry to assess the performance of these equipment. In order to create awareness of energy efficient pumps among consumers, BEE has launched a voluntary star labeling of pump sets in India. The scheme covers electric mono set pumps, submersible pump sets and open well submersible pump sets. No such ratings have yet been developed for boilers or compressors. However, even the existing pump ratings are only applicable for 3-phase pump sets from 1.1 kW (1.5 HP) to 15 kW (or 20 HP). Furthermore, these values are mainly to guide consumers on energy savings but do not provide any specific industry benchmarks. The PAT scheme has shown that benchmarking is an effective tool to set energy reduction targets for DCs.

Several developed countries such as Canada, Belgium, the Netherlands, Norway and the USA have supported the development of benchmarking programs in various forms. As part of its energy and climate policy the Dutch government has reached an agreement with its energy intensive industry that is explicitly based on industry's energy efficiency performance relative to that of comparable industries worldwide. Industry is required to achieve world best practice in terms of energy efficiency. In return, the government refrains from implementing additional climate policies. In the USA, EPA's Energy STAR for Industry program has developed a benchmarking system for selected industries, like automotive assembly plants, cement etc. The system is used by industries to evaluate the performance of their individual plants against a distribution of the energy performance of US peers. (IPCC-Bernstein, L. et al 2007).

Among the large industries, benchmarking studies could be initiated in the textile industry of the state and in the steel-rerolling and forging industry in the SME sector.

- **Adoption of best operating practices (BOPs)**

Cross-sectoral best practices offer immense potential to conserve energy across a variety of industrial segments irrespective of the type of manufacturing process. Particular emphasis needs to be placed on BOP as such practices improve energy efficiency without major investments. Such practices are also relatively easier to adopt and they can be implemented without major investments. Typically, the energy saving potential by adoption of improved practices is between 5 to 20%. According to an IPCC study (IPCC 2007), application of housekeeping and general maintenance on less-efficient plants can yield energy savings of 10–20%. Low-cost capital measures (combustion efficiency optimization, recovery and use of exhaust gases, use of correctly sized, high efficiency electric motors and insulation, etc.) show energy savings of 20–30%. More emphasis needs to be placed on documentation and promotion of BOPs through benchmarking and capacity building programmes. Some of these best practices are elaborated below:

  - ***Reduce, recycle and reuse***

Reduction of rejections in industries could lead to significant material and energy savings. The culture of continuous quality improvement or Kaizen needs to be promoted in a systematic manner among industries. Simple measures such as monitoring and analysis of defectives, identifying the root causes and initiating corrective actions in the process hold great promise among Indian industries. Recycling of used materials like aluminium and paper is less energy–intensive than processing the primary raw materials. For example, steel recycling is a well-established practice and recycling of paper is also increasing worldwide–waste paper recovery in Austria and the Netherlands is more than 60%. Recycling of steel in electric arc furnaces accounts about a third of world production and typically uses 60–70% less energy (ILO 2012).

In the cement sector, it is further possible to increase the use of blended cements, which would result in reducing the usage of limestone per tonne of cement produced. Since process emissions from cement production is one of the major sources of CO_2 emission in the cement sector, systemic shift to higher proportions of blended cements would not only help in reducing the CO_2 emissions, it would also help reducing the exploitation of cement grade limestone deposits in the country. Materials substitution, for example the addition of wastes (blast furnace slag, fly ash) and geo-polymers to clinker helps reduce CO_2 emissions from cement manufacture significantly (IPCC 2007).

Box 1: Recycling and Waste— An Example from Brazil

Brazil has a tradition of recycling with recovery levels for many materials matching or exceeding those in industrialized countries. Some 95% of all aluminum cans and 55% of all polyethylene bottles are recycled. About half of all paper and glass is recovered. Recycling in Brazil generates a value of almost US$ 2 billion and avoids 10 million tons of GHG emissions. At the initiative of local governments, some 60,000 recycling workers have been organized into cooperatives or associations and work in formal employment and service contracts. Their income has increased doubled than that of individual waste pickers, lifting families out of poverty. The National Solid Waste Policy (PNRS) – established by law on 2 August 2010 – aims to build on this potential. It provides for the collection, final disposal and treatment of urban, hazardous and industrial waste in Brazil.

Source: UNEP 2011

- ***System optimisation***

Most of the industries in Punjab (especially in the MSME sector), persist with outdated and inefficient technologies and there is not much focus on system optimization. As in other countries, both markets and policy makers in India tend to focus more on individual components despite the larger energy savings potential in a system optimization approach especially for steam, pumping and compressed air systems.

Plant equipment is discarded only after it has completed its entire life cycle and even when the equipment is upgraded, the focus is on the component and not on the entire system in place. For example, an outdated reciprocating compressor may be replaced with a modern screw compressor, but no effort is made to evaluate the piping systems, pressure controls and supporting equipment for the compressor. Similarly, factors such as pipes, cables, panel boards and the quality of power impact the performance of pumps.

A large share of the energy efficiency benefit is lost when such auxiliaries and practices are ignored. Hence, it is important to also focus on the practice of system optimization amongst industries. Considering the expanse of industry in India, there is immense potential for energy savings and consequent reductions in its GHG emission levels. Experience shows that while energy efficient components, such as pump, steam and compressed air systems can raise average efficiency 2–5 %, whereas system optimization measures can yield 20–30 % gains– with a payback period of less than two years.

- *Use of ICTs to enhance energy efficiency*

Achieving industrial energy efficiency is a multifarious task and involves access to information, financing, human resources and technology, improved decision making processes, and the ability to measure and verify the achieved energy savings. One of the best technological options is "adoption of Information and Communication Technologies (ICT)". Application of ICT tools in critical processes and equipment of industries would help in its optimization and also maintain the operating parameters close to the design level. Close control of various operating parameters in production processes may be achieved through advanced control, metering and feedback information.

Application of ICT tools can be either process related or cross-cutting across different industry sub-sectors. Few examples of process related ICT solutions include operating conditions of reformers in fertilizer industry or application in state-of-the-art smelter technology in an aluminium industry. A cross-cutting example of ICT includes the ERP (Enterprise Resource Planning) systems.

A number of Indian industries have acquired the benefits of standardized procedures through adoption of ERP systems. A sector-specific application of use of ICT for improving product yields are three-dimensional CAD simulation softwares for Indian foundry sector. These softwares can be used to study the actual fluidity and solidification progress of molten steel in the moulds. Better understanding of the solidification structure (i.e. dendrite pattern) of risers and runners of the castings helps in optimum design of the mould and thus improves the overall product yield.

Another example of use of ICT in pulp and paper industry is adoption of Advanced Process Control (APC) technology in conjunction with the existing DCS (Distributed control system). The technology allows varying of the multiple parameters to achieve the desired outputs of increased productivity and enhanced energy efficiency. For example ITC Bhadrachalam, haeg successfully installed APC systems for their soda recovery boiler. The APC takes corrective actions every 30 seconds for disturbances in the unit to maintain excess oxygen close to the minimum allowable limit.

Mid-term

- *Creating an enabling environment*

The state government needs to play a crucial role in setting the cross-sectoral framework for energy efficiency. This includes implementing enabling policies to cost-effectively increase energy efficiency by establishing market signals to motivate effective action to accelerate the introduction of new technologies. According to IEA, to achieve energy savings in the industrial sector, the governments need to (a) support industry adoption of energy management protocols; (b) mandate minimum energy performance standards (MEPS) for electric motors; implement a package of measures to promote energy efficiency in MSMEs. The Punjab government can design their programs on these lines. The government will have to take aggressive steps to stimulate investment in energy efficiency and accelerate implementation through synergies with national level energy efficiency plans.

Additionally, government needs to put in place complementary financial policies that promote energy-efficient investment. This could be done by:

- Reducing energy subsidies and internalizing the external costs of energy through policies
- Encourage investment in energy-efficient technologies and processes by putting in place targeted financial incentives such as tax incentives for adopting EETs
- Foster private finance of energy efficiency upgrades in industry through risk-sharing or loan guarantees with private financial institutions and enabling the market for energy performance contracting.

There can be no single instrument to promote industrial energy efficiency effectively amongst different stakeholders and across all levels. The main stakeholders involved in energy efficiency landscape other than the government agencies are (i) energy suppliers (ii) equipment manufacturers and technology suppliers (iii) energy efficiency service providers (consultants) (iv) financial institutions and (v) energy consumers. The equipment manufacturers, the technology providers, financial institutions and energy efficiency service providers who act as intermediaries have a very important role in the energy efficiency market place.

Large companies have greater resources, and usually more incentives, to factor environmental and social considerations into their operations than MSMEs, but MSMEs provide the bulk of employment and manufacturing capacity. Punjab government needs to integrate MSME development strategy into the broader state level developmental strategies for sustainable development. The concept of 'designated consumers' as in large industries can be extended to MSMEs at the state level. High energy intensive clusters can be classified as 'designated clusters' and cluster level programs should be formulated and implemented for them. Donor agencies such as UNIDO, UNDP who are implementing EE projects in the state also need to focus on developing new low-cost clean technological solutions for these energy intensive MSME clusters. Often technological solutions that are available in developed countries cannot be used by MSMEs in developing countries because of their high cost and different scales of operation.

- **Fuel switch options**

Switch over from coal to low carbon fuels like natural gas and biomass offers one of the best opportunities in terms of moving towards a low carbon economy. Punjab can explore the biomass potential in the state. Waste materials (tyres, plastics, used oils and solvents and sewerage sludge) are being used by a number of industries. Even though many of these materials are derived from fossil fuels, they can reduce CO_2 emissions compared to an alternative in which they were landfilled or burned without energy recovery. In Japan, use of plastics wastes in steel has resulted in a net emissions reduction of 0.6 $MtCO_2$-eq/yr (IPCC 2007).

In case of certain applications like cement manufacturing, the plants can use municipal solid waste as well as other fuels like used tyres to replace fossil fuels. Industries with low temperature water requirements (around 100°C) such as dairy, textiles and pharmaceuticals can also use solar thermal systems. PEDA can play an important role in this regard.

- **Adoption of cross-cutting best available technologies (BATs)**

Cross-cutting technological options have potential to conserve energy across a variety of industrial segments irrespective of the type of manufacturing process. It has been estimated that in general, in the industries, approximately 50% of the industrial energy use is consumed in cross-cutting areas such as boilers, air compressors, motors, pumps, blowers and so on. Some of the BATs available for realizing energy savings are mentioned below:

  - **Cogeneration (combined heat and power CHP) systems**

Cogeneration (also called CHP) involves using energy losses in power production to generate heat for industrial processes and district heating, providing significantly higher system efficiencies. Industrial cogeneration is an important part of power generation in Germany and the Netherlands (IPCC 2007).

Cogeneration is common in many pulp and paper, sugar and chemical industries in India. However, there is a significant scope to improve the efficiencies of the cogeneration plants by adoption of high pressure systems, suitable regulatory framework needs can go a long way in encouraging industries to adopt advanced cogeneration systems and explore surplus power to the grid. As per the Integrated Energy Policy Report prepared by an expert committee constituted by the Planning Commission, renewable sources may contribute to nearly 6% of India's energy mix by 2032. Additional power could be generated through bagasse based cogeneration in Punjab's sugar mills, if these sugar mills were to adopt technically and economically optimal levels of cogeneration for extracting power from the bagasse produced by them.

  - **Use of energy efficient equipment**

Use of energy efficient equipment such as pumps, motors, and air compressors have good potential to save energy among industries. Motors and motor driven systems account for a major share of electricity used by industries in India for operating various machines, fans, pumps, conveyors, compressors.

These machines find applications in various types of industries like pharmaceuticals, sugar, pulp & paper and cement manufacturing, and electronics, etc. and hence there is a great need to use more EE motors for different application in all the industries. The electric motor is the main element in a motor-driven system that offers the potential for savings. Replacement of inefficient motors with EE ones such as IE1, IE2 and IE3 can yield a savings of 10-15% with quick payback period and cost-effectiveness.

  - **Energy-efficient lighting**

Replacing incandescent and mercury vapour lamps with energy efficient lamps such as CFLs and low pressure sodium lamps could effectively reduce the energy consumption in lighting systems. These lamps would require proper ballasts to operate effectively.

However, while replacing the lamps in industry, their suitability in specific areas will have to be seen in view of their colour rendering index.

In general, the electricity savings for switching over to energy-efficient lamps can be of the order of 35–45% from the existing level. According to an EESL study (EESL 2014), replacement of a 60W incandescent lamp with 10W LED will result in saving of over 80% energy savings. Lighting controls and voltage stabilization systems would also offer substantial energy savings as well as enhance the life of the lighting systems.

- **Implementation of ISO 50001 energy management standard**

Using energy efficiently helps organizations save money as well as helping to conserve resources and tackle climate change. The International Standards Organization (ISO) has developed ISO 50001 - a standard focusing exclusively on energy management. ISO 50001 supports organizations in all sectors to use energy more efficiently, through the development of an energy management system (EnMS). The Bureau of Indian Standards (BIS), Government of India, has accepted this standard and introduced its own version for the Indian market. ISO 50001 has been successful in many countries including the United States and many European countries and there are several lessons that can be leveraged. While ISO 50001 is fast penetrating the industrial space in global enterprises, it has yet to show such pace in India. Currently, there are only around 30 enterprises in the entire country that have adopted the standard; it is evident that an additional impetus is required to catalyze its widespread adoption.

With regard to the energy management practices followed by industries in India, it is seen that most industries persist with outdated and inefficient technologies and systems. Revenue generation by increasing production remains at the forefront, while cost savings through energy efficiency is a less sought after method of operation. Promoting ISO 50001 is imperative in this context. Seminars can be organized in association with various chambers of commerce and industry to promote ISO 50001 across the country. Assistance from industry associations will be sought for disseminating information to energy intensive SME clusters.

ISO 50001 is based on the management system model of continual improvement also used for other well-known standards such as ISO 9001 or ISO 14001. This makes it easier for organizations to integrate energy management into their overall efforts to improve quality and environmental management. ISO 50001 provides a framework of requirements for organizations to:

1. Develop a policy for more efficient use of energy
2. Fix targets and objectives to meet the policy
3. Use data to better understand and make decisions about energy use
4. Measure the results
5. Review how well the policy works, and

6. Continually improve energy management

- **Adoption of Sector specific cleaner technological options**

Sector specific energy efficient technologies can lead to significant energy savings, sometimes as high as 25-50%. This section discusses some sector specific mitigation options for major energy intensive industrial sectors of Punjab viz. fertilizers, pulp and paper, textiles, and iron and steel.

  - ***Fertilizer Sector***
    - Feedstock conversion from Naptha to Regassified Liquified Natural Gas in ammonia-Urea plants
    - Use of carbon-di-oxide recovery plant to recover carbon-di-oxide from flue gases of various furnaces
    - Installation of two-stage carbon-di-oxide recovery system
    - Re-processing of Purge Gas for Ammonia-fertiliser
    - Installation of low temperature shift (LTS) guard with additional heat recovery to preheat boiler feed water
    - Conversion of single stage flash vessel system in regeneration section with multi-stage flash vessel system with ejectors
  - ***Textile Sector***

Textile industry is highly energy intensive. Wet processing or dyeing operation consumes almost 50% of the energy in a composite mill. Thermal energy (steam and hot water) is primarily used to process, dye, print and dry the cloth during wet processing. There is a large scope to save energy in the boilers, steam distribution and drying operation in a textile mill. Some examples of energy conservation measures in a textile mill are the following:

- Energy efficiency improvement in humidification plant
- Conversion of thermic fluid heating system to direct gas firing system in stenters and dryers
- Temperature control system in processing machines

Recovery of condensate in wet processing plants

- Energy efficiency improvement in cylinder dryer
- Waste heat recovery in stenters, merceriser machines and bleaching system
- Replacing electric heating with thermic fluid heating in polymeriser machine

- Installation of photocells for speed frames

- ***Pulp and paper industry***

Process optimization, waste heat recovery, and cogeneration systems offer significant scope for improving the performance of Indian paper mills. Other energy conservation measures, which require marginal or no investments and would resulting 5–10% energy savings, are listed below:

- Excess air control in boilers through ducting design and instrumentation to help in reducing the load on induced draft (ID)/forced draft (FD) fans.
- Proper temperature control in slaking and causticizers to reduce steam consumption.
- Better instrumentation loop in agitators.
- Cascading system for efficient use of steam in the dryer section of the paper machine.
- Vacuum piping with minimum bends in the paper machine section.
- Replacement of beaters by double disc refiners in small paper mills.
- Adoption of bio methanation.
- Use of de-silication technology for silica-rich raw materials such as rice straw, bagasse, and bamboo based raw materials.

- ***Iron & Steel industry***

Mandi Gobindgarh steel rolling cluster in Punjab is one of the most polluting MSME clusters in the state. Hence it would be essential to develop strategies to reduce the energy consumption and GHG emission of this cluster. Some energy efficient options for steel rolling mills located in the cluster are given in Table 4.

Table 4: Energy saving options in Mandi Gobindgarh steel rolling cluster

S.No.	Technology	Investment (Rs)	Energy Savings Potential
Low-cost technologies			
1	Installation of high efficiency recuperator with improved furnace design	1.5-2 crores	20-25%
2	Replacement from lump coal to coal producer gas as fuel		
3	Technology for using pulverized coal as fuel		
4	Use of biomass gas as fuel		
Hi-cost technologies			
5	Installation of regenerative burner system	5-6 crores	30-40%

S.No.	Technology	Investment (Rs)	Energy Savings Potential
6	Hot charging of Continuous Cast Billet		
7	Top-and-Bottom firing system in reheating furnace		
8	Oxy-fuel combustion system in reheating furnace		
9	Walking hearth/Beam furnace		

Source: UNDP (2014)

Long-term

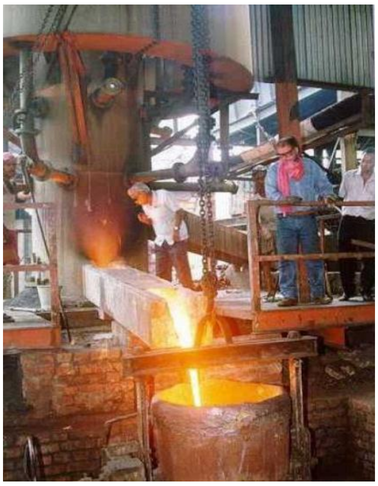
Development of new energy efficient technologies

Innovation is clearly central to the idea of green growth in the long run. While existing technologies can significantly reduce industrial GHG emissions, new and lower-cost technologies are needed in the industry sector to meet long-term mitigation objectives of India. Public and private participation is required for RDD&D (Research, Development, Demonstration and Deployment) for clean technologies that can reduce GHG emissions. Especially in the MSME sector in India, where ready technology solutions are not available, the government and the industry needs to invest in R&D solutions. The state government needs to set up incubation centers, cluster level fabricators need to be incentivized to develop low cost technological solutions as per local conditions.

Most industrial processes use at least 50% more than the theoretical minimum energy requirement determined by the laws of thermodynamics, suggesting a large potential for energy-efficiency improvement and GHG emission mitigation (IEA, 2006a). RDD&D can help capture these potential efficiency gains and achieve significant GHG emission reductions.

Additionally, in order to expedite uptake of energy efficient and clean technologies in the MSME sector, there is a need to go beyond conventional methodologies. Innovation is essential and studies have shown that new technologies offer up to 30% energy savings potential. Experience shows that RDD&D has proven to be successful in terms of increasing the capabilities of the manufacturing sector and the SME workforce as a whole (see box2). In RDD&D, the focus needs to be on customizing technologies for sub-sectors and clusters/units, extending technical/financial support, and providing units with dedicated assistance on implementation. This model was followed by the Swiss Agency for Development and Cooperation (SDC) in India in selected energy intensive MSME sub-sectors (glass, brick, foundry) and has proven to be very successful. Customization has to be followed by successful demonstration to increase uptake of technologies in the MSME sector. Thereafter, dissemination assumes utmost importance so that other units and clusters can also benefit.

Box 2: RDD&D in small scale grey iron foundries in India



An example of one such technology is the energy efficient melting furnace technology called the divided blast cupola (DBC). TERI designed and developed the energy efficient DBC for foundry industries in India. Around 100 DBCs in different units within the foundry clusters like Coimbatore, Ahmedabad, Rajkot, Howrah, etc. have adopted this technology design. TERI successfully strengthened the capabilities of local fabricators to promote and sustain the uptake of DBCs among foundries in various clusters. The intervention enhanced the technological capacities of cluster-level providers and fabricators of DBCs. The DBC typically helps in energy saving of 20%-30% and increases production quality. The successful implementation of the technology in a few units convinced a number of foundries to adopt the DBCs.

Source: To read more, visit the resources section the SAMEEEKSHA website (www.sameeeksha.org)

Keeping pace with constantly improving technologies is critical for industry competitiveness in a developing country such as India. This requires an enabling environment at the state level and infrastructure that nurtures research and development of modern technologies matching the best available worldwide. Technology developers, supply industries and users need to cooperate, brainstorm and discuss market mechanisms to develop suitable technologies. Technology RDD&D has to be carried out by both governments (public sector) and the corporate (private sector). Ideally, the roles of the public and private sectors will be complementary. Many studies have indicated that the technology required to reduce GHG emissions and eventually stabilize their atmospheric concentrations is not currently available in the developing countries (Bernstein, L. et al 2007).

A collaborative R&D and demonstration approach that combines the know-how of local/national and international experts is needed. Such an approach will lead to building the technical capacities of local actors on manufacturing and trouble shooting of the technology and thus promote dissemination of the new technology at a faster pace. In order to create a delivery system for the developed technology it is important to identify and develop a network of local service providers (LSPs). The LSPs who can be consultants, fabricators or consultancy organisations, can play an important intermediary role in hand-holding of the units to successfully implement the technology. The LSPs can be developed as project promoters for providing services such as technical assistance, financial intermediation and ESCO services.

7 References

BEE. (2008). *The Action Plan for Energy Efficiency*. New Delhi: Bureau of Energy Efficiency, Government of India

BEE. (2012). *Perform, Achieve and Trade*. New Delhi: Bureau of Energy Efficiency, Government of India

Bernstein, L., J. Roy, K. C. Delhotal, J. Harnisch, R. Matsuhashi, L. Price, K. Tanaka, E. Worrell, F. Yamba, Z. Fengqi, (2007): Industry In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

CII. (2013). *Technology Compendium on Energy Savings Opportunities — Iron & Steel*. Hyderabad: Confederation of Indian Industry

CII. (2013). *Technology Compendium on Energy Savings Opportunities —Fertilizers, Textile*. Hyderabad: Confederation of Indian Industry

CSO (2014). *Energy Statistics*. Central Statistics Office. Government of India.

DCED. (2012). *Green Industries for Green Growth*: The Donor Committee for Enterprise Development

Dhingra, Upinder et al (editors). (2013). *Proceedings of the National Summit on Energy Efficiency in MSMEs, 2012*. New Delhi: The Energy and Resources Institute.

ECA. (2001). Energy Conservation Act. New Delhi: Ministry of Power, Government of India

EESL.(2014). Promotion of Energy Efficiency through Standard Offer Program (SOP): Approach Case Study of an Innovative and Replicable Project on Demand Side Management based Efficient Lighting Program (DELP) in Puducherry. New Delhi: Energy Efficiency Service Limited

GoI. (2008). *National Action Plan on Climate Change*. New Delhi: Prime Minister's Council on Climate Change, Government of India

GoI. (2010). *Report of Prime Minister's Task Force on Micro, Small and Medium Enterprises.* New Delhi: Government of India

GoP. (2011). *Environment Statistics of Punjab 2011.* Chandigarh: Economic & Statistical Organisation, Government of Punjab.

GoP. (2012). *Punjab State Action Plan on Climate Change.* Punjab State Council for Science & Technology.

GoP. (2013). *Economic Survey 2012-13.* Chandigarh.

IGES. (2014). *investing in Low-Carbon Development in India: A Guidebook (draft).* Kangawa, Japan: Institute for Global Environmental Strategies

ILO. (2012). Working *Towards Sustainable Development: Opportunities for decent work and social inclusion in a green economy,* Geneva: International Labour Office.

Mckinsey & Company. (2012). *India: Taking on the green-growth challenge.* McKinsey on Sustainability & Resource Productivity.

MoMSME. (2012). Report of the Working Group on Micro, Small & Medium Enterprises Growth for 12th Five year Plan. New Delhi: Ministry of Micro, Small and Medium Enterprises, Government of India

NPC. (2010). *State wise electricity consumption and conservation potential in India.* New Delhi: National Productivity Council

PC. (2012). *Twelfth Five Year Plan (2012–2017) Economic Sectors (DRAFT).* New Delhi: Planning Commission, Government of India.

PHDCCI. (2011). Punjab: The State Industrial Profile, New Delhi: PHD Chamber of Commerce and Industry

Swain, A. (2014). India's Green Industrial Policy: Pursuing Clean Energy for Green Growth, New Delhi

TERI. (2009). *GREEN India 2047 renewed: Looking Back to Change Track* . New Delhi: TERI Press.

TERI. (2010). Joint policy research on co-benefits in tackling climate change and improving energy efficiency in India – Preliminary Report, New Delhi: The Energy and Resources Institute and Institute of Global Environmental Strategies

TERI. (2012). *India's green Economy: Road map to an inclusive and equitable growth*. New Delhi: The Energy and Resources Institute

TERI. (2013). *Green Growth and Development Quarterly, Volume I Issue 3.* New Delhi: TERI.

TERI. (2014). *The Collaborative Study on Energy Efficiency and Conservation in India: Phase-5*, New Delhi: The Energy and Resources Institute

TERI. (2014). *TERI Energy Data Directory and Yearbook* (TEDDY) 2013-14. New Delhi: The Energy and Resources Institute

UNEP. (2011). *Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication - A Synthesis for Policy Makers.* Nairobi: United Nations Environment Programme.

UNESCAP. (2012). *Low Carbon Green Growth Roadmap for Asia and the Pacific.* Bangkok: UNESCAP.

Online sources:

http://www.punjabonline.in/About/profile/Economy/policy.html

http://www.worldbank.org/en/news/press-release/2012/09/06/100-million-world-bank-loan-support-himachal-pradesh-green-growth-agenda-inclusive-sustainable

About TERI

A unique developing country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to helping shape the development of the Indian oil and gas sector; from tackling global climate change issues across many continents to enhancing forest conservation efforts among local communities; from advancing solutions to growing urban transport and air pollution problems to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in. However, while TERI's vision is global, its roots are firmly entrenched in Indian soil. All activities in TERI move from formulating local- and national-level strategies to suggesting global solutions to critical energy and environment-related issues. TERI has grown to establish a presence in not only different corners and regions of India, but is perhaps the only developing country institution to have established a presence in North America and Europe and on the Asian continent in Japan, Malaysia, and the Gulf.

TERI possesses rich and varied experience in the electricity/energy sector in India and abroad, and has been providing assistance on a range of activities to public, private, and international clients. It offers invaluable expertise in the fields of power, coal and hydrocarbons and has extensive experience on regulatory and tariff issues, policy and institutional issues. TERI has been at the forefront in providing expertise and professional services to national and international clients. TERI has been closely working with utilities, regulatory commissions, government, bilateral and multilateral organizations (The World Bank, ADB, JBIC, DFID, and USAID, among many others) in the past. This has been possible since TERI has multidisciplinary expertise comprising of economist, technical, social, environmental, and management.

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