



SMALL AND MEDIUM SCALE INDUSTRIES (SMIs) IN ASIA: ENERGY, ENVIRONMENT AND CLIMATE INTERRELATIONS

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Greenhouse (GHG) Gas Emission Reduction Opportunities for Foundry Sector In India

A study was carried out by School of Energy, PSG College of Technology to estimate the Greenhouse Gas (GHG) emission reduction options in Indian foundry sector based on the improved operation and maintenance, switching over to efficient technologies and implementation of policy options.

SMI Foundry sector in India

The Small and Medium Industries (SMI) of foundry Indian industry occupies a place of special importance in shaping the Indian economy. India is currently the tenth largest producer of ferrous and non-ferrous castings. It was estimated that there are ten thousand foundries all over India with a total casting output of approximately 3 million tonnes, out of which 2.36 million tonnes are grey iron castings, 400,000 tonnes are steel castings, 268,000 tonnes are malleable iron castings and 20,000 tonnes are non-ferrous castings. This sector employs over 2.2 million people including direct and indirect employees.

For melting, various types of furnaces such as coke-fired cupola, electric arc, rotary and induction furnaces are used. The environmental burdens caused by iron foundries are flue gases, dust, slag, sludge, solid wastes, wastewater and some hazardous gases. The flue gas contains CO₂, CO, SO₂ which causes global warming conditions.

Contents

- Greenhouse (GHG) Gas Emission Reduction Opportunities for Foundry Sector In India
- Case Study – Ceramics
- Energy/Environment News
- CDM – An Introduction
- SMI Asia News
- Information on
 - Capacity Building*
 - Websites*
 - Publications*
 - Newsletters*

Energy use in Foundry sector

The foundry sector in India uses electricity, coal, oil and natural gas to meet its energy needs. Energy is consumed for the production of castings through all its stages like melting, moulding, ladle drying, core making, heat treatment and cleaning services. The energy consumption shares by different types of furnaces are shown in Table 1.

Table 1 Energy Consumption share in different types of furnaces

| Energy consumption pattern in Foundry Sector | |
|--|----------|
| Cupola or Coal fired furnace | 80 – 90% |
| Electrical furnace | 10 – 20% |

The specific energy consumption details of various furnaces are given in Table 2.

Continued on page 2.

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Continued from page 1

Table 2 Specific energy consumption details of various furnaces

| Description | Energy consumption per tonne of liquid metal |
|--|--|
| Power consumption in induction furnace for cast iron grade | 620 kWh |
| Oil Consumption in Rotary furnace for cast iron grade | 135 litres |
| Coke consumption in cupola cast iron grade | 135 kg |

The GHG emission from SMI foundry sector was estimated using IPCC guidelines and is given in Table 3.

Table 3 GHG emission from SMI foundry sector

| Annual Production (Million tonnes) | Number of Employees (Millions) | Primary energy use (Million kWh) | Weighted SEF | | | SMI sectoral emissions (Million kg /yr) |
|------------------------------------|--------------------------------|----------------------------------|-----------------------------------|-------------------------|-----------------------------|---|
| | | | kg-CO ₂ /kg of product | kg-CO ₂ /kWh | t-CO ₂ /employee | |
| 2.36 | 2.2 | 3097 | 0.68 | 1.13 | 0.73 | 1,605 |

GHG Emission Reduction Options

The GHG emission reduction potential was studied for the following three options:

- Operation and maintenance
- Technology options
- Policy options

Operation and maintenance

Operation and maintenance of equipments is one of the important options to reduce energy and emission. The estimated saving is about 11%. Some important measures are oxygen enrichment of blast air, refractory insulating blanket, preheating the charge and avoiding part-loading of equipments.

Technology options

Number of Energy efficient and Environmentally Sound Technologies (E3STs) are available for foundry sector. In this analysis, emission reduction potential by implementation of the following technologies was studied. The estimated reduction is given in Table 4.

- Installation of automatic star-delta converters for lightly loaded motors
- Replacement of Conventional Cupola with Cokeless Cupola
- Replacement of main frequency induction furnace with medium frequency furnace
- Duplexing of cupola and induction furnace

Policy options

The GHG emission reduction potential by implementation of policy measures was estimated. The estimated reduction is 5%. The policies include:

- Benchmarking of specific energy consumption
- Energy conservation incentives
- Tax benefits
- Energy pricing towards cleaner fuel
- Capital subsidy on energy conservation infrastructures
- Creation of revolving fund

Overall GHG Reduction

The overall potential in GHG reduction for Indian SMI foundry sector is given in Table 4.

Continued on page 3

Continued from page 2

Table 4 Overall GHG Emission Reduction Potential for Indian SMI Foundry Sector

| Sl. No | Technology options | GHG Reduction Potential (million tonne/yr) |
|--------|---|--|
| 1 | Operation and maintenance (11%) | 0.176 |
| 2 | Technology options | |
| | (i) Installation of Automatic Star – Delta converters for lightly loaded motors (2.61%) | 0.040 |
| | (ii) Replacement of conventional cupola with cokeless cupola (3.67%) | 0.056 |
| | (iii) Replacement of main frequency induction furnace with medium frequency furnace (6.47%) | 0.099 |
| | (iv) Duplexing of cupola and induction furnace (5.69%) | 0.087 |
| 3 | Policy options (5%) | 0.076 |

For more information, please contact: PSG College of Technology, India (See address on page 8)

Case Study – Ceramics

Application of Fiber-lined Kiln and LPG in Ceramic Industry

Bat Trang ceramic village is the primary ceramic producer of Vietnam with more than 1,000 enterprises engaged in production and export. It has more than 1,400 ceramic kilns which uses coal as the main fuel in their traditional kilns. The new technology using fiber-lined kilns and the fuel switch to LPG was introduced in 1999, and has revolutionized the energy consumption pattern in the sector.

The baking process requires a temperature close to 1000°C. In the process of firing the traditional kilns, a significant amount of heat dissipates to through the kiln walls and with the exhaust gases. Due to large space requirement and poor working condition, higher rate of product reject was reported. In better designed fiber-lined kilns using LPG, significant reduction of heat loss through the kiln walls was observed. Thus, the use of cleaner and energy efficient fuel in the form of LPG would create a better working environment, lesser space requirement for the installations, shorter baking time for the products with uniform heating, and lower production costs in the long run. The fiber-lined kiln is known to save 30 - 50% energy and the energy costs per batch firing as given in Table 5. Use of fiber lined kiln not only helps ceramic production but decreases energy consumption. The investment for a 6.0m³ of fiber-lined kiln as shown in Figure 4 was found to be US\$1900 USD with a pay back period 1-3 years based on savings on energy use (coal, firewood and electricity).

| Table 5 Comparison of energy consumption in fiber-lined and traditional ceramic kilns | | | |
|---|--------------------|------------------|-----------------|
| Energy Source | Unit | Fiber lined kiln | Coal fired kiln |
| Electricity | KWh/m ³ | 0.2 | 0.5 |
| Gas | Kg/m ³ | 25.7 | |
| Coal | Kg/m ³ | | 560 |
| Firewood | Kg/m ³ | | 37 |



Figure 4 Fiber-lined LPG fired ceramic kiln

For more information, please contact: Consulting Center for Cooperation and Capacity Building, Vietnam (See address on page 8)

Industrial Services Bureau of Sri Lanka (ISB) performing in the field of GHG reduction

The SMI Asia Project had given the opportunity to widen the scope of ISB in energy and environment management in the industrial sector. At the same time it created other energy related interventions in the industry at the commercial level. One of the major outcomes is the recognition and the credibility in the energy sector. ISB, through the SMI Asia project had initiated services and service packages not only in the industrial services but also in the areas of renewable energy, mini hydro, emission and air quality with partnerships from other agencies. Further, most of the partners identified ISB as the best professional work partner in energy industry.

Off grid Wind Power Applications

ISB commenced the promotion of wind power in 2003 in Sri Lanka and Maldives. The main products promoted are micro turbines with the capacity from 450 to 3000 Watts and wind electric water pumps. USAID / US-AEP came forward in sponsoring the first demonstration project in Baththalanunduwa fishing island off Kalpitiya in the Puttalam district that will never have access to the national grid, for assessing the technical and financial viability. This project that provides round the clock electricity with 2 micro turbines to 20 houses is used mainly for lighting, entertainment (TV and radio) and to run a refrigerator, was handed over to the community on 20th June 2003. The demonstration was not only to prove the technical and financial viability but also to test a new working model of public-private partnership for the promotion of renewable energy. Commercially oriented and self-sustained model used in this community based power system has drawn the attention and interest of many energy lovers; nationally and internationally.

The installation of wind power alternative in the fishery community at Batthalagunduwa, saves transporting and consuming of 900 lts of diesel fuel, which otherwise would have generated 2.7 Tons of GHG emissions annually. Even though this would be of marginal impact on the environment in terms of an isolated island, the impacts would be greater for inland applications. ISB is planning to implement a few more projects in 2005 to demonstrate the suitability of wind power for 'non-lighting' applications such as irrigation, water purification, refrigeration, health & sanitation and for eco-tourism.

Mini Hydro Project

Venturing into the development of mini hydro was one of the major tasks of ISB in 2004. Construction of the 2 MW maiden was commenced in Aranayake in Kegalle District in August. It is expected to complete the civil construction work within one year. ISB will undertake the construction management of the project from the beginning and act as the technology provider. The grid connected system while enhancing the share of hydro based electrical energy generation, will decrease the reliance of thermal energy based on fossil fuel. At present Sri Lanka consumes 650 to 800 million litres of fossil fuel on energy and for 10 MW reduction of usage the reduction GHG would be around 33,000 tonne of CO₂. ISB is in the process of mobilizing few more mini hydro sites with a total generating capacity of 10 MW.

Sri Lanka Vehicle Emission Testing (VET) programme

The vehicle emission have been recognized as the major contributor for the fast deteriorating ambient air quality of urban and sub-urban areas of Sri Lanka and contributes for an adverse impact on human health, eco systems and physical structures. Of the several initiatives taken, one measure is to control the vehicle emission by implementing an island wide programme for the testing of vehicle emission. The M/s Cleanco Ltd, a partnership between Environmental Systems & Products Inc. (ESP) of USA, ISB and Hayleys Ltd, has been selected by the technical evaluation committee as one of the service providers to implement an island wide network of vehicle testing stations. Once implemented, the impacts would be far-reaching and very positive. On the area of GHG emissions, the annual direct savings due to penalty and license procedure alone would be significant amount of CO₂ in addition to savings because of reduced fuel consumption by better combustion.

Conclusion

The above few instances show that capacity building of institutions could generate positive outcomes or far reaching spill over effects than the specific objectives of involving in a project. The association with SMI Asia project, made ISB to seek new opportunities than the specified outputs and hence project an outlook which is both technically savvy and socially acceptable organization.

For further details contact: Industrial Services Bureau of North Western Province, Sri Lanka (See address on page 8)

Clean Development Mechanism

CDM is one of the market-based flexibility mechanisms (the others are Emissions Trading and Joint Implementation) that were included in the Kyoto Protocol for project-based activities in developing countries to make its transition economically efficient. Under Article 12 of the Protocol, the CDM shall assist these countries to achieve "sustainable development" and contribute to the ultimate objective of the Convention, and to assist the countries to achieve compliance with their quantified emission limitation and reduction commitments. This mechanism allows Annex I countries to earn "certified emission reductions units (CERs)" whenever they undertake projects that contribute to sustainable development and result in real, measurable and long-term GHGs reductions.

Key Eligibility Criteria for CDM Projects

The mandatory criteria (or validation requirements) for CDM projects are:

- Only GHGs covered by the Kyoto Protocol are eligible.
- The host country should be a party to the Kyoto Protocol.
- The emission reductions of the project must be additional to any that would occur in the absence of the project.
- If a project is financed by sources of public funding, this must not result in a diversion of official development assistance, and the sources of public funding must be separate and not be counted towards the financial obligations of the Annex I countries.
- The project must contribute to the host country's sustainable development objectives.
- The project should not result in unacceptable negative impacts on the environment. If it is expected that the unintended environmental impacts of the project are significant, then an Environmental Impact Assessment (EIA) in accordance with the procedures as required by the host country should be carried out.
- The project concept must be acceptable to the host country and conform to its CDM requirements.
- The project should lead to the transfer of environmentally safe and sound technology and know-how.
- The project developer should define the period over which CERs will be claimed.
- The emission reductions of the project need to be measurable and need to be validated/determined and verified by an Operational Entity (OE)/Independent Entity.

Eligible CDM Project Categories

The following are eligible CDM project categories:

- Installations based on renewable energy sources (geothermal, wind, solar, biomass, small hydro, etc.);
- Fuel switch to lower carbon intensive fuels (in electricity and heat sector, industry);
- Energy efficiency at supply side (improvement of the efficiency with which a fuel is used to generate power or heat. (Ex. Use of improved technologies, improved transmission and distribution systems, updated district heating networks, etc.);
- Energy efficiency at the demand side, including an improvement of the efficiency of the use of supplied energy. This includes projects in the residential as well as the industrial sector;
- Combined heat and power (CHP) projects;
- Agricultural sector projects, other than land-use change, e.g. change of food chain, manure management, rice cultivation, etc.;
- Transport sector;
- Reduction in methane emissions from landfills and other waste-handling activities;
- Reforestation and afforestation projects

The above is only an indicative list and does not include other project ideas, which the project developer can propose and would be analysed later on a case-to-case basis.

Eligible CDM Technologies

There are no specific performance standards for the applicable CDM project technology. The project technology, however, should introduce at least an equal or better performance standard than the existing operational technologies in the host country. The technology to be applied must be:

- A proven technology (not necessarily in the host country);
- An established and commercially feasible technology, although not necessarily in the host country;
- The technology should be replicable and/or facilitate technology transfer to the host country.

Continued on page 6.

Continued from page 5

Eligible Project Developers

The following organisations can submit CDM projects:

- Governmental bodies (i.e. government departments or ministries);
- Government agencies (can be independent from the government);
- Municipalities;
- Foundations;
- Financial institutions;
- Private sector companies and NGOs.

CDM PROJECT CYCLE

The CDM project cycle is as follows:

- The operational entities (OE) will validate proposed CDM projects on the basis of project design documents. This will include a check to ensure the validity of the baseline, on which basis the emission reductions will be calculated, and the project's monitoring plan;
- The executive board will formally register the project under the CDM;
- Once the project is running, the participants will monitor the project;
- A different OE will verify the monitored emission reductions;
- This different OE will eventually certify those emission reductions as legitimate CERs.
- Based on this, the executive board will issue the CERs and distribute them to project participants as requested.

(Adapted from the report on "Primer on Clean Development Mechanism (CDM)" prepared for World Energy Council Asia-Pacific Region Members by CRL Energy Limited, New Zealand)

SMI Roadmap Version 2.0 CD Released

The SMI Roadmap Version 2.0 provides complete information on the research activities of the project Small and Medium Industries (SMI) in Asia under the Asian Regional Research Programme on Energy, Environment and Climate (ARRPEEC). It contains documents related to the research outputs of AIT researchers and the partner institutions from China, India, Sri Lanka, The Philippines and Vietnam in the three phases of ARRPEEC up to October 2004.

The documents include technology, energy efficiency and cleaner production, environmental sustainability and regulatory measures for iron and steel industry, cement, and pulp and paper industries (first phase activities). In the second phase, five sectors of SMI, bricks/tiles and ceramics, desiccated coconut, foundry, tea and textile were identified for the study of energy efficiency and environment. The third phase considered greenhouse gas emission and mitigation options, techno-economic evaluation of the options and barriers inhibiting the promotion of energy efficient and environmentally sound technologies in SMI. The documents in the CD are linked to the research carried out in the three phases in all the mentioned sectors and research directions stated above and can be briefly described by the following:

1. Research team and the professional associations (AIT, NRIs and their partners)
2. Project research publications and journals
3. Research methods
4. Technical fact sheets related to the studies of the individual SMI sectors
5. Success stories from the SMI sectors where implementation of E3ST and other environmental measures have given environmental and economic benefits
6. Papers presented in conferences, workshops and seminars
7. SMI Newsletters
8. Movie clips and photographs (slide shows) illustrating production processes in the SMIs
9. Weblinks of the participating institutions and their partners, and other stakeholders in the SMI related sectors (consultants, equipment suppliers etc), GHG emission and climate change, cleaner production, energy efficiency and environmentally sound issues; and
10. Government, non-governmental and international organizations (UN related and multilateral aid agencies) involved in the above cited activities and research.

For details regarding the CD, please contact smiasia@ait.ac.th, Fax: +66 2 524 5439

Sustainable Energy Asia 2005: 30 November – 1 December 2005, Suntec, Singapore. This conference will bring under one roof policy makers, technology providers, project managers, regional utilities as well as end users of energy management technologies and services. The topics will cover a range of issues impacting the energy industry regionally as well internationally including impact of Kyoto Protocol, privatisation of energy utilities and its impact, energy efficiency and financial impact, latest innovative technologies, services and products as well as alternative/renewable sources of Energy. *For further details visit:* <http://environmexasia.com/Conf.htm>

Reduction of Emissions and Geological Storage of CO₂: 15 - 16 September 2005, Paris, France. The purpose of the symposium is to examine the role of technical innovation as well as the capture and geological storage of CO₂ in reducing greenhouse gas emissions. This symposium will also consider new technological approaches in the light of the resources needed to finance such operations. Using a broad and multidisciplinary approach, this symposium is intended not only for researchers, industrialists, economists and financiers in the various sectors concerned but also for public and private-sector decision-makers required to make economic and financial choices in this area. *For further details visit:* <http://www.co2symposium.com/>

New Earth 2005: 26 - 29 October 2005, Osaka, Japan. This Global Environment Technology Show and International Symposium is organised by The Japan Society of Industrial Machinery Manufacturers (JSIM), Research Institute of Innovative Technology for Earth (RITE) and Osaka International Trade Fair Commission. The topics of coverage include Global environment monitoring technology, recycling technology, energy-saving and new-energy technology, waste treatment, waste water treatment and air pollution control technology, environment-friendly products, environment policies, environment evaluation technology. *For further details visit:* <http://oitfc.fair.or.jp/newearth/>

Pollutec China 2006: 8 - 10 March 2006, Shanghai, China. This event which is being organized by Shanghai Environmental Protection Association and Reed Exhibitions (China) Ltd. aims to offer a complete marketing platform for companies to tap into the world's biggest market. Visitor's delegations from different provinces will attend the event, which enable exhibitors to network and explore business opportunities with high-profile visitors. A series of high level conferences and seminars with special focus including Water, Air and Waste, Energy and Green City Planning will be held alongside the event to offer more opportunities in networking and technology exchanges. *For further details visit:* <http://www.pollutec-china.com>

Websites

<http://www.wmo.ch/web/gcos/gcoshome.html>.

This is the website of the Global Climate Observing System (GCOS) which was established in 1992 to ensure that the observations and information needed to address climate-related issues are obtained and made available to all potential users. It is co-sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the United Nations Environment Programme (UNEP) and the International Council for Science (ICSU). GCOS is intended to be a long-term, user-driven operational system capable of providing the comprehensive observations required for monitoring the climate system, for detecting and attributing climate change, for assessing the impacts of climate variability and change, and for supporting research toward improved understanding, modelling and prediction of the climate system. It addresses the total climate system including physical, chemical and biological properties, and atmospheric, oceanic, hydrologic, cryospheric and terrestrial processes.

<http://www.me3.org>

This is the website of Minnesotans for an Energy-Efficient Economy (ME3) is a non-profit organization leading the transition to a clean, efficient, and fair energy system. ME3 uses a combination of strategies to ensure significant and

sustained progress toward a clean energy future. This website hosts more than 5,000 energy resource links, along with daily updates, and provides information for environmental groups, policy makers, businesses, students and concerned citizens who are interested in energy issues. Included on the site is information on renewable energy, energy efficiency, global warming, energy and the economy, energy and human health and more.

<http://cdiac.esd.ornl.gov/>

The Carbon Dioxide Information Analysis Center which includes the World Data Center for Atmospheric Trace Gases, is the primary global-change data and information analysis center of the U.S. Department of Energy (DOE). CDIAAC responds to data and information requests from users from all over the world who are concerned with the greenhouse effect and global climate change. CDIAAC's data holdings include records of the concentrations of carbon dioxide and other radiatively active gases in the atmosphere; the role of the terrestrial biosphere and the oceans in the biogeochemical cycles of greenhouse gases; emissions of carbon dioxide to the atmosphere; long-term climate trends; the effects of elevated carbon dioxide on vegetation; and the vulnerability of coastal areas to rising sea level.

News items, articles, information on training courses, websites related to energy and environmental issues in the small and medium scale industrial sector and other correspondence can be sent to: SMI Project, School of Environment, Resources and Development, Asian Institute of Technology, PO Box 4, Klong Luang, Pathumthani 12120, Thailand
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<http://www.arrpeec.ait.ac.th>

Publications

Kyoto and Beyond - The low-emission path to innovation and efficiency, David Suzuki Foundation, 2002, ISBN 0-9689731-3-2

This book presents a detailed, end-use oriented analysis of the Canadian energy economy, using 2004 as a base year and looking out to 2030. By considering each sector of the economy (residential, commercial, transportation, industry, electric power, non-energy sources), it identified options for reducing emissions by adopting new, efficient technologies or switching to low or zero emission fuels. The objective of this work was to find the best ways to cut Canadian emissions by half. Here are some of the key policy principles that shaped the report's conclusions: In a rational economy, energy is developed and used in response to the demand for goods and services, not for its own sake; Emission reduction strategies should be based on existing technologies that have been shown to be effective and economic; The implementation plan should not rely on punitive energy taxes; Energy from local, small-scale sources will encourage greater self-reliance and insulate consumers from

geopolitical crises and large-scale system failures.

An Implementation Guide to the Clean Development Mechanism: Putting the Marrakech Accords into Practice, by Jon Rosales and Gao Provone, United Nations Foundation, 2003.

This report is an outcome of UNCTAD/Earth Council Carbon Market Programme and is part of a series aimed at enabling developing countries to evaluate risks and capture trade and investment opportunities arising from the Kyoto Protocol. The CDM Guide is also intended to assist in the pursuit of the Protocol's goal of combating global climate change in ways that do not place undue pressure on the global economy. The CDM Guide has been particularly relevant for policy and decision makers. Many developing countries have expressed interest in using it as a model for developing their own national guides, as a means of explaining CDM to their citizens, and as a tool to interest national and international investors and project developers in CDM opportunities.

Newsletters

CDM Investment

This quarterly newsletter is a joint initiative of the Climate Business Network (CBNet) and Bureau of Environmental Analysis International aiming to present and review CDM opportunities that will support sustainable development in Non-Annex I countries. Among the key subjects addressed by the Newsletter are: identification of barriers to CDM investments; recommendations for removal of such barriers; identification of CDM best practices. *For further details visit:* <http://www.climatebusiness.net/index.php?option=content&task=category§ionid=5&id=71&Itemid=28>

Global Clean Energy and Climate Change

This monthly newsletter is published by Baker & McKenzie's on various issues related to clean energy and climate change around the world. *For further details visit:* <http://www.bakernet.com/newsletters/newsletter.asp?NLID=34>

eCarbon News

This monthly newsletter is published by the Cooperative Research Centre for Greenhouse Accounting, Australia. This is a digest of climate change news from around the world, with brief summaries linking to web sites for more detailed information. Sections include Kyoto and emissions, carbon sequestration, energy, climate and climate change, trading, and conferences. *For further details visit:* <http://www.greenhouse.crc.org.au/crc/ecarbon/>