

Appendix A¹ to the simplified modalities and procedures for small-scale CDM project activities

**CLEAN DEVELOPMENT MECHANISM
SIMPLIFIED PROJECT DESIGN DOCUMENT
FOR SMALL-SCALE PROJECT ACTIVITIES (SSC-PDD)
Version 01 (21 January, 2003)**

Introductory Note

1. This document contains the clean development mechanism project design document for small-scale project activities (SSC-PDD). It elaborates on the outline of information in appendix B 'Project Design Document' to the CDM modalities and procedures (annex to decision 17/CP.7 contained in document FCCC/CP/2001/13/Add.2) and reflects the simplified modalities and procedures (herewith referred as simplified M&P) for small-scale CDM project activities (annex II to decision 21/CP.8 contained in document FCCC/CP/2002/7/Add.3).
2. The SSC-PDD can be obtained electronically through the UNFCCC CDM web site (<http://unfccc.int/cdm/ssc.htm>), by e-mail (cdm-info@unfccc.int) or in print from the UNFCCC secretariat (Fax: +49-228-8151999).
3. Explanations for project participants are in italicized font (*e.g. explanation*).
4. The Executive Board may revise the SSC-PDD if necessary. Revisions shall not affect small-scale CDM project activities validated prior to the date at which a revised version of the SSC-PDD enters into effect. Versions of the SSC-PDD shall be consecutively numbered and dated. The SSC-PDD will be available on the UNFCCC CDM web site in all six official languages of the United Nations.
5. In accordance with the CDM modalities and procedures, the working language of the Board is English. The completed SSC-PDD shall therefore be submitted to the Executive Board in English.
6. Small-scale activities submitted as a bundle, in accordance with paragraphs 9 (a) and 19 of the simplified M&P for small-scale CDM project activities, may complete a single SSC-PDD provided that information regarding A.3 (*Project participants*) and A.4.1 (*Location of the project activity*) is completed for each project activity and that an overall monitoring plan is provided in section D.
7. A small-scale project activity with different components eligible to be proposed² as a small-scale CDM project activity may submit one SSC-PDD, provided that information regarding subsections A.4.2 (*Type and category(ies) and technology of project activity*), and A.4.3 (*brief statement on how anthropogenic emissions of GHGs(greenhouse gases) by sources are to be reduced by the proposed CDM*

¹ This appendix has been developed in accordance with the simplified modalities and procedures for small-scale CDM project activities (contained in annex II to decision 21/CP.8, see document FCCC/CP/2002/7/Add.3) and it constitutes appendix A to that document. For the full text of the annex II **to decision 21/CP.8** please see <http://unfccc.int/cdm/ssc.htm>.

² In paragraph 7 of simplified M&P for small-scale CDM project activities, on clarifications by the Executive Board on small-scale CDM project activities, the Board agreed that in a project activity with more than one component that will benefit from simplified CDM modalities and procedures, each component shall meet the threshold criterion of each applicable type, e.g. for a project with both a renewable energy and an energy efficiency component, the renewable energy component shall meet the criterion for 'renewable energy' and the energy efficiency component that for 'energy efficiency'.

project activity) and sections B (*Baseline methodology*), D (*Monitoring methodology and plan*) and E (*Calculation of GHG emission reductions by sources*) is provided separately for each of the components of the project activity.

8. If the project activity does not fit any of the project categories in appendix B of the simplified M&P for small-scale CDM project activities, project proponents may propose additional project categories for consideration by the Executive Board, in accordance to paragraphs 15 and 16 of the simplified M&P for small-scale CDM project activities. The project design document should, however, only be submitted to the Executive Board for consideration after it has amended appendix B as necessary.

9. A glossary of terms may be found on the UNFCCC CDM web site or from the UNFCCC secretariat by e-mail (cdm-info@unfccc.int) or in print (Fax: +49-228-8151999).

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Annex 2: Information regarding public funding

A. General description of project activity

A.1 Title of the project activity:

Energy efficiency improvement in small-scale foundry units at Rajkot cluster, Gujarat, India

A.2 Description of the project activity:

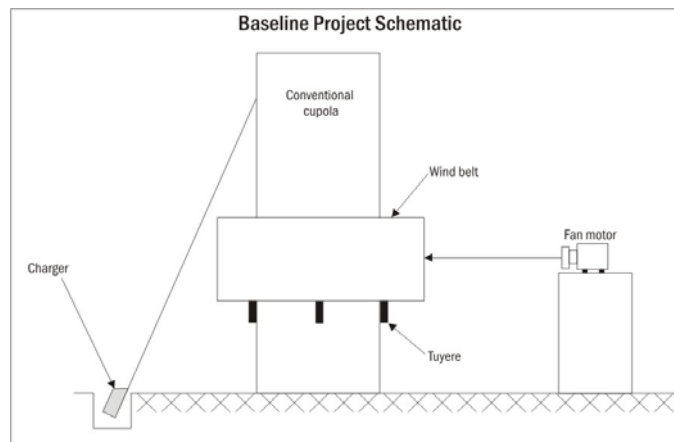
(Please include in the description

- the purpose of the project activity

- the view of the project participants on the contribution of the project activity to sustainable development (max. one page).)

The purpose of this project is to achieve energy savings with consequent reduction of carbon-dioxide emissions by adoption of cleaner and EE (energy efficient) iron melting furnaces in small-scale foundry units located at Rajkot in the state of Gujarat in India. Implementation of the project would lead to changing the conventionally designed melting furnaces (cupolas) of foundry units at Rajkot to EE designs of DBC (divided blast cupola).

The Rajkot foundry cluster, located in the state of Gujarat in western India, is an important foundry cluster primarily catering to the diesel engine industry located in and around Rajkot. The cluster is also an important supplier of castings for the engineering and machine tools industry. A small, but significant, percentage of foundry units (about 10%) cater to the export market. There are about 500 small-scale foundry units at Rajkot cluster, operating highly energy-inefficient conventional cupola furnaces. A schematic of the baseline conventional cupola plant is provided below.



Energy saving, by adoption of DBC, was demonstrated by TERI in 1998 at a foundry industry cluster (Howrah) located in eastern India. Since Rajkot is a major cluster of foundry units in western part of India, a seminar was organized by TERI in April, 2002 at Rajkot to disseminate the technology among the foundry units there. Subsequently two DBCs were installed and are operating at a foundry unit in Rajkot cluster since August 2003. Two more DBCs are presently under installation which are expected to be commissioned by end of 2004.

During 2002-03, TERI conducted a survey of the foundry units located at Rajkot. The study (TERI, 2003) has helped to generate excellent baseline information about the cluster³. Through the survey, 190 foundry units were identified as good prospect for adopting the DBC. Eighty per cent of the units have an average production of 50 tonne of castings per month and the rest have an average production of 150 tonne of castings per month. Together they produce 162 000 tonne of castings, consume 17 000 tonne of fossil fuel (coke) and emit about 46 000 tonne of carbon dioxide per annum.

Contribution to Sustainable Development: Such a project would deliver significant local and national development benefits. The foundry sector is an important small-scale industry sector in India. There are over 5 000 foundry units employing nearly 0.5 million people. The project would speed the market development of a climate friendly technology, an essential element in accomplishing the ultimate objective of the Climate Convention. The technology would help to improve the business competitiveness of the units, helping them to survive in the face of increased market competition. In the longer term, survival of the units would lead to sustenance of a large number of jobs in a number of upstream and downstream sectors. The cleaner technology would lead to improvement in the local work environment, which will have long term health benefits. Hence, the project would contribute greatly to the sustainable development of the industry and local communities.

A.3 Project participants:

(Please list Party(ies) and private and/or public entities involved in the project activity and provide contact information in annex 1 of this document.)

(Please designate one of the above as the official contact for the CDM project activity.)

Parties to the Project:

The project will be delivered by 190 foundry units in Rajkot. The names of 181 of the foundry units who have agreed to participate in the project are listed in Annex 1.

Contract Party:

The local industry association will be the contact party. Details of the association are provided below:

Rajkot Engineering Association (REA)
Bhaktinagar Industrial Estate
Rajkot 360 002. Gujarat
Ph. 0281-2362235
Fax. 0281-2362506
Contact person: Maganbhai Antala, Hon. Secretary

One of the foundry units which has agreed to act as the official contact point for all the foundry units in Rajkot which participate in the project activity is given below:

³ In this document, cluster means an agglomeration of foundry units in a geographical area. The terms unit and entity have been used interchangeably in the document and is used to denote one foundry. Cupola is the most common melting furnace in a foundry industry. A foundry may have one or more cupolas for melting.

Shining Engineers & Founders
Aji G.I.D.C.-II, Plot No. 319-20, Road-K,
Opp. Balaji Wafers, Rajkot 360 003. Gujarat
Ph. 0281-2387764, 2389253 (office)
0281-2388422 (Res.)
Fax. 0281-2389246
Email. shining_ad1@sancharnet.in
Contact person: M H Patel

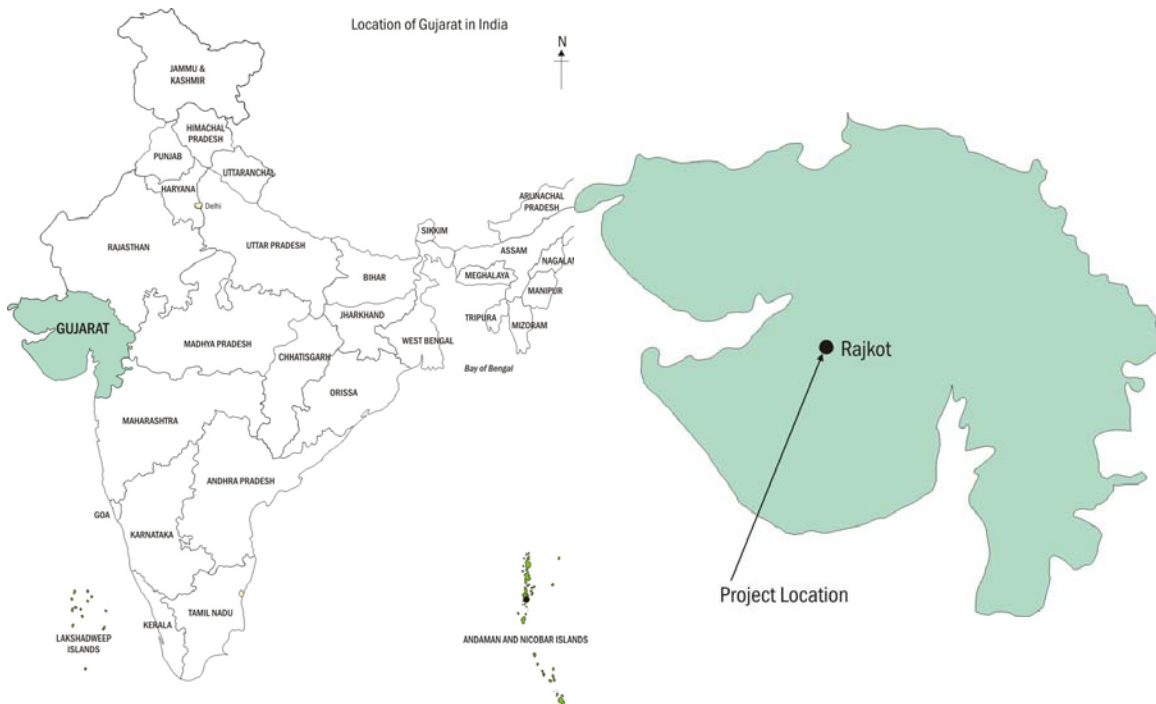
A.4 Technical description of the project activity:

A.4.1 Location of the project activity:

- A.4.1.1 Host country Party(ies): India
- A.4.1.2 Region/State/Province etc.: Gujarat
- A.4.1.3 City/Town/Community etc.: Rajkot
- A.4.1.4 Detailed description of the physical location, including information allowing the unique identification of this project activity (*max one page*):

The foundry units at Rajkot, in the state of Gujarat, in the western region of India, is well known for producing castings at a competitive price for industries manufacturing diesel engines, machine tools and general engineering industry.

The location maps of Gujarat are given.



The Rajkot foundry industry comprises around 500 cupola based units, 50 rotary furnace based units, 100 pit/crucible furnace based units and 25 units with induction furnace. The installed capacity of the local foundry industry, which is mainly in the SSI sector, could be put at 3 84 000 tonne per year, with an estimated average annual production of 1 68 000 tonnes of different types of castings. The industry provides direct employment to 30 000 persons and indirect employment opportunities to another 20 000 persons. The industry also exports Rs 800 million worth of goods per year. Most of the foundry units are located in and around the city. The major concentration of foundry units is in Aji Vasahat, Gondal Road and Bhavanagar Road areas.

A.4.2 Type and category(ies) and technology of project activity

(Please specify the type and category of the project activity using the categorization of appendix B to the simplified M&P for small-scale CDM project activities, hereafter referred to as appendix B. Note that appendix B may be revised over time and that the most recent version will be available on the UNFCCC CDM web site.

In this section you shall justify how the proposed project activity conforms with the project type and category selected (for simplicity, the rest of this document refers to 'project category' rather than 'project type and category').

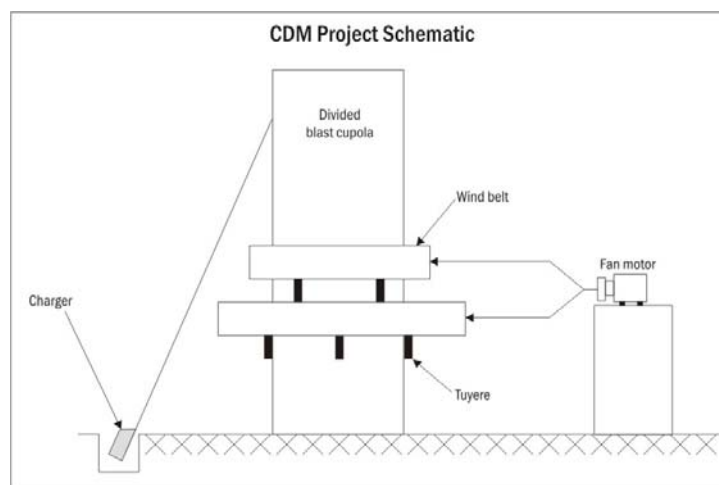
If your project activity does not fit any of the project categories in appendix B, you may propose additional project categories for consideration by the Executive Board, in accordance with paragraphs 15 and 16 of the simplified M&P for small-scale CDM project activities. The final SSC-PDD project design document shall, however, only be submitted to the Executive Board for consideration after the Board has amended appendix B as necessary.)

(This section should include a description of how environmentally safe and sound technology and know-how is transferred to the host Party, if such a transfer is part of the project.)

Type II – Energy Efficiency Improvement Projects – II D. Energy Efficiency and Fuel Switching measures for Industrial Facilities

Justification: The project activity involves energy efficiency improvement in an industrial process (iron furnaces). The aggregate energy consumption of the project is 0.13 GWh per year (17 000 tonnes of coke per year) and energy savings is about 0.03 GWh (4 200 tonnes of coke per year) which is below 15 GWh.

Transfer of environmentally safe and sound technology and know-how: The Divided Blast Cupola (DBC) concept being propagated under the project was developed and fine-tuned in the UK. Subsequently, the technology has spread to different countries, including India. TERI and its partners have successfully imbibed the technology through training and jointly working with UK experts in a bilaterally assisted project, sponsored by the SDC (Swiss Agency for Development and Cooperation), which aims at energy efficiency improvement of the foundry sector. To showcase the benefits of DBC, a demonstration plant was installed at a foundry unit in Howrah (West Bengal), which is operating successfully since 1998. Energy saving of 35% was achieved in the demonstration plant. A schematic of the CDM DBC technology is provided.



Till September 2004, seven foundry units in different foundry clusters have replicated the technology. Two of the replication units are located in Rajkot. Through the on-going project activities, TERI and its partners have established a high credibility in Rajkot cluster and are now recognized as credible interlocutors by the foundry units there.

In India, there are about 5 000 ferrous foundry units. Most of these foundry units are in the small-scale sector and use cupola as their primarily melting furnace. The total coke consumption by the foundry units is estimated to be about 600 000 tonnes per year. On an average, it is possible to save about 25% of the coke by adoption of the energy-efficient technology, which translates into a reduction of 150 000 tonnes of coke or 410 000 tonnes of CO₂.

A.4.3 Brief statement on how anthropogenic emissions of greenhouse gases (GHGs) by sources are to be reduced by the proposed CDM project activity:

(Please state briefly how anthropogenic greenhouse gas (GHG) emission reductions are to be achieved (detail to be provided in section B.) and provide the estimate of total anticipated reductions in tonnes of CO₂ equivalent as determined in section E. below.)

Reduction of Emissions: A total of 190 conventional melting furnaces (cupolas) operating at foundry units in Rajkot will be replaced by DBC (EE divided blast cupola). Put together these foundry units consume 17 000 tonne of coke and emit about 46 000 tonne of carbon dioxide per annum. Replacement by DBC will result in coke (containing 85% carbon) savings of at least 25%⁴. This translates into a CO₂ emission reduction of about 8 300 tonne per year. See also sections B and E below.

Cluster characteristics: Rajkot is a *homogeneous* foundry cluster with respect to the melting furnace technology employed. All the conventional cupolas are very similar in design and melting capacities. Cupola furnace is, and is likely to remain, the most predominant melting technology among the foundry units in Rajkot, primarily because of economy of operation. The use of other fuel in cupola is not viable at the scale of operation found in Indian foundries and hence fuel switching is not an option in the

⁴ Actual energy audits conducted by TERI in a large number of foundry units have revealed that energy saving (reduction of coke consumption) potential ranges between 25-65% by adoption of DBC. A conservative saving estimate of 25% coke reduction from present levels is assumed in the document, so that there is not shortfall in actual CER realization after implementation.

foreseeable future for these foundries.

The technology of the cupola and operating practices of all the entities are quite similar. Hence the energy efficiency (coke consumption) levels of these cupolas are quite comparable. Because of the scale of operation, the coke consumption of individual foundry units is small. However, the aggregate coke consumption of the cluster is quite large, simply because of the sheer number of small and tiny foundry units operating within the geographical area. Hence the foundry cluster is an ideal candidate for bundling of small CDM projects.

A.4.4 Public funding of the project activity:

(Indicate whether public funding from Parties included in Annex I is involved in the proposed project activity. If public funding from one or more Annex I Parties is involved, please provide information on sources of public funding for the project activity in annex 2, including an affirmation that such funding does not result in a diversion of official development assistance and is separate from and is not counted towards the financial obligations of those Parties.)

There is no ODA (Overseas Development Assistance) assistance for subsidising the hardware cost of installing the DBC by foundry units. However capacity building and information dissemination efforts to promote the EE technology have been supported by SDC (the Swiss Agency for Development and Cooperation) as part of a project aimed at promoting cleaner technologies among small-scale foundry units. These activities have built a firm foundation for successful implementation of the project at Rajkot cluster with CDM as an enabling tool.

A.4.5 Confirmation that the small-scale project activity is not a debundled component of a larger project activity:

(Please refer to appendix C to the simplified M&P for the small-scale CDM project activities for guidance on how to determine whether the proposed project activity is not a debundled component of a larger project activity.)

The project has not been de-bundled from any larger project.

B. Baseline methodology

B.1 Title and reference of the project category applicable to the project activity:

(Please refer to the UNFCCC CDM web site for the most recent list of the small-scale CDM project activity categories contained in appendix B of the simplified M&P for small-scale CDM project activities.)

Type II – Energy Efficiency Improvement Projects – II D. Energy Efficiency and Fuel Switching measures for Industrial Facilities

B.2 Project category applicable to the project activity:

(Justify the choice of the applicable baseline calculation for the project category as provided for in appendix B of the simplified M&P for small-scale CDM project activities.)

The energy baseline consists of the energy use of the existing conventional furnaces that is replaced and/or retrofitted by EE furnace design.

Justification: Most of the furnaces are over 10 year's vintage and of conventional designs. Hence, under business as usual (BAU) scenario, it can be expected that these units will keep operating their old and inefficient melting furnaces as they have done in the past. No significant changes in technology are expected to occur in the foreseeable future.

Cupola furnace is the most economical melting furnace technology the world over. The use of other fuel in cupola is not viable at the scale of operation found in Indian foundries and hence fuel switching is not an option in the foreseeable future for the foundry here.

B.3 Description of how the anthropogenic GHG emissions by sources are reduced below those that would have occurred in the absence of the proposed CDM project activity (i.e. explanation of how and why this project is additional and therefore not identical with the baseline scenario)

(Justify that the proposed project activity qualifies to use simplified methodologies and is additional using attachment A to appendix B of the simplified M&P for small-scale CDM project activities.)

(National policies and circumstances relevant to the baseline of the proposed project activity shall be summarized here as well.)

Justification:

The project qualifies to be under the small-scale category of CDM projects since the reduction in anthropogenic emissions of CO₂ by adoption of the new technology is 10 111 tonnes/annum which is below 15 kilotonnes (kt) of carbon-dioxide equivalent annually.

Without the proposed project, the foundries in Rajkot will keep operating their conventional melting furnaces as has been in practice in the past. Under BAU scenario, no significant changes in technology are likely to occur. The following barriers constrain the adoption of energy efficient designs of melting furnaces among SSI foundry units. The proposed project would aim at removing these barriers.

1. *Barrier due to prevailing practice:* Conventional melting furnace technology and operation is well seeded in the foundry units. Although no official figures on the number of DBCs operating in Rajkot are available, the survey conducted by TERI (TERI, 2003) revealed that 90% of the foundry

units at Rajkot are using conventional cupolas. The remaining 10% of the foundry units have converted to sub-optimal DBC furnaces which have been designed by local consultants. Hence there is no significant difference between the energy performance of operating DBCs, and conventional cupolas were observed during the survey. The average efficiency (charged coke consumption) of operating furnaces (either conventional or sub-optimal DBCs) is about 10%. Whenever a new furnace is built, either as a replacement or for capacity enhancement; the foundry units simply replicate the design of their existing/earlier furnace. Registration of the project under CDM will greatly help in promoting the energy-efficient DBC among foundry units in Rajkot cluster, since apart from saving in operating costs (due to lower coke consumption), additional revenues from sale of CERs will be generated. Moreover, the credibility of the project (dissemination of energy-efficiency DBC among foundry units) will be increased enormously.

2. *Limited in-house technological capacity:* Foundry units in India, in general, have limited technological capacity to select, evaluate and adopt technological changes. This is because most of the foundry units are family-owned-and-managed and thus do not employ technical personnel for design and development work. India has over 5 000 small-scale foundry units spread in over 20 geographical clusters. To showcase the benefits of DBC, TERI, with support of SDC (the Swiss Agency for Development and Cooperation), installed a demonstration DBC at Howrah (a foundry cluster in Eastern India) in 1998. Subsequently, poor industry database and large geographical distances between clusters hindered dissemination of the demonstrated technology to units in other clusters. To reach out to foundry units in Rajkot (in Western Indian and approx. 2 500 km from Howrah) a seminar was organised by TERI in April 2002 and the first TERI designed DBC was commissioned in Rajkot in August 2003. TERI's project has helped in spreading awareness about a properly designed DBC among foundry units in Rajkot. It has even helped in building capacities of a couple of foundry units that are replicating TERI's technology. However, it cannot be claimed that capacity of majority of foundry units has been enhanced through the ongoing project. The CDM project is expected to help in much wide-spread technology adoption among the foundry units in Rajkot.
3. *Lack of institutional and technological support:* Since the design of the furnace would need customised, technical assistance is an important component during implementation. The existing technical/managerial capacity institutions in the cluster are weak to support/promote any such technological innovations. The existing government institutions for technical support like DIC (District Industries Centre) lack credibility and industry associations like the REA (Rajkot Engineering Association) have focused on administrative rather than technical work. As explained under (2), the SDC-TERI collaboration, which has focused on unit-level technology replications, have been working in Rajkot for only the past couple of years. Strengthening of existing cluster level institutions is a long and complex process. However in the brief period of work at Rajkot, TERI has established a high degree of credibility among cluster stakeholders like DIC and REA. Since large-scale technology conversions will take place under this CDM project, it will help to strengthen existing cluster institutions.
4. *Investment barrier:* A new DBC or retrofit DBC requires high upfront investment. The cost of a new DBC is approximately Rs 1 million (about US Dollar 22 000) which is almost twice that of the cost of a conventional furnace to install. Since small-scale units typically go for first-cost minimisation, a higher initial cost is a barrier to adoption of the technology. However depending on the condition of the furnace shell, it may be possible to retrofit/convert a conventional furnace to a DBC in which case the investment involved is Rs 2 lakh (about US dollar 4 500). In both cases (new furnace or a retrofit) the payback period/IRR of the project are very attractive even without the revenue from CERs. However, the tendency to minimise first-costs and high credit/asset risk of the small-scale industrial units are some of the barriers to investment. The additional revenue

stream earned from CERs by the entities is expected to make the technological switchover much more attractive and reduce these risk perceptions considerably.

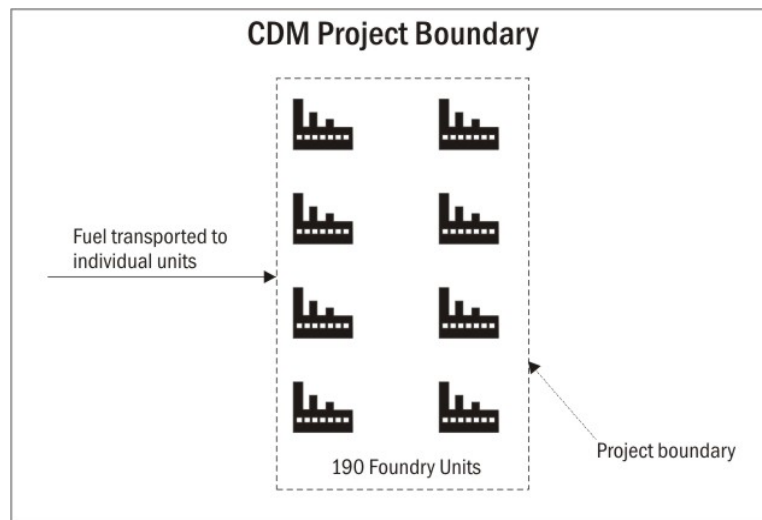
National policies and circumstances:

There is no legally binding local or national laws or regulations that require foundry units to adopt energy efficient DBC. Energy efficiency improvement of cupola is purely a cost saving measure and hence foundry units adopting DBC would have emissions that need to be controlled by intake of appropriate pollution control systems. Intake of pollution control system has no effect on the energy performance of the cupola and hence does not change the emission reduction envisaged in the project.

B.4 Description of the project boundary for the project activity:

(Define the project boundary for the project activity using the guidance specified in the applicable project category for small-scale CDM project activities contained in appendix B of the simplified M&P for small-scale CDM project activities.)

The physical/geographical site of the industrial facilities is spread in and around the town of Rajkot in the state of Gujarat in Western India. The location of the different industrial facilities has not marked in the map of Rajkot, since physical mapping of these units has not been done. A schematic drawing of the CDM project boundary is given.



Project boundary with respect to the processes that are affected by the project activity is the cupola furnace section in each of the participating foundry units. The processes or equipments which are a part of the cupola furnace section are the following: (1) vertical shaft cupola furnaces, (2) blowing fan and air ducts and (3) bucket charging system for charging the feed stocks. Transport emissions for fuels are not included as this is conservative.

B.5 Details of the baseline and its development:

B.5.1 (Specify the baseline for the proposed project activity using a methodology specified in the applicable project category for small-scale CDM project activities contained in appendix B of the simplified M&P for small-scale CDM project activities)

The proposed baseline methodology for the project is explained here.

The GHG emissions (carbon-dioxide in this case) are a function of the following:

- 1) Consumption of fossil fuel, i.e., coke
- 2) Consumption of limestone
- 3) Consumption of electricity in auxiliary equipments (cupola fan and bucket charging system)

The baseline emissions from each of the sources can be estimated using the formulae given below:

(1) Annual emissions from coke

Total annual fossil fuel (coke) consumption at cluster level, E

$$E(\text{tonnes of coke / annum}) = \sum_{i=1}^n \sum_{j=1}^m C_{i,j} J_{i,j} = C_{1,1} J_{1,1} + C_{1,2} J_{1,2} + \dots + C_{1,m} J_{1,m} + \dots + C_{n,m} J_{n,m}$$

Where,

- $C_{i,j}$ = tonnes of coke per tonne of melt for the i^{th} unit j^{th} cupola
 $J_{i,j}$ = melt produced per annum by the i^{th} unit j^{th} cupola in tonnes
 n = number of units
 m = number of cupola in any unit

Annual carbon equivalent (CE) of coke (baseline)

$$CE(\text{tonne of carbon / annum}) = \sum_{i=1}^n \sum_{j=1}^m P_i C_{i,j} J_{i,j}$$

Where,

- P_i = weighted average of fixed carbon in coke for i^{th} cupola

The carbon in coke is utilised in one of the following ways:

1. The carbon in coke gets converted to CO₂ and CO during combustion. Hence a CO₂ emission factor [(weight % of CO₂ in flue gases/ (weight % of CO₂ in flue gases + weight % of CO in flue gases)] needs to be considered. Based on flue gas analysis done during audits undertaken by TERI, this factor has been estimated to be 0.92 for conventional cupola (baseline).
2. A small amount of carbon, approximately 3%, is emitted as un-burnt carbon particles in the dust of the flue gas. Hence a correction factor of 0.97 for un-burnt carbon needs to be considered.
3. A small amount of carbon is retained in the cast iron produced. This amount is very small. A correction factor of 0.98 may be used for accounting for this loss.
4. Some amount of un-burnt carbon is present in the cupola bed, dropped at the end of the melting campaign. This coke is returned/used in the next production run. While recording the coke consumption, the units must not double account this returned coke.

$$\begin{aligned}
& \text{Annual baseline emissions from coke (t CO}_2\text{/annum)} \\
& = \text{CE} * [\text{CO}_2 \text{ emission factor}] * \\
& \quad [\text{unburnt carbon in dust factor}] * \\
& \quad [\text{carbon loss to iron factor}] * 44/12 \\
& = \text{CE} \times 0.92 \times 0.97 \times 0.98 \times 44/12 \\
& = \text{CE} \times 0.8745 \times 44/12 \\
& = \text{CE} \times 3.2067 \dots\dots\dots (1)
\end{aligned}$$

Where, 44 & 12 are the molecular weights of carbon dioxide and carbon respectively

(2) Annual emissions from limestone

Since limestone acts as a fluxing agent, its consumption is a function of the actual coke consumption. From the audits conducted by TERI at foundry units in Rajkot, it has been found that the limestone consumption varies between 27-29% of the coke consumption. Hence assuming a conservative estimate of 27%, the limestone consumption at the cluster level, L, is calculated as follows

$$L(\text{tonne of limestone / annum}) = 0.27 \times E = \sum_{i=1}^n \sum_{j=1}^m 0.27 C_{i,j} J_{i,j}$$

The percentage of calcium carbonate in limestone is 93% and molecular weights of carbon dioxide and calcium carbonate are 44 and 100 respectively.

$$\text{Annual baseline emissions from limestone (tonne of CO}_2\text{/annum)} = L \times 0.93 \times 44/100 \dots\dots\dots(2)$$

(3) Annual emissions due to electrical energy (from electricity consumption in auxiliaries, viz. cupola fan motor and charging system motor):

$$E_B = \sum_{i=1}^n \sum_{j=1}^m (p_{i,j} d_{i,j} o_{i,j}) / (1-l)$$

Where,

E_B = annual energy baseline (in kWh)

n = number of units

m = number of motors that are replaced with the cupola in i^{th} foundry

$p_{i,j}$ = Rating of the motor that is replaced in the cupola in the i^{th} unit's j^{th} cupola, in kW

$d_{i,j}$ = loading of the motor in the i^{th} unit's j^{th} cupola, %

$o_{i,j}$ = annual operating hours of the motors replaced in the i^{th} unit's j^{th} cupola, hours

l = average technical distribution losses for the grid in diesel powered mini-grids installed by public programs or distribution companies in isolated areas, is assumed to be '0' in this case since the grid is not considered in this category

$$\text{Annual emissions due to electrical energy} = E_B \times \text{emission factor in kg CO}_2/\text{kWh}$$

An emission factor of 930 g CO₂/kWh has been using the baseline methodology 29b of Appendix B of the simplified modalities and procedures for small-scale CDM project activities for the power generation in the Western Grid for the year 2001-02. The details can be obtained from the TERI Report No. 2002RT64 submitted to MNES, GOI, November 2003.

$$\text{Hence, annual baseline emissions due to electrical energy (tonne of CO}_2/\text{annum)} = E_B \times 0.93 \quad \dots(3)$$

$$\text{Total baseline emission} = (1) + (2) + (3)$$

The proposed baseline method is suitable for all emitters. It may be noted that the number of units, n , and melt produced per annum, J_i , may change over the crediting period, as small-scale industries may close down. Hence these will be part of the monitoring.

After modification, if annual production is:

- (a) less or equal to the baseline production, then credits will be given on lesser production
- (b) more, then credits will be treated as produced in a new facility. An additional baseline is required for the foundry unit with energy use of coke, limestone and electrical energy in the facility that would otherwise be built in case of a new facility (Appendix B of simplified M&P). Cluster-level survey conducted by TERI (TERI, 2003) does not reveal any significant difference in the energy efficiency of cupola among foundry units. However, data on date/vintage of capacity additions was not collected during the survey. This can be done by conducting a quick study separately at the beginning of the project.

B.5.2 Date of completing the final draft of this baseline section:

31 December 2004. The baseline need not be reviewed for any purpose till the crediting period of 10 years. The need for updating the baseline will arise when a new project is proposed in the same location later.

B.5.3 Name of person/entity determining the baseline:

(Please provide contact information and indicate if the person/entity is also a project participant listed in annex 1 of this document.)

From the project participant

Rajkot Engineering Association (REA)
Bhaktinagar Industrial Estate, Rajkot 360 002. India
Tel. 91-0281-2362235. Fax. 9100281-2362506
www.reaindia.com
Contact person: Mr Maganbhai Antala, Hon. Secretary.

From the project developer

TERI, Darbari Seth Block, India Habitat Center, Lodhi Road,
New Delhi – 110003. India
Tel. 91-11-24682111 or 24682100
Fax. 91-11-24682144 or 24682145
mailbox@teri.res.in
Contact person: Mr Prosanto Pal

C. Duration of the project activity and crediting period

C.1 Duration of the project activity:

C.1.1 Starting date of the project activity:

(For a definition of the term 'starting date', please refer to the UNFCCC CDM web site).

1 July 2005

C.1.2 Expected operational lifetime of the project activity: *(in years and months, e.g. two years and four months would be shown as: 2y-4m.):*

10 years. The 10 year period is chosen because the usual life a new furnaces, without major maintenance is around 10-12 years.

C.2 Choice of the crediting period and related information: *(Please underline the selected option (C.2.1 or C.2.2) and provide the necessary information for that option.)*

(Note that the crediting period may only start after the date of registration of the proposed activity as a CDM project activity. In exceptional cases, the starting date of the crediting period can be prior to the date of registration of the project activity as provided for in paragraphs 12 and 13 of decision 17/CP.7 and in any guidance by the Executive Board, available on the UNFCCC CDM web site.)

C.2.1 Renewable crediting period (at most seven [7] years per crediting period):

C.2.1.1 Starting date of the first crediting period *(DD/MM/YYYY):*
N/A

C.2.1.2 Length of the first crediting period *(in years and months, e.g. two years and four months would be shown as: 2y-4m.):*
N/A

C.2.2 Fixed crediting period (at most ten (10) years):

C.2.2.1 Starting date *(DD/MM/YYYY):*
01/07/2005

C.2.2.2 Length (max 10 years): *(in years and months, e.g. two years and four months would be shown as: 2y-4m.):* 10 years

D. Monitoring methodology and plan

(The monitoring plan shall incorporate a monitoring methodology specified for the applicable project category for small-scale CDM project activities contained in appendix B of the simplified M&P for small-scale CDM project activities and represent good monitoring practice appropriate to the type of project activity.

The monitoring plan shall also provide information on the collection and archiving of the data specified in appendix B of the simplified M&P for small-scale CDM project activities to:

- Estimate or measure emissions occurring within the project boundary;*
- Determine the baseline, as applicable;*
- Estimate leakage, where this needs to be considered.*

Project participants shall implement the registered monitoring plan and provide data, in accordance with the plan, through their monitoring reports.

Operational entities will verify that the monitoring methodology and plan have been implemented correctly and check the information in accordance with the provisions on verification. This section shall provide a detailed description of the monitoring plan, including an identification of the data to be collected, its quality with regard to accuracy, comparability, completeness and validity, taking into consideration any guidance contained in the methodology and archiving of the data collected.

Please note that monitoring data required for verification and issuance are to be kept for two years after the end of the crediting period or the last issuance of CERs for this project activity, whichever occurs later.

An overall monitoring plan that monitors performance of the constituent project activities on a sample basis may be proposed for bundled project activities. If bundled project activities are registered with an overall monitoring plan, this monitoring plan shall be implemented and each verification/certification of the emission reductions achieved shall cover all of the bundled project activities.)

D.1 Name and reference of approved methodology applied to the project activity:

(Please refer to the UNFCCC CDM web site for the most recent version of the indicative list of small-scale CDM project activities contained in appendix B of the simplified M&P for small-scale CDM project activities.)

(If a national or international monitoring standard has to be applied to monitor certain aspects of the project activity, please identify this standard and provide a reference to the source where a detailed description of the standard can be found.)

Type II: Energy efficiency improvement project – IID. Energy Efficiency and Fuel Switching measures for Industrial Facilities.

The monitoring methodology proposed shall consist of:

- i. Baseline - documentation of energy and/or production related data for old cupola
- ii. CDM - monitoring of energy and/or production related data for retrofit/new cupola
- iii. Difference – calculation of energy savings/emission reduction from using the above data (i) & (ii).

D.2 Justification of the choice of the methodology and why it is applicable to the project activity:
(Justify the choice of the monitoring methodology applicable to the project category as provided for in appendix B.)

There are three sources of CO₂ emissions in cupola melting:

- (a) The primary source of CO₂ is from combustion of coke in the furnace. The major charge materials to cupola are metallics (in form of pig-iron, bought-out scrap and foundry returns), coke (fuel) and limestone. The foundry units maintain a production chart of every melting campaign in which the weight of the feed materials are recorded. The fixed carbon in coke is estimated from chemical analysis of coke.
- (b) A secondary source of CO₂ is by decomposition/calcination of limestone (calcium carbonate) which is added as a fluxing agent in iron melting. The calcium carbonate decomposed to calcium oxide (CaO) and CO₂ in the furnace.
- (c) While improving the energy efficiency of a furnace, the rating of electric motors used in air blower and charging system may have to be increased.

The CO₂ emissions from (a), (b), and (c) can be calculated using the formula given in B 5.1

Most of the new furnaces will be a retrofit measures (following Art. 61) in which the blowing fan and air distribution system to the furnace are modified. However, if the outer shell of the existing furnace is in poor condition, then a new furnace needs to be built in place of the older one, in which case it would be treated as a new facility (Art. 62).

A mix of the following approaches is possible for monitoring every variable:

- A. Measurement of data of all furnaces in the cluster
- B. Statistical approach for a certain cohort based on random sampling

The proposed monitoring approach is dynamic and can be extended to include new sub-projects commissioned over a period of time. The methodology is robust and can be independently verified by a third party. A database of all the records provided by individual foundry units will be maintained by REA. Since the project proponent (REA), is also a nodal industry organisation at Rajkot, it can influence all the entities to provide the required data. The quality assurance and quality control of the data will be the responsibility of REA.

Monitoring methodology

Every variable can be monitored by either of the two approaches (A) or (B). Activity data such as melt output and coke input have to be monitored for 100% of the foundry units by approach (A). Variables that are more or less the same for all elements of a certain cohort may be determined with a statistical approach (B) for a certain cohort, but based on suitable random sampling. An example of this is the specific lime consumption.

The variables to be monitored and other details such as recoding frequency and approach are given in the table in section D.3.

D.3 Data to be monitored:

(The table below specifies the minimum information to be provided for monitored data. Please complete the table for the monitoring methodology chosen for the proposed project activity from the simplified monitoring methodologies for the applicable small-scale CDM project activity category contained in appendix B of the simplified M&P for small-scale CDM project activities.

Please note that for some project categories it may be necessary to monitor the implementation of the project activity and/or activity levels for the calculation of emission reductions achieved.

Please add rows or columns to the table below, as needed)

| ID number | Data type | Data variable | Data unit | Measured (m), calculated (c) or estimated (e) | Recording frequency | Proportion of data to be monitored | How will the data be archived? (electronic/paper) | For how long is archived data to be kept? | Comment |
|-----------|-----------------------|-------------------------------------|-----------|---|---------------------|------------------------------------|---|---|-----------------|
| 01 | Melt output | Quantity of metal melted | Tonnes | m | Quarterly | 100% | Electronic/paper | 10 years | Methodology (A) |
| 02 | Coke input | Quantity of coke consumed | Tonnes | m | Quarterly | 100% | Electronic/paper | 10 years | Methodology (A) |
| 03 | Coke quality | Fixed carbon in coke | % | m | Quarterly | Random sampling | Electronic/paper | 10 years | Methodology (B) |
| 04 | Limestone input | Specific limestone consumed | % | m | Quarterly | Random sampling | Electronic/paper | 10 years | Methodology (B) |
| 05 | Limestone quality | Calcium carbonate in limestone | % | m | Quarterly | Random sampling | Electronic/paper | 10 years | Methodology (B) |
| 06 | Fan motor size | Specifications of the fan motor | kW | c | Quarterly | Random sampling | Electronic/paper | 10 years | Methodology (B) |
| 07 | Fan motor loading | Loading | % | m | Quarterly | Random sampling | Electronic/paper | 10 years | Methodology (B) |
| 08 | Charger motor size | Specifications of the charger motor | kW | c | Quarterly | Random sampling | Electronic/paper | 10 years | Methodology (B) |
| 09 | Charger motor loading | Loading | % | m | Quarterly | Random sampling | Electronic/paper | 10 years | Methodology (B) |
| 10 | Operating hours | Time of cupola operation | hours | m | Quarterly | Random sampling | Electronic/paper | 10 years | Methodology (B) |

D.4 Name of person/entity determining the monitoring methodology:

(Please provide contact information and indicate if the person/entity is also a project participant listed in annex 1 of this document.)

Prosanto Pal
TERI, Darbari Seth Block, India Habitat Center, Lodhi Road,
New Delhi – 110003. India
Tel. 91-11-24682111 or 24682100
Fax. 91-11-24682144 or 24682145
prosanto@teri.res.in

E. Calculation of GHG emission reductions by sources

E.1 Formulae used:

(In E.1.1 please provide the formula used to calculate the GHG emission reductions by sources in accordance with the applicable project category of small-scale CDM project activities contained in appendix B of the simplified M&P for small-scale CDM project activities.)

In case the applicable project category from appendix B does not indicate a specific formula to calculate the GHG emission reductions by sources, please complete E.1.2 below.)

E.1.1 Selected formulae as provided in appendix B:

(Describe the calculation of GHG emission reductions in accordance with the formula specified for the applicable project category of small-scale CDM project activities contained in appendix B of the simplified M&P for small-scale CDM project activities.)

n/a

E.1.2 Description of formulae when not provided in appendix B:

E.1.2.1 Describe the formulae used to estimate anthropogenic emissions by sources of GHGs due to the project activity within the project boundary: *(for each gas, source, formulae/algorithm, emissions in units of CO₂ equivalent)*

The anthropogenic GHG emissions (carbon-dioxide in this case) would be affected on account of the following sources:

1. Reduction of carbon-dioxide emissions by displacement of coke
2. Reduction of carbon-dioxide emissions by displacement of limestone
3. Increase in emissions of carbon-dioxide by the additional electricity consumption in cupola fan

(1) Annual emissions from coke:

Total annual coke consumption at cluster level after DBC implementation, E'

Where,

$$E'(\text{tonnes of coke / year}) = \sum_{i=1}^n \sum_{j=1}^m C'_{i,j} J'_{i,j} = C'_{1,1} J'_{1,1} + C'_{1,2} J'_{1,2} + \dots + C'_{1,m} J'_{1,m} + \dots - C'_{n,m} J'_{n,m}$$

- C'_{i,j} = tonnes of coke per tonne of melt for the ith unit jth cupola
- J'_{i,j} = melt produced per annum by the ith unit jth cupola in tonnes
- n = number of units
- m = number of cupola in any unit

Annual carbon equivalent of coke (DBC implemented scenario)

$$CE' \text{ (tonne of carbon / annum) } = \sum_{i=1}^n \sum_{j=1}^m P'_i C'_{i,j} J'_{i,j}$$

Where,

P'_i = weighted average of fixed carbon in coke for i^{th} unit

The carbon in coke is utilised in one of the following ways:

1. The carbon in coke gets converted to CO₂ and CO during combustion. Hence a CO₂ emission factor [(weight % of CO₂ in flue gases/ (weight % of CO₂ in flue gases + weight % of CO in flue gases)] needs to be considered. Based on flue gas analysis done during audits undertaken by TERI, this factor has been estimated to be 0.94 for DBC (post-implementation).
2. A small amount of carbon, approximately 3%, is emitted as un-burnt carbon particles in the dust of the flue gas. Hence a correction factor of 0.97 for un-burnt carbon needs to be considered.
3. A small amount of carbon is retained in the cast iron produced. This amount is very small. A correction factor of 0.98 may be used for accounting for this loss.
4. Some amount of un-burnt carbon is present in the cupola bed, dropped at the end of the melting campaign. This coke is returned / used in the next production run. While recording the coke consumption, the units must not double account this returned coke.

Annual emissions from coke post implementation (t CO₂/annum)

$$\begin{aligned} &= CE' * [\text{CO}_2 \text{ emission factor}] * \\ &\quad [\text{unburnt carbon in dust factor}] * \\ &\quad [\text{carbon loss to iron factor}] * 44/12 \\ &= CE' \times 0.94 \times 0.97 \times 0.98 \times 44/12 \\ &= CE' \times 0.8936 \times 44/12 \\ &= CE' \times 3.2764 \qquad \dots\dots(1') \end{aligned}$$

Where, 44 & 12 are the molecular weights of carbon dioxide and carbon respectively.

(2) Annual emissions from limestone:

Since limestone acts as a fluxing agent, its consumption is a function of the actual coke consumption. From the audits conducted by TERI at foundry units in Rajkot, it has been found that the limestone consumption varies between 27-29% of the coke consumption. Hence assuming a conservative estimate of 27%, the limestone consumption at the cluster level post-implementation, L' , is calculated as follows

$$L'(\text{tonne of limestone / annum}) = 0.27 \times E' = \sum_{i=1}^n \sum_{j=1}^m 0.27 C'_{i,j} J'_{i,j}$$

The percentage of calcium carbonate in limestone is 93% and molecular weights of carbon dioxide and calcium carbonate are 44 and 100 respectively.

$$\begin{aligned} \text{Annual emissions from limestone, post-implementation (tonne of CO}_2\text{/annum)} \\ = L' \times 0.93 \times 44/100 \quad \dots\dots\dots(2') \end{aligned}$$

(3) Annual emissions due to electrical energy (from electricity consumption in auxiliaries viz. cupola fan motor and charging system motor) after DBC implementation, E'_B :

$$E'_B = \sum_{i=1}^n \sum_{j=1}^m (p'_{i,j} d'_{i,j} o'_{i,j}) / (1-l)$$

Where,

E'_B = annual energy after implementation (in kWh)

n = number of units

m = number of motors that are replaced with the cupola in i^{th} foundry

$p'_{i,j}$ = Rating of the motor that is replaced in the cupola in the i^{th} unit's j^{th} cupola, in kW

$d'_{i,j}$ = loading of the motor in the i^{th} unit's j^{th} cupola, %

$o'_{i,j}$ = annual operating hours of the motors replaced in the i^{th} unit's j^{th} cupola, hours

l = average technical distribution losses for the grid in diesel powered mini-grids installed by public programs or distribution companies in isolated areas, is assumed to be '0' in this case since the grid is not considered in this category

$$\text{Annual emissions due to electrical energy} = E'_B \times \text{emission factor in kg CO}_2\text{/kWh}$$

An emission factor of 930 g CO₂/kWh has been using the baseline methodology 29b of Appendix B of the simplified modalities and procedures for small-scale CDM project activities for the power generation in the Western Grid for the year 2001-02. The details can be obtained from the TERI Report No. 2002RT64 submitted to MNES, GOI, November 2003.

$$\begin{aligned} \text{Hence, annual emissions due to electrical energy post-implementation (tonne of CO}_2\text{/annum)} \\ = E'_B \times 0.93 \quad \dots\dots(3') \end{aligned}$$

Total emissions after the CDM activity = (1') + (2') + (3')

E.1.2.2 Describe the formulae used to estimate leakage due to the project activity, where required, for the applicable project category in appendix B of the simplified modalities and procedures for small-scale CDM project activities (*for each gas, source, formulae/algorithm, emissions in units of CO₂ equivalent*)

Nil. There is no leakage of emissions, due to the manner in which the data monitoring is proposed in the project. The actual consumption of fossil fuel, limestone and electricity is monitored in log sheets of the foundry unit. The data is furnished to REA on a monthly basis by individual foundry units.

E.1.2.3 The sum of E.1.2.1 and E.1.2.2 represents the project activity emissions:

DBC implemented scenario project activity emissions, t CO₂/annum =
 $[CE' \times 0.8936 \times 44/12] + [L' \times 0.93 \times 44/100] + [E'_B \times 0.93]$

E.1.2.4 Describe the formulae used to estimate the anthropogenic emissions by sources of GHG's in the baseline using the baseline methodology for the applicable project category in appendix B of the simplified modalities and procedures for small-scale CDM project activities: (*for each gas, source, formulae/algorithm, emissions in units of CO₂ equivalent*)

1. Annual emissions from coke:

Coke consumption, E

$$E(\text{tonnes of coke / year}) = \sum_{i=1}^n \sum_{j=1}^m C_{i,j} J_{i,j} = C_{1,1} J_{1,1} + C_{1,2} J_{1,2} + \dots + C_{1,m} J_{1,m} + \dots - C_{i,j} J_{i,j}$$

C_i = tonnes of coke per tonne of melt for the ith unit jth cupola
 J_i = melt produced per annum by the ith unit jth cupola in tonnes
 n = number of units
 m = number of cupola in any unit

Annual carbon equivalent of coke in baseline scenario

$$CE (\text{tonne of carbon / annum}) = \sum_{i=1}^n \sum_{j=1}^m P_i C_{i,j} J_{i,j}$$

Where,

P_i = weighted average of fixed carbon in coke for ith unit

The carbon in coke is utilised in one of the following ways:

1. The carbon in coke gets converted to CO₂ and CO during combustion. Hence a CO₂ emission factor [(weight % of CO₂ in flue gases/ (weight % of CO₂ in flue gases + weight % of CO in flue gases)] needs to be considered. Based on flue gas analysis done during

audits undertaken by TERI, this factor has been estimated to be 0.92 for conventional cupola (baseline).

2. A small amount of carbon, approximately 3%, is emitted as un-burnt carbon particles in the dust of the flue gas. Hence a correction factor of 0.97 for un-burnt carbon needs to be considered.
3. A small amount of carbon is retained in the cast iron produced. This amount is very small. A correction factor of 0.98 may be used for accounting for this loss.
4. Some amount of un-burnt carbon is present in the cupola bed, dropped at the end of the melting campaign. This coke is returned/used in the next production run. While recording the coke consumption, the units must not double account this returned coke.

$$\begin{aligned}
 \text{Annual baseline emissions from coke (t CO}_2\text{/annum)} &= \text{CE} * [\text{CO}_2 \text{ emission factor}] * \\
 &\quad [\text{unburnt carbon in dust factor}] * \\
 &\quad [\text{carbon loss to iron factor}] * 44/12 \\
 &= \text{CE} \times 0.92 \times 0.97 \times 0.98 \times 44/12 \\
 &= \text{CE} \times 0.8745 \times 44/12 \\
 &= \text{CE} \times 3.2067 \quad \dots\dots\dots (1)
 \end{aligned}$$

Where, 44 & 12 are the molecular weights of carbon dioxide and carbon respectively

2. Annual emissions from limestone:

Since limestone acts as a fluxing agent, its consumption is a function of the actual coke consumption. From the audits conducted by TERI at foundry units in Rajkot, it has been found that the limestone consumption varies between 27-29% of the coke consumption. Hence assuming a conservative estimate of 27%, the limestone consumption at the cluster level is calculated as follows

$$L(\text{tonne of limestone / annum}) = 0.27 \times E = \sum_{i=1}^n \sum_{j=1}^m 0.27 C_{i,j} J_{i,j}$$

The percentage of calcium carbonate in limestone is 93% and molecular weights of carbon dioxide and calcium carbonate are 44 and 100 respectively.

$$\text{Annual baseline emissions from limestone (tonne of CO}_2\text{/annum)} = L \times 0.93 \times 44/100 \quad \dots\dots\dots(2)$$

3. Annual emissions due to electrical energy (from electricity consumption in auxiliaries like fan motor and charging system motor) E_B :

$$E_B = \sum_{i=1}^n (n_i p_i d_i o_i) / (1 - l)$$

Where

E_B = annual energy baseline

N_i = the number of motors which is replaced in the cupola operating in the 'i'th foundry

p_i = power (in kW) of the motors that is replaced in the cupola of the 'i'th foundry

d_i = loading of the motor, %

o_i = average annual operating hours of the motors replaced in ith foundry

l = average technical distribution losses for the grid in diesel powered mini-grids installed by public programs or distribution companies in isolated areas, is assumed to be '0' in this case since the grid is not considered in this category

Annual baseline emissions due to electrical energy (tonne of CO₂/annum)

$$= E_B \times \text{emission coefficient (kg CO}_2\text{/kWh)}$$

An emission factor of 930 g CO₂/kWh has been using the baseline methodology 29b of Appendix B of the simplified modalities and procedures for small-scale CDM project activities for the power generation in the Western Grid for the year 2001-02. The details can be obtained from the TERI Report No. 2002RT64 submitted to MNES, GOI, November 2003.

Hence, annual baseline emissions due to electrical energy (tonne of CO₂/annum)

$$= E_B \times 0.93 \quad \dots(3)$$

Total baseline emissions = (1) + (2) + (3)

E.1.2.5 Difference between E.1.2.4 and E.1.2.3 represents the emission reductions due to the project activity during a given period:

Emission reduction =

$$(3.2067 \text{ CE} - 3.2764 \text{ CE}') \times 44/12 + (L - L') \times 0.93 \times 44/100 + (E_B - E'_B) \times 0.93$$

The monitoring methodology proposed will account for changes in emissions on account of changes in production levels, efficiency of operation, coke quality etc

E.2 Table providing values obtained when applying formulae above:

The emission reductions are associated with the rate of implementation that is number of foundry units converting to DBC. The estimated number of foundry units adopting DBC in the 1st, 2nd, 3rd, and 4th year are estimated to be 20, 70, 140 and 190. Thus by 4th year all the 190 foundry units would have converted to DBC. The generation of CERs will happen in a phased manner as more and more foundry units adopt the technology. The year-wise emission reductions will happen as follows:

| | | Year 1 | Year 2 | Year 3 | Years 4 to 10 |
|------------------|--|---------|---------|---------|---------------|
| A | Total melt output (t/year) | 162,000 | 162,000 | 162,000 | 162,000 |
| B | Melt output from DBCs (t/year) | 17,053 | 59,684 | 119,368 | 162,000 |
| C | Baseline Carbon Emission Factor (t CO ₂ /t output) | 0.287 | 0.287 | 0.287 | 0.287 |
| D | Carbon Emission Factor post conversion to DBCs (t CO ₂ /t output) | 0.225 | 0.225 | 0.225 | 0.225 |
| E = A x C | Baseline emissions (t CO ₂) | 46,508 | 46,508 | 46,508 | 46,508 |
| F = (A-B)C + BxD | Emission after installation of DBC (t CO ₂) | 45,444 | 42,783 | 39,058 | 36,397 |
| G = E -F | Emission reduction (t CO ₂) | 1,064 | 3,725 | 7,450 | 10,111 |

Hence the project is estimated to displace approximately 83,016 tonne of CO₂ over 10 years. The total emissions would amount to 465,080 tonne of CO₂ over the next 10 years in the absence of the CDM project.

Typical values for baseline and post-CDM, have been calculated here using the formulae provided in sections E 1.2.1 and E 1.2.4 for one typical conventional cupola converted to DBC at a foundry unit in Rajkot by TERI.- Shining Engineers & Founders, Rajkot.

Baseline scenario:

Tonne of coke per tonne of melt, Ci = 0.10 or 10%

$$\begin{aligned} \text{Melt produced per annum, } J_i &= 10 \text{ (tonne/melt)} * 20 \text{ (no. of melts/month)} * 12 \text{ (months/year)} \\ &= 2400 \text{ t} \end{aligned}$$

$$E = 0.10 * 2400 = 240 \text{ t of coke/annum}$$

Weighted average of fixed carbon, Pi = 85%

$$CE = 240 * 0.85 = 204 \text{ t of carbon/annum}$$

$$\text{Annual emission baseline from coke} = 204 * 0.8745 * 44/12 = 654 \text{ t of CO}_2/\text{annum} \quad \dots(\text{a})$$

$$L = 0.27 * E = 65 \text{ t of limestone/annum}$$

$$\text{Annual emissions from limestone} = 65 * 0.93 * 44/100 = 26.5 \text{ t of CO}_2/\text{annum} \quad \dots(\text{b})$$

Annual electric energy baseline EB = (15) hp * 0.746 kW/HP * 1 (100% loading)*3.33 (average operating hours/melt)*20 (no. of melts/month)*12 (months/year)
 = 8952 kWh

Weighted average emission factor for Western Grid = 930 g CO₂/kWh

Annual emissions from electricity = 8952 kWh * 0.93 kg CO₂/kWh
 = 8325 kg = 8.3 t of CO₂/annum(c)

Total emission baseline = (a) + (b) + (c) = 688.8 t of CO₂/annum

After CDM activity

Tonne of coke per tonne of melt = 0.075 or 7.5%
 Melt produced per annum = 10*20*12 = 2400 t
 E' = 0.075 * 2400 = 180 t of coke/annum

Weighted average of fixed carbon = 85 %
 CE' = 180*0.85=153 t

Annual emission from coke (post DBC) = 153 * 0.8936 * 44/12
 = 501.3 t of CO₂/annum ... (a')

L' = 0.27 * E' = 48.6 tonne of limestone/annum

Annual emissions from limestone (post DBC) = 48.6 * 0.93 * 44/100
 = 19.9 t of CO₂/annum(b')

Annual electric energy baseline EB' = (32.5) hp * 0.746 kW/HP * 1 (100% loading) * 3.33 (average operating hours/melt)*20 (no. of melts/month)*12 (months/year)
 = 19396 kWh

Weighted average emission factor for Western Grid = 930 g CO₂/kWh

Annual emissions from electricity (post DBC) = 19396 kWh * 0.93 kg CO₂/kWh
 = 18038 kg = 18 t of CO₂/annum ... (c')

Total emission (post DBC) = (a') + (b') + (c') = 539.2 t of CO₂/annum

Emissions reduction for 2400 t of melt per annum = 688.8 – 539.2 = 149.6 t CO₂

Since the total melt output in the cluster is 162,000 t per year

Total emission reduction is the cluster per year = 149.6*(162000/2400)
 = 10,098 t of CO₂ (max.)

F. Environmental impacts

F.1 If required by the host Party, documentation on the analysis of the environmental impacts of the project activity: *(if applicable, please provide a short summary and attach documentation)*

Not applicable

G. Stakeholders comments

G.1 Brief description of the process by which comments by local stakeholders have been invited and compiled:

All the foundry units are members of the local industry association –REA (Rajkot Engineering Association). Many of them are also members of the IIF (Institute of Indian Foundrymen).

REA is the largest industry association in the region with a membership of over 1000 industrial units. More than half of the members are foundry units. The origin of the association dates back to 1943, and has been named REA since 1963. The association aims at promoting and developing manufacturing activities. One of the major activities of the association is procurement and supply of major raw material to its members at 'no-profit no-loss' basis. REA has a team of professionals for managing its activities. It has its own building and conference facilities at Rajkot. The association has a well-equipped office and conference facility in a central location in Rajkot.

IIF is a national body and has 3200+ members all over India. The headquarters of IIF is in Kolkata. The office of the Rajkot Chapter of IIF is located within the REA building.

Since member foundry units of REA and IIF are the most important stakeholders in the project, meeting was convened with office-bearers of the two associations on 22 April 2004 at Rajkot to seek their views on the PDD. About 10 foundry owners and office-bearers of the associations were present in the meeting. TERI was represented by Vivek Sharma and Prosanto Pal.

In the meeting, TERI first made a presentation of the CDM rules, procedures, project cycle and timelines. The objectives, implementation plan, monitoring methodology and benefits of the proposed project were also explained.

Comments were sought from the participants on the proposed project methodology, timelines, monitoring and verification procedures etc. The comments received are summarised in G.2.

G.2 Summary of the comments received:

The comments received were primarily with respect to the follow:

1. Information dissemination & capacity building of project proponents
2. Getting buyers/investors for the project CERs
3. Monitoring and verification issues

The comments under each of the heads are summarized below:

1. Information dissemination & capacity building of project proponents
Since CDM is entirely a new concept for the foundry units, it was suggested that TERI should organize a larger seminar to generate awareness and build capacity of all the member foundry units.
2. Getting buyers/investors for the project CERs
Since REA/IIF has little or no knowledge of potential buyers of CERs, it requested TERI's help in marketing the project among potential buyers.

3. **Monitoring and verification issues**
The methodology for developing a transparent monitoring protocol for energy consumption was discussed. Since most of the conventional furnaces have similar designs, some foundry units were of the opinion that it would be adequate to take a standard baseline for all the entities, based on the detailed baseline audits conducted by TERI in the cluster. Monitoring and verification at multiple locations would be time and resource intensive.
4. **Bundling of small projects**
The foundry units are comfortable with the idea of bundling individual small projects under the industry association umbrella and have no problem with such an arrangement.

G.3 Report on how due account was taken of any comments received:

The specific actions taken/proposed in light of the comments received at the meeting are given below:

1. **Information dissemination & capacity building of project proponents**
An information dissemination/capacity building workshop for all stakeholders on CDM is a good idea. The initial meeting with the office-bearers was convened, since they represent the views of individual foundry units. However, a larger capacity building workshop on CDM for all stakeholders at Rajkot cluster can be organised by TERI, subject to availability of budget for the activity.
2. **Getting buyers/investors for the project CERs**
Even after preliminary capacity building, the industry association would need advisory support during implementation, 'selling' the project idea and during contract negotiations. TERI can provide the necessary technical assistance to the association for this activity.
3. **Monitoring and verification issues**
Individual audit of operation is very resource intensive and hence not a viable monitoring option. However taking a standard baseline for all the foundry units may be a very broad assumption. The foundry units maintain adequate in-house documentation of records like invoices of purchases, melting-schedules, production, coke consumption, coke quality etc. After brainstorming on the monitoring procedure it was felt that individual foundry units can submit the required information to REA on a monthly basis, which will be compiled by REA. For verification purposes, a random sampling of 10% of the foundry units who have implemented the project was felt to be adequate.
4. **Bundling of small projects**
Bundling of 190 individual foundry units is proposed. A list of 181 foundry units who are likely to participate in the project is provided in Annexure 1.

Annexure 1

CONTACT INFORMATION FOR PARTICIPANTS IN THE PROJECT ACTIVITY

(Please repeat table as needed)

| | |
|------------------|--|
| Organization: | Shining Engineers & Founders |
| Street/P.O.Box: | GIDC Ajit - II, Road-'K', Plot No.318-20 |
| Building: | |
| City: | Rajkot |
| State/Region: | Gujarat |
| Postcode/ZIP: | 360 003 |
| Country: | India |
| Telephone: | 387764 |
| FAX: | |
| E-Mail: | |
| URL: | |
| Represented by: | |
| Title: | |
| Salutation: | Mr |
| Last Name: | Patel |
| Middle Name: | |
| First Name: | M H |
| Department: | |
| Mobile: | |
| Direct FAX: | |
| Direct tel: | |
| Personal E-Mail: | |

| | |
|-----------------|--------------------------------------|
| Organization: | Rajkot Engineering Association (REA) |
| Street/P.O.Box: | Bhaktinagar Industrial Estate |
| Building: | |
| City: | Rajkot |
| State/Region: | Gujarat |
| Postcode/ZIP: | 360 002 |
| Country: | India |
| Telephone: | 91-281-2362235. |
| FAX: | 91-281-2362506 |
| E-Mail: | |
| URL: | www.reaindia.com |
| Represented by: | |
| Title: | Hon. Secretary |
| Salutation: | |
| Last Name: | Antala |
| Middle Name: | |
| First Name: | Maganbhai |
| Department: | |
| Mobile: | |
| Direct FAX: | |

| | |
|------------------|--|
| Direct tel: | |
| Personal E-Mail: | |

| | |
|------------------|----------------------------------|
| Organization: | TERI |
| Street/P.O.Box: | India Habitat Centre, Lodhi Road |
| Building: | |
| City: | New Delhi |
| State/Region: | |
| Postcode/ZIP: | 110003 |
| Country: | India |
| Telephone: | 91-11-24682111 or 24682100 |
| FAX: | 91-11- 24682144 or 24682145 |
| E-Mail: | mailbox@teri.res.in |
| URL: | www.teriin.org |
| Represented by: | |
| Title: | Fellow |
| Salutation: | |
| Last Name: | Pal |
| Middle Name: | |
| First Name: | Prosanto |
| Department: | |
| Mobile: | |
| Direct FAX: | |
| Direct tel: | |
| Personal E-Mail: | prosanto@teri.res.in |

List of 181 foundries interested in participating in the project

| Sl. No. | Name |
|---------|---------------------------------|
| 1 | Shining Engineers & Founders |
| 2 | Alankar Foundry |
| 3 | Adarsh Foundry |
| 4 | Alankar Foundry |
| 5 | AAI Shri Khodiyar Industries |
| 6 | Amkut Industries |
| 7 | Airking Engineers |
| 8 | Airking Industries |
| 9 | Ashwin Technocast |
| 10 | Ashok Foundry |
| 11 | Anand Engineers |
| 12 | Ajanta Metals |
| 13 | Ashok Casting |
| 14 | Ambica Casting Co. |
| 15 | Ameet Foundry |
| 16 | Arrow Techno Cast (Guj) Pvt Ltd |
| 17 | Ajay Manufacturers |

| Sl. No. | Name |
|---------|-------------------------------------|
| 18 | Adarsh Foundry |
| 19 | Bhoomi Cast |
| 20 | Bhoomi Cast |
| 21 | Bhojalram Foundry |
| 22 | Balaji Technocast |
| 23 | Balaji Technocast |
| 24 | Balaji Casting |
| 25 | Bhavna Industrial Corpn. |
| 26 | Bhuwneshwari Foundry |
| 27 | Chandraprakash Industries |
| 28 | Chirag Foundry |
| 29 | Castomate Pvt Ltd |
| 30 | Chirag Manufacturers |
| 31 | Craftman Engineers |
| 32 | Chamunda Foundry |
| 33 | Dipti Industrial Corpn |
| 34 | Deepak Engg Works |
| 35 | Digvijay Foundry |
| 36 | Die Cast Industries |
| 37 | Dayanand Foundry |
| 38 | Durga Technocast |
| 39 | Deep Metals |
| 40 | Deepjyot Metals |
| 41 | Everest Casting |
| 42 | SIR Technocast |
| 43 | Standard Casting Co. |
| 44 | Super Cast Alloys Foundries Pvt Ltd |
| 45 | Trishul Technocast |
| 46 | Timco Machine Tools |
| 47 | Tirupati Casting Co. |
| 48 | Takdeer Industries |
| 49 | Tirupati Foundry |
| 50 | Tilara Foundry |
| 51 | Usha Liner Pvt Ltd |
| 52 | Vardhman Foundry |
| 53 | Varudi Krupa Foundry |
| 54 | Varun Casting Co. |
| 55 | Vaibhav Foundry |
| 56 | Vishnu Technocast |
| 57 | Vijayankit Foundry |
| 58 | Vishvas Industries |
| 59 | Viraj Metal Industries |
| 60 | Vishal Foundry |
| 61 | Vrajmani Casting |
| 62 | Vijaya Metallica Incorporated |
| 63 | Yogi Casting |
| 64 | Suresh Industries |

| Sl. No. | Name |
|---------|------------------------------|
| 65 | Sanjay Cast |
| 66 | Sanjay Technocast |
| 67 | Satyajeet Industries |
| 68 | Sri Sannath Foundry |
| 69 | Shivam Technocast |
| 70 | Shayam Metal |
| 71 | Shiv Technocast |
| 72 | Sorathia Sales Corporation |
| 73 | Shree Ram Metals |
| 74 | Sitaram Moulding |
| 75 | Shree Ganesh Industries |
| 76 | Shivangi Casting |
| 77 | Shri Jay Ramdev Foundry |
| 78 | Shri Ram Metals |
| 79 | Shiv Rajani Industries |
| 80 | Super Melt |
| 81 | Super Foundry |
| 82 | Sanjay Casting Co. |
| 83 | Sanjay Technocast |
| 84 | S S Steel |
| 85 | Shivam Metal |
| 86 | Satyam Metals |
| 87 | Shining Engineers & Founders |
| 88 | Cupola 2 |
| 89 | Sorathiya Moulding |
| 90 | Shri Vallabha Casting |
| 91 | Sunrise Casting Co. |
| 92 | Search Foundry |
| 93 | Shreeji Foundry |
| 94 | Rajendra Casting Co. |
| 95 | Rupali Industries |
| 96 | Sita Foundry |
| 97 | S S Steel |
| 98 | Surya Casting |
| 99 | Sudhang Foundry |
| 100 | Sardar Castings |
| 101 | Sanjay Casting Co. |
| 102 | Shri Ram Moulding |
| 103 | Kartik Casting |
| 104 | Kunal Technocast |
| 105 | Kirit & Co. |
| 106 | Kishan Industries |
| 107 | Krunal Manufacturers |
| 108 | Milan Foundry |
| 109 | Maruti Casting Co. |
| 110 | Milan Foundry |
| 111 | Moonrise Foundry |

| Sl. No. | Name |
|---------|---------------------------------|
| 112 | Metallic Industries |
| 113 | Maruti Technocast |
| 114 | Meghdoot Foundry |
| 115 | Mukesh Machine Tools |
| 116 | Micro Melt (P) Ltd |
| 117 | Mangal Foundry |
| 118 | New Ramesh Industries |
| 119 | Neptun Cast |
| 120 | Poonam Metals |
| 121 | Power Metals |
| 122 | Prabhu Krupa Industries |
| 123 | Prabhu Krupa Industries |
| 124 | Power-Metic Product |
| 125 | Patel Foundry |
| 126 | Progressive Industries |
| 127 | Priya Industries |
| 128 | Pattern Cast |
| 129 | Poducer Industries |
| 130 | Parag Casting Co. |
| 131 | Pawan Engg Works |
| 132 | Poonam Castech Pvt Ltd |
| 133 | Parasmani Technocast |
| 134 | Pancham Engg Works |
| 135 | Parmeshwari Casting |
| 136 | Pollen Foundry |
| 137 | Rahul Metal |
| 138 | Rekha Foundry |
| 139 | Ram Vijay Foundry |
| 140 | Radheshyam Foundry & Engg Works |
| 141 | Radheshyam Foundry |
| 142 | Ratnasagar Casting Co. |
| 143 | Rameshwar Technocast |
| 144 | Real Cast |
| 145 | Rajavir Foundry |
| 146 | Fontac Foundry Pvt Ltd |
| 147 | Fine Cast |
| 148 | G R Casting |
| 149 | Giriraj Industries |
| 150 | Gautam Technocast |
| 151 | Benign Technocast |
| 152 | Manek Investment Cast Pvt Ltd |
| 153 | Ganesh Technocast |
| 154 | Gautam Casting Ind. Pvt Ltd. |
| 155 | Hari Om Foundry |
| 156 | Hindustan Steel Co. |
| 157 | Hari Om Foundry |
| 158 | Inova Cast Pvt Ltd |

| Sl. No. | Name |
|---------|-----------------------------|
| 159 | Ishwar Krupa Moulding Works |
| 160 | J J Metal |
| 161 | Jay Somnath Casting |
| 162 | Jayant Casting Co. |
| 163 | Jay Matel |
| 164 | Jalaram Foundry |
| 165 | Jay Mangal Foundry |
| 166 | Jay Metals |
| 167 | Jadeshwar Foundry |
| 168 | Jay Ma Khodiyar Co. |
| 169 | Cupola 2 |
| 170 | Jay Vasuki Engineers |
| 171 | Jupiter Moulding Works |
| 172 | Jyoti Casting Co. |
| 173 | Jayram Foundry |
| 174 | Jivanjyot Moulding Works |
| 175 | Jaydev Foundry |
| 176 | Jaydeep Casting |
| 177 | Jyoti Industries |
| 178 | J Hasmukhrai & Co. |
| 179 | Kamani Foundry |
| 180 | Kishor Engg Works |
| 181 | Kishor Casting Co. |

Annexure 2

INFORMATION REGARDING PUBLIC FUNDING

- - - - -

Annexure 3

FORMAT FOR DATA COLLECTION FROM INDIVIDUAL FOUNDRY UNITS

Participating foundry units are requested to submit the information in this questionnaire on a quarterly basis to REA. In case of clarifications, please contact REA

Quarterly cupola production summary report
M/s, Rajkot

Cupola no. _____

Internal diameter (I.D.) _____

Type of cupola: DBC / Conventional (strike of which ever not applicable)

Electrical details

H.P. of fan motor _____

Fan loading, % _____

H.P. of charger motor _____

Loading of charger motor, % _____

| S.No. | Date | Melt output, tonnes | Coke input, tonnes* | Fixed carbon in coke, % | Limestone input, % [†] | CaCO ₃ in limestone, % | Time of cupola operation, hours [‡] |
|----------------|------|---------------------|---------------------|-------------------------|---------------------------------|-----------------------------------|--|
| 1. | | | | | | | |
| 2. | | | | | | | |
| .. | | | | | | | |
| .. | | | | | | | |
| Total/ Avg. | | Total | Total | Average | Average | Average | Total |

* Important – do not double-account for burnt coke in bed drop

[†] Limestone charged as percentage of charged coke

[‡] time from blower-on to blower-off, excluding interruptions, if any

OTHER INFORMATION RELATED TO THE PROJECT

1. Project specific bundling issues

Some of the specific bundling issues are discussed below:

- *Heterogeneity of the set of emitters*

Although the entities employ similar technologies, there is variation among the units in terms of size of furnace, quantity of metal produced, hours of operation, frequency of operation, quality of fuel (coke) consumed, operating practices etc. A monitoring methodology has been proposed in the PDD, which is quite intensive in terms of data collection and compilation. However, due to the above-mentioned heterogeneities it is felt by the project developer that there is a limited scope to simplify the monitoring methodology in a big way from what has been proposed in the project.

- *Suitability for all emitters*

The proposed baseline and monitoring methodology is suitable for all the emitters.

- *Simplification of proposed methodology*

The foundry units operate in a dynamic situation where production may increase or decrease over time. Hence the production levels of individual entities need to be monitored in addition to energy consumption data. For a solid fossil fuel like coke, developing a fool-proof and verifiable monitoring system is always difficult, due to the risk of leakages from the system.

The proposed methodology has hence been made rigorous keeping the nature of operation and recordkeeping among small units in mind. It has been proposed that the energy consumption and production data will be sent by all the participating foundry units individually to REA. The data supplied can be verified by a third party from the purchase invoices, bills, and production records etc, at any time.

Due to the nature of operation of the units, it is felt that the proposed methodology cannot be very much simplified from that proposed in the PDD. The only simplification which is possible is to monitor the consumption only of coke and exclude emissions from limestone and electricity, since the emissions from these sources are very small and approximately nullify each other.

- *Size of bundle*

Bundling of 190 foundry units has been proposed in the PDD. It is possible to change the size of the bundle (decrease or increase the participating entities) without major changes in the proposed methodology.

2. Calculation and discussion of ICER

The ICER (Incremental Cost of Emission Reductions) was estimated for the project.

The following assumptions have been made for calculating the ICER.

1. Average rate of inflation: 5 %
2. Nominal rate of interest: 10 %

3. Base year: 2005
4. Exchange rate: 1 US Dollar = Rs. 45
5. Calculation period: 10 years
6. No. of participating units: 190
7. Investment cost of baseline technology: Rs 300 000 per unit
8. Investment cost of new technology: Rs 500 000 per unit
9. Total metal output of participating units: 162 000 tonnes
10. Price of coke: Rs 15 000 per tonne
11. Coke consumption in conventional cupola: 10% of metal output
12. Coke consumption in DBC: 7.5% of metal output
13. Cost of electricity: Rs 4.5 per kWh
14. Connected electricity load (baseline): 15 hp
15. Connected electricity load (CDM): 32.5 hp
16. Motor loading: 100%
17. Cost of energy includes both coke and electricity costs
18. Maintenance cost is Rs 50 000 per unit
19. Personnel cost is Rs 0.5 per kg
20. Running cost, which is the cost of input metallic, is Rs 9 800 per tonne
21. The maintenance costs, personnel costs, and running costs remain unchanged in baseline and CDM scenario.

The ICER calculations, based on the abovementioned assumptions, are given in Annexure 5. The ICER value is (-) 195 USD/t CO₂. The value is negative denotes that new technology results in energy savings.

Since lending to small-scale units are perceived to be high-risk according to a sensitivity of the ICER to changing discount rate was done. It was found that the ICER is not very sensitive to the discount rate. Changing the discount rate from 10% to 15%, decreases the ICER by 2 USD/t CO₂, that is, to (-) 197 USD/t CO₂.

3. Sample calculation of baseline carbon intensity of production

The carbon intensity of production is a measure of the tonnes of CO₂ produced per tonne of metal melted in a cupola. Carbon intensity of production is measured as t CO₂/t of melt. As described in the PDD, CO₂ is emitted from three sources (a) combustion of coke, (b) calcinations of limestone, and (c) electricity consumed in by the fan and charger. Out of these three sources, CO₂ emission from combustion of coke is, by far, the largest. The conversion of a conventional furnace to a DBC improves the combustion efficiency and hence reduces the CO₂ emissions from coke. The other two emissions, viz, calcination of limestone and electricity consumption, are only marginally affected by the technology conversion.

As an example, the baseline carbon intensity of production is calculated below. The coke and limestone consumptions are assumed values and have been based on actual audit results of a foundry unit in Rajkot.

Baseline carbon intensity of production

Basis: 1 (one) tonne of metal melted in a single furnace

(a) Specific emissions from fossil fuel (coke)

| | | |
|-------------------------------|---|-----------------------------|
| Coke consumption | = | 0.10 tonnes (10 % of metal) |
| Fixed carbon in coke | = | 85% |
| Carbon equivalent of coke, CE | = | 0.10 * 0.85 |
| | = | 0.085 t of carbon |

The carbon in coke is utilised in one of the following ways:

1. Most of the carbon in coke is emitted as products of combustion. The products of combustion of carbon in coke is primarily CO₂ and CO. Hence a CO₂ emission factor [(weight % of CO₂ in flue gases/(weight % of CO₂ in flue gases + weight % of CO in flue gases)] needs to be considered. Based on flue gas analysis done during audits undertaken by TERI, this factor has been estimated to be 0.92 for conventional cupola (baseline) and 0.94 for DBC (post-implementation).
2. A small amount of carbon, approximately 3%, is emitted as un-burnt carbon particles in the dust of the flue gas. Hence a correction factor of 0.97 for un-burnt carbon needs to be considered.
3. A small amount of carbon is retained in the cast iron produced. This amount is very small. A correction factor of 0.98 may be used for accounting for this loss.
4. Some amount of un-burnt carbon is present in the cupola bed, dropped at the end of the melting campaign. This coke is returned/used in the next production run. Care need to be taken not to double account this returned/used coke.

| | | |
|------------------------------|---|---|
| Specific emissions from coke | = | CE * [CO ₂ emission factor] * [unburnt carbon in dust factor] * [carbon loss to iron factor] * 44/12 |
| | = | 0.085 * 0.92 * 0.97 * 0.98 * 44/12 |
| | = | 0.2726 t of CO ₂ /t of metal output(1) |

(b) Specific emissions from limestone

| | | |
|--------------------------|---|------------------------------|
| Consumption of limestone | = | 27 % of the coke consumption |
| Tonnes of limestone, L | = | 0.27 * 0.10 |
| | = | 0.027 tonne |

| | | |
|--|---|------|
| CaCO ₃ content in limestone | = | 93 % |
|--|---|------|

| | | |
|-----------------------------------|---|---|
| Specific emissions from limestone | = | 0.027 * 0.93 * 44/100 |
| | = | 0.0110 t of CO ₂ /t of metal output(2) |

(b) Specific emissions from electricity consumed

| | | |
|--|---|---|
| Total rating of fan and charger motors | = | 15 hp |
| Melting rate of cupola | = | 3 tonnes per hour |
| Electrical energy consumption | = | [hp * 0.746 kW/hp] / [output, tonne/hour] |
| | = | 15 * 0.746*(1/3) kWh |
| | = | 3.73 kWh/t of metal output |

Weighted average emission factor of Indian Western Grid (Rajkot is supplied by the Western Grid) is 930 g CO₂/kWh

| | | |
|-------------------------------------|---|---|
| Specific emissions from electricity | = | 3.73 * 0.00093 |
| | = | 0.0034 t of CO ₂ /t of metal output(3) |

| | | |
|---------------------------------------|---|--|
| Carbon intensity of production | = | (1) + (2) + (3) |
| | = | 0.2726+0.011+0.0034 |
| | = | 0.287 t CO₂/t of melt output |

5. Replication Potential

Foundry sector is an important small-scale industrial sector. There are over 5,000 foundry units in India employing nearly 0.5 million people. The total coke consumption by the foundry units is estimated to be about 600,000 tonnes per year. On an average, it is possible to save about 25% of the coke by adoption of the energy-efficient technology, which translates into a reduction of 150,000 tonnes of coke or 410,000 tonnes of CO₂.

The majority of foundry units are dispersed in about 20 well-known geographical clusters in India. The foundry industry meets the requirements of several important sectors like railways, post and telegraph, automobiles, engineering and manufacturing industries, municipalities, housing and construction, agriculture etc. A significant export potential also exists from these clusters.

The Rajkot foundry cluster caters to the diesel engine industry located in and around Rajkot. The cluster is also an important supplier of castings for the engineering and machine tools industry. A small, but significant, percentage of foundry units (about 10%) cater to the export market.

These foundries fall under the unorganized sector, operating highly energy-inefficient conventional cupola furnaces. Within these clusters, the operating capacities and hence fuel consumption varies widely. Given the high energy savings potential due to reduced coke consumption to the tune of at least 25%, the CO₂ reduction will be significant if such measures are implemented on a wider scale. Such projects have substantial local environmental advantages and several socio-economic benefits as well.

The strict need for compliance of emission standards has made most of the small-scale foundry units extremely difficult to comply, primarily due to the lack of availability of emission control system and finance. Despite financially attractive lack of awareness and access to technology constraints these clusters in implementing the measures. This presents an ideal situation where both energy saving and emission reduction could be achieved through technological upgradation.

CDM provides a platform for motivating the foundry owners by providing additional revenue in implementing such projects, though with the current low CER price.

Despite the efforts to accelerate technological progress within and beyond individual industry clusters, the adoption of energy-efficient and environmentally-souder technologies faces numerous technical, financial, and institutional constraints. These constraints are essentially related to the limited capacity of the units to identify, research, develop, and, absorb appropriate technologies as well as to access credit for their implementation. The overall purpose of the CDM projects in the clusters should, therefore, be to decrease transaction costs to users, and thus increase the financial attractiveness of such technologies for their wider adoption. CDM interventions in these clusters could also involve establishing delivery chains for credit and technology to the small-scale units.

Replications can be aimed at creating a pool of industry mentors who could then be instrumental in expanding the projects benefits to other companies. The focus during these replications needs to be on local capacity building, essential for technology diffusion on its own in the long term. Hence it is envisaged, that initially, the technology will diffuse to a small group of entrepreneurs, who have few financial limitations and high motivation to adopt the efficient package. Long term success of this intervention will involve persuading and managing this group who will then help in marketing the efficient technology.

However the challenge will remain in bundling these projects (cluster approach) to reduce the transaction cost in terms of validation, monitoring and verification.

Annexure 5

CALCULATION OF INCREMENTAL COST OF EMISSIONS REDUCTION (ICER)

| Basic assumptions | | | | | | |
|--------------------------|-----------------------------------|------|-------------------------------|---|-----------------------------|-------------------|
| | Calculation period | 10 | years | (= crediting period of the CDM-project) | | |
| | Average inflation rate | 5 | % | | | |
| | Nominal interest rate | 10 | % | | | |
| | Real interest rate | 5.00 | % | real cost calculation | | |
| | Base year | 2005 | | | | |
| | Exchange rate | | 50 | (1US\$ = xy Rs) | | |
| | Power generation (if applicable) | | N.A | kWh/a | | |
| | | | | | | |
| | Calculation | | | Baseline | CDM-Project Activity | difference |
| 1 | total investment costs | | [Rupees/a] | 95,000,000 | 57,000,000 | |
| 2 | annual energy costs | | [Rupees /a] | 245,719,170 | 190,147,500 | |
| 3 | annual maintenance cost | | [Rupees /a] | 9,500,000 | 9,500,000 | |
| 4 | annual personnel cost (salaries) | | [Rupees /a] | 81,000,000 | 81,000,000 | |
| 5 | other annual running costs | | [Rupees /a] | 1,587,600,000 | 1,587,600,000 | |
| 6 | total annual operating costs | | [Rupees /a] | 2,018,819,170 | 1,925,247,500 | |
| 7 | annual capital costs | | [Rupees /a] | 12,302,935 | 7,381,761 | |
| 8 | total annual costs | | [Rupees /a] | 2,031,122,105 | 1,932,629,261 | |
| 10 | annual incremental costs (netto) | | [Rupees /a] | | | -98,492,844 |
| 11 | GHG emissions reduction potential | | [t CO ₂ equi/a] | 46508 | 36397 | 10111 |
| | | | [kg CO ₂ equi/kWh] | | | |

| | | | | | | |
|----|--|--|-----------------------------------|-----|-----|-------|
| 12 | marginal incremental abatement costs | | [Rupees / t CO ₂ equi] | | | -9741 |
| | | | [US\$/ t CO ₂ equi] | | | -195 |
| 13 | power generation costs (if applicable) | | [Rupees /kWh] | N.A | N.A | N.A |

Remarks/ explanations:

input

6 total annual operating costs = 2+3+4+5

Depreciation and payment of interest for the up-front investment (real interest rate, activity period) = discounted annualized

7 investment costs.

8 total annual costs = 6+7

9 Income generated from co-products of the CDM-project, e.g. sale of electricity from a cogeneration plant.

10 annual incremental costs (nett) = $(8_{\text{CDM-project}} - 9_{\text{CDM-project}}) - (8_{\text{baseline}} - 9_{\text{baseline}})$

11 greenhouse gas emissions baseline - greenhouse gas emissions CDM-project

12 marginal incremental abatement costs = 10 / 11