Green Growth Background Paper

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Green Growth and Industry in Himachal Pradesh

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1. Introduction

Himachal Pradesh has made significant progress in terms of industrialization, although it is a hilly state with poor train and air connectivity. The state has a diversified base of industries ranging from traditional handloom/handicrafts to modern textiles, electronics, telecommunication, precision tools, pharmaceuticals, engineering and food processing units. The industry sector contributed to about 40% of the state's GDP during 2009-10 in contrast to about 26% during the year 1990-91 reflecting a progressive trend in the industrialization of the state (GoHP 2013).

According to the economic survey report of Himachal Pradesh (GoHP 2013) in the year 2012-13, the number of large & medium scale industrial units in the state stood at 494 and that of small scale units at 38,592. The state has about 4 large-scale cement plants and 3 cement grinding units and 18 textile mills. The large and medium scale units provided employment to about 0.22 million persons, and had a turn-over of INR 165 billion. The industrial activity in the state are concentrated in the districts of Solan, Sirmaur, Una, Bilaspur, and Kangra. The Baddi-Nalagarh area of Solan district has concentration of textile, pharmaceutical and packaging industries; Bilaspur district has concentration of cement industries, whereas steel industry is coming up in the Sirmaur district.

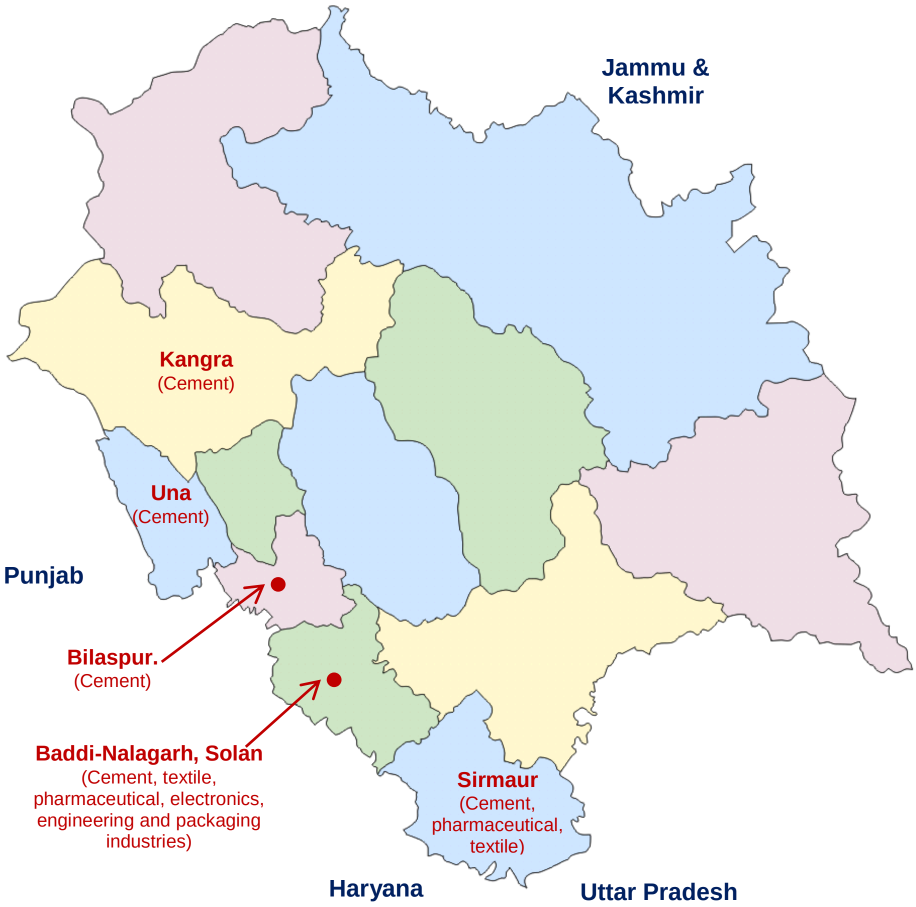

Figure 1 Industrial clusters in Himachal Pradesh

Source: BEE, 2012 and TERI studies

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 1

Table 1 Co-benefits of greenhouse-gas mitigation or 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 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

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).

A review of 54 emerging energy-efficient technologies, produced or implemented in the USA, EU, Japan and other industrialized countries for the industrial sector, found that 20 of the technologies had environmental benefits in the areas of 'reduction of wastes' and 'emissions of criteria air pollutants'. The use of such clean technologies is often most compelling when it enables the expansion of incremental production capacity without requiring additional environmental permits. In addition, 35 of the technologies had productivity or product quality benefits (IPCC 2007). The quantification of the co-benefits of industrial technologies is often done on a case-by-case basis. An evaluation of 52 selected projects form the USA, the Netherlands, UK, New Zealand, Canada, Norway and Nigeria that monetized non-energy savings had an average simple payback time of 4.2 years based on energy savings alone. Addition of the quantified co-benefits to this, reduced the simple payback time to 1.9 years (Worrell et al., 2003).

2. Energy intensive industries

The industry sector is one of the major consumers of energy in the state and the sector also accounts for high emissions of greenhouse gases (GHG). Within the sector, cement sector is a very significant energy consumer. The power consumption by the state's industry sector in the year 2011-12 was 4,315 million kWh, which was 63% of the total power consumed in the state (GoHP 2013). This is highlighted in Figure 2.

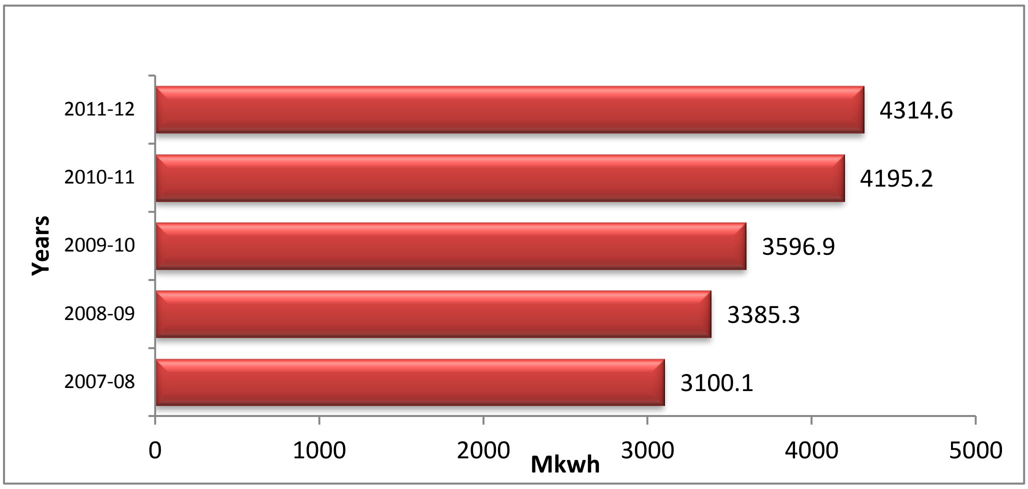

Figure 2 Power consumption in industrial sector in HP

Source: (GoHP 2013)

A total of 10 Designated Consumers (DCs) are situated in the state. These large DCs account for a major share in the total energy consumption and in the GHG emissions of the state. The DCs include 3 cement plants and 7 textile units (BEE 2012). The total energy consumption (in toe) by the cement and textile sectors is highlighted in Figure 3. These DCs together consume 0.67 MTOE of energy annually.

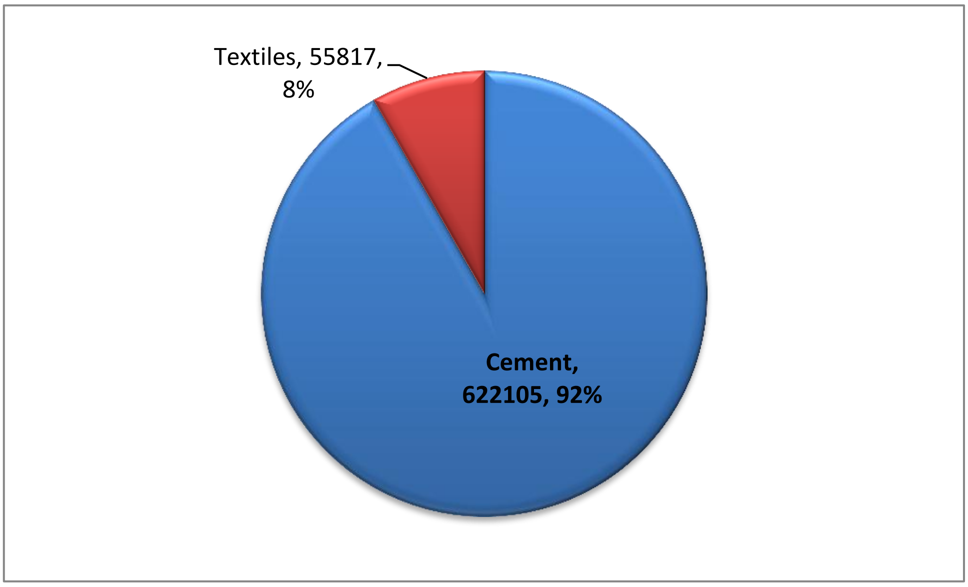

Figure 3 Energy Consumption (TOE) by large industrial sectors in HP

Source: (BEE 2012)

Other major energy intensive industries in the state include pharmaceutical, food processing and electronic industries. Most of these units are in the MSME sector and situated in the Baddi-Nalagarh area.

Owing to the high energy consumption, the industry sector also leads in the levels of GHG emissions in the state. During 2007- 09, GHG emissions from the state's industry sector were estimated to be 5.49 million tons of CO2 eq., while the total emissions from all the sectors was 11.7 million tons of CO2 eq (GoHP 2012a). Industry sector emissions are generated from manufacturing processes of cement, glass, metals and chemicals. Figure 4 and Table 2 show the contribution of various industrial sectors to the GHG emissions of the state. As can be seen from the table, cement production contributes to over 90% of the state's industrial sector GHG emissions and over 50% to the state's total GHG emissions making it imperative for the state government to focus its efforts on adoption of clean technologies in the cement sector.

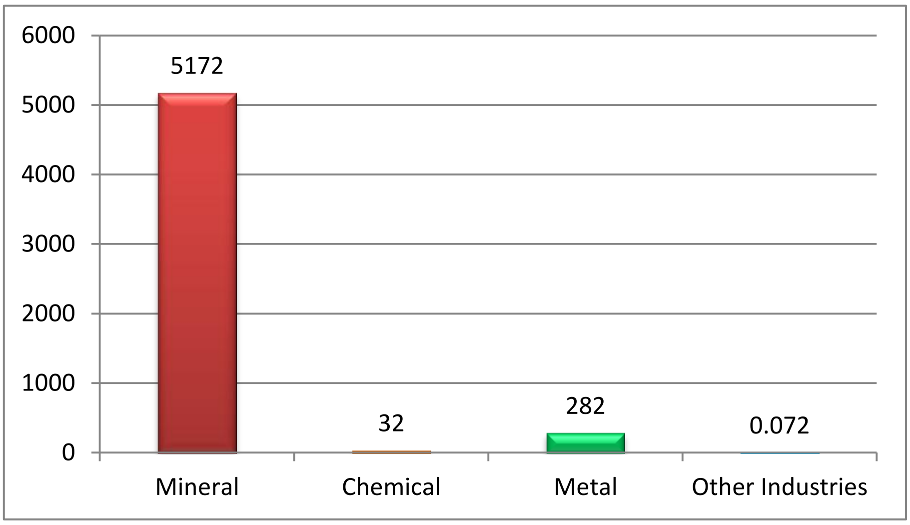

Figure 4 GHG emissions-Industry sector in HP during 2007- 09 (000'tons)

Source: (GoHP 2012a)

Table 2 GHG emissions-Industry sector in Himachal Pradesh during 2007- 09

S. No.	Industry Sub-Sector	GHG emissions(000'tons)
Mineral		
1	Cement Production	5170.4
2	Glass Production	1.5
Chemical		
3	Carbide Production	26.5
4	Methanol	5.1
Metal		
5	Ferroalloys	82.2
6	Aluminium	170.5
7	Lead (Secondary Production)	28.9
8	Zinc production	0.02
Other Industries		
9	Pulp & Paper	0.02

S. No.	Industry Sub-Sector	GHG emissions(000'tons)
10	Textile & Leather	0.01
11	Food Processing	0.04
12	Mining and Quarrying	0.002
TOTAL		**5485.2**

Source: GoHP 2012a (HP GHG Inventory report)

3. Energy saving potential

According to a NPC-BEE report (NPC, 2010), the annual electricity sales to the industry sector including low & medium voltage consumers (SME) and high voltage consumers (large industries) was 3165 MU and works out to 62 % of the total electricity sold. The larger industries segment is covered for energy efficiency under the mandates of EC Act as designated consumers, while SME segment is being addressed for energy efficiency through cluster based initiatives by Bureau of Energy Efficiency. Based on several studies & energy audits, the electrical energy saving potential in industry sector varies from 7-10%. The energy savings potential for the sector is assessed to be 221 MU.

In the SME sector, there are about 13 SME clusters spread across the state. There are two main clusters which are energy intensive i.e. pharmaceuticals and light engineering. There are about 185 units in pharmaceutical cluster and about 135 units in light engineering cluster. The assessed annual savings potential is 65.49 MU (Table 3).

Table 3 Energy saving potential in HP's SME sector

Cluster Location	Product/cluster	Units	Estimated Annual Energy Consumption MUs (TOE)	Energy savings potential, %	Annual energy saving potential
Baddi	Pharmaceutical	185	98.63 MU 9355 TOE	15	14.79 MU 1403 TOE
Baddi, Nalagarh, Barotiwala	Light Engineering	135	338 MU 8100 TOE	15	50.7 MU 1215 TOE
TOTAL			436.63 MU 17455 TOE		65.49 MU 2618 TOE

Source: (NPC 2010)

4. Interventions in Energy Efficiency

The Energy Conservation (EC) Act, 2001 provides a legal mandate for the implementation of energy-efficient (EE) measures through Bureau of Energy Efficiency (BEE) at both, the central government level and at the state level. In line with this, the HP government is implementing an energy efficiency saving program under its state action plan (GoHP 2012b). A number of programmes have been initiated and it is anticipated that these would result in saving of 500 MW in the overall consumption of energy in HP. Some of the major programmes initiated to enhance energy efficiency in the industry sector include:

- Complete ban on use of coal for space heating.
- Developing economic instruments to promote energy efficiency in the state.
- Discouraging the energy intensive industries that contribute majorly to GHG emissions.
- Launched 'Atal Bijli Bachat Yojna' and distributed free CFL's.
- Committed to harness the entire potential of 22,000 MW of hydro power available in the state to contribute greatly to country's clean energy demand.
- Encourage the use of solar heating systems and promote the use of biogas plants.

The government in its recent industrial policy aims to promote cleaner production, adopt environment management systems, discourage polluting industries and encourage public disclosure of pollution status at the unit and cluster level (GoHP 2012b). The focus of industrial policy is now on promotion of eco-friendly and local skill material based industries to the interior areas of the state by granting location based subsidies and incentives.

5. Institutional Framework

Each state has created a statutory body, the state designated agency (SDA), to implement the energy efficiency programs and to undertake monitoring and evaluation of energy conservation activities that are to be implemented by BEE. The Directorate of Energy has been appointed as the SDA under the Himachal Pradesh government.

5.1 Directorate of Energy

Directorate of Energy has been appointed as the SDA under the Himachal Pradesh government and all the programs and schemes of BEE are implemented through it. It is responsible for the implementation of state objectives on energy efficiency improvements under its action plan on climate change. The directorate has recently empanelled 24 energy auditors (22 firms and 2 individuals) to carry out energy audits across the state under its on-going program 'Conservation of Energy and its efficient use' under the Energy Conservation Act 2001. Other key stakeholders who are active in promoting energy efficiency and sustainable development in the industrial sector in HP are:

5.2 Department of Environment, Science and, Technology

The department works towards improving the effectiveness of environmental management, to protect vulnerable ecosystems and to enhance sustainable development in various sectors. It deals in matters related to development of new technologies and environment protection. It also coordinates actions and discussions between the state and central authorities in this connection. It conducts research and development (R&D) activities in collaboration with premier institutions in the domain of environment protection. The *HP State Council for Science and Technology* also works under the department and performs tasks related to development and demonstration of clean technological solutions.

5.3 H.P. State Pollution Control Board

H.P. State Pollution Control Board (HPSPCB) is a nodal agency within the state government for planning, promotion, co-ordination and overseeing the implementation of environmental programs. 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.

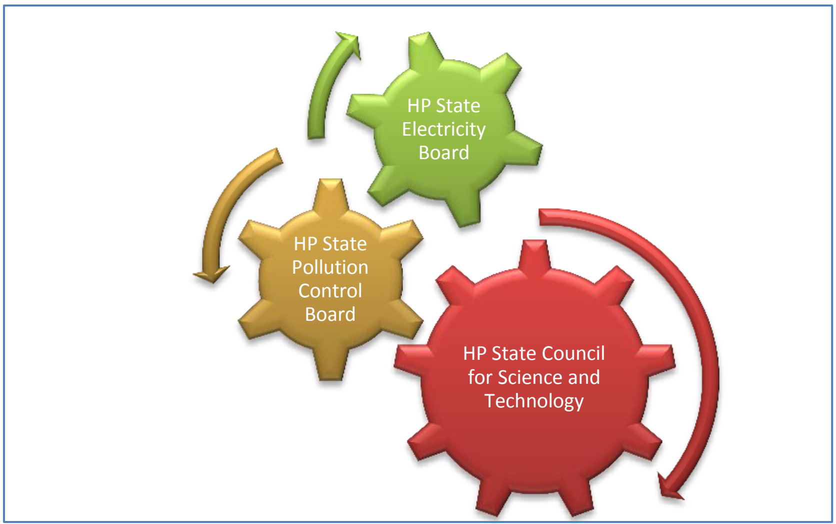

Figure 5 Key Regulatory Institutions- H.P Industry Sector

6. Ways Forward

Energy efficiency improvements have proven to be the most cost-effective means to bring about reductions in GHG emissions in the industry sector. Adoption of best available technologies (BATs) and best operating practices (BOPs) can significantly reduce the energy consumption and CO_2 emissions in the industrial sector in the state during the short and medium term. In the long run, development and use of new energy efficient technologies could address the dual problems of growing resource scarcity, growing energy demand and environmental degradation. Emerging technologies that are resource-efficient, such as low temperature waste heat recovery and high energy-efficient electric motors, seem promising and could boost the energy efficiency of the industrial sector in the state 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 industry sector in HP are mentioned below:

Short-term

Promote energy audits

Management of heavily energy-consumptive systems can lead to significant cost and energy savings as well as help achieve lower maintenance costs and extended equipment life. A successful energy management program begins with a thorough energy audit. In order to improve the energy efficiency of an industry, it is necessary to first examine the existing industrial processes and identify the patterns of energy use in various stages. This exercise, known as *energy audit*, (1) helps identify the areas where energy saving measures could be taken, and (2) provides the basis on which energy-efficient technological options can be developed for an industry. Typically, an energy audit examines the most energy-consumptive systems and equipment such as motors, furnaces, boilers, pumps, blowers, HVAC (heating, ventilation and air cooling) systems, and also examines the load and demand management of the plant. The HP Electricity Board could formulate 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.

<u>Support financing of energy-efficient technologies</u>

Energy efficiency in any industry has two dimensions - technology and financing. Technologies are available in different stages of commercialization, namely, pre-commercial, semi commercial and fully commercial. Energy efficient technologies are more expensive as compared to the conventional technologies.
For this reason, financing will have to adapt itself to meet the requirement at each stage during the process of scaling-up energy efficiency amongst the industries. Therefore, energy efficiency financing models need to be customized to the specific financing needs of technologies in different stages of commercialization.

Public finance and finance from bilateral and multilateral agencies have a crucial role in supporting R&D and innovation of technological solutions in their pre-commercial stage, especially in the MSME sector, especially in the context of climate change. Supported bank finance is important for developing the market for commercially available technologies. It is essential to ensure that the financial assistance for energy efficiency promotion gets channelized properly for relevant 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 savings 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.

<u>Benchmarking</u>

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. It can also be used to compare with the 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 have a large scope of improvement in energy efficiency when compared to those manufactured in more advanced economies. However, no comprehensive benchmarking studies have been carried out to assess the performance of such 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 rating systems 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 and 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, 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 formed 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).

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 (IPPC 2007), application of housekeeping and general maintenance 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.) 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 needs to be promoted in a systematic manner amongst industries. Simple measures such as monitoring and analysis of defectives, identifying the root causes and initiating corrective actions in the process hold great promise amongst 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 account about a third of world production and typically uses 60–70% less energy (ILO 2012).

In the cement sector, it is 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 CO2 emission in the cement sector, systemic shift to higher proportions of blended cements would not only help in reducing the CO2 emissions, it would also help reducing the exploitation of cement grade limestone deposits in the country. The addition of wastes (blast furnace slag, fly ash) and geo-polymers to clinker helps reduce CO2 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 doubled than that of individual waste pickers, thereby has helped 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 HP (especially in the MSME sector), exist with outdated and inefficient technologies and there is not much focus on system optimization. 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 that can be achieved especially in 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 little on the entire system in place. For example, an outdated reciprocating compressor may be replaced with a modern screw compressor, but little 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 energy efficient components, such as pump, steam and compressed air systems, can raise average efficiency by 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, technology and improved decision making processes. It also enables 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.

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 national 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 state government can design their programs on these lines. The government agencies 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. Government needs to integrate MSME development strategy into the broader state developmental strategies. The concept of 'designated consumers' can be extended to MSMEs. 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, World Bank-GEF who are implementing EE projects in India 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. The state should explore possibilities of harnessing the biomass potential. Waste materials (tyres, plastics, used oils, 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 CO2 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 MtCO2-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 also use solar thermal systems. Rational pricing of cleaner fuels like natural gas at the national level will help in encouraging industries to explore switchover to cleaner fuels in a big way.

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. Conservative estimates suggest a huge potential of over 20,000 MW from cogeneration units in India. 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.

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. As per TERI analysis, 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 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 Himachal Pradesh viz. cement and textiles.

Cement Sector

Significant potential for energy savings exist in cement industry. A few major energy-efficient technologies and practices in cement plants are outlined below:

- *Utilization of industrial wastes*: Blended cement can be manufactured from industrial wastes such as slag and fly ash. Other industrial wastes like biomass, petroleum coke, and waste tyres) can also be utilized beneficially during clinker burning process. Various substitute fuels need to be explored depending on their availability locally.

- *Raw material grinding*: The use of vertical roller mill can make a significant contribution to the reduction of power consumption in the raw material grinding process. To dry and grind at the same time, this process flows a large volume of gas through the system, increasing the power consumed by the fan. Therefore, the difference of the facility power of the mill itself is not related to the reduction of electric power but, as compared to the existing process with the ball mill, reduces the power consumption by 10 to 15% (CII 2013a). More reduction can be expected by reducing of the volume of gas passing through or circulating in the process.

- *Cogeneration by utilizing waste heat*: Sources of waste heat in cement industry include flue gases, vapor streams, convective and radiant heat loss and so on. On an average, the Indian cement industry is losing almost 35% (CII 2013a) of its energy through flue gases and hot air streams. The losses through kiln exhaust gases (20%) and hot air from cooler (12.8%) are quite prominent and are the potential areas for the waste heat recovery. Cogeneration or waste heat power generation (WHPG) system will utilize the waste heat and produce electricity thereby reducing the overall energy cost of cement plants. A cogeneration system utilizing the waste heat can deliver up to 20% of total electrical energy required for the process.

Textile Sector

Textile industry is considered to be highly energy intensive. Wet processing or dyeing operation consumes almost 50% of the energy in a composite mill (CII 2013b). 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

Long-term

Innovation is central to the idea of green growth. While existing technologies can significantly reduce industrial GHG emissions, newer 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. Government needs to set up incubation centers and 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 box 2). 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 the small scale glass industry

An example of one such technology is the energy efficient Natural Gas (NG) fired pot furnace system—the 'recuperative furnace'. TERI designed and developed the energy efficient pot furnace for the glass bangle units of Firozabad. The TERI-designed furnace yields energy savings of up to 50%, as compared to the traditional coal-fired pot furnace; and over 30%, when compared to the 'conventional' NG-fired pot furnace TERI successfully strengthened the capabilities of local fabricators to promote and sustain the uptake of the energy efficient furnace among glass melting units in Firozabad. The intervention enhanced the technological capacities of cluster-level service providers and fabricators. The successful implementation of the technology in a few units convinced all the open pot furnace units in Firozabad to adopt the TERI design.

Keeping pace with constantly improving technologies is critical for industry competitiveness in a developing country such as India. This requires an enabling environment and infrastructure that nurtures research and development of modern technologies that match 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.

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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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