



**IGES- TERI CDM Reform Paper:
Linking Ground Experience
with CDM Data
in the Cement Sector in India**

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1. Introduction

India has been undergoing rapid economic development and is racing to build new buildings and infrastructure. Similarly, concerns of the greenhouse gas (GHG) emissions from these activities have been increasing. As India's cement sector is a prime GHG emitter, emissions from this sector need to be reduced. In order to do so, Indian cement manufacturers have implemented the Clean Development Mechanism (CDM) as one countermeasure. Prior to 2008, India led in the number of CDM projects under development, but over the last 2 years no projects have been registered. In terms of Certified Emission Reduction (CER) issuance, although a long time has passed since registering of Indian cement projects, only 12 projects out of 26 registered projects had received CERs as of January 2011. Despite the fact that India is ranked as the top CDM host country as assessed in terms of climate-related institutions, investment climate and project potential and status (Point Carbon, 2009), the CDM status of the cement sector points to the presence of several issues in the area of project implementation—from registration planning to CER issuance—which need resolving.

IGES (Institute for Global Environmental Strategies), in corporation with TERI (The Energy and Resources Institute), started CDM capacity building activities in India in 2003, one of which is conducting consultations with project proponents in the cement sector to assist in their project development. At the same time, IGES and TERI have tried to identify particular issues and challenges currently faced by project proponents. This paper, which was developed by IGES and TERI, is thus aimed at supporting project proponents, and lays out the most recent information, issues and challenges in the cement sector identified through their capacity-building activities, as well as proposals to enhance CDM project development.

The first part of this paper provides background information of the cement sector; the cement market, energy efficiency in the production process and CO₂ emission source/reducing measures. The second part explains the status of CDM projects in the cement sector based on the IGES CDM Project Database, including registration, CER issuance and monitoring methodology. Based on these findings, in the last part, proposals are provided for improving CDM project implementation.

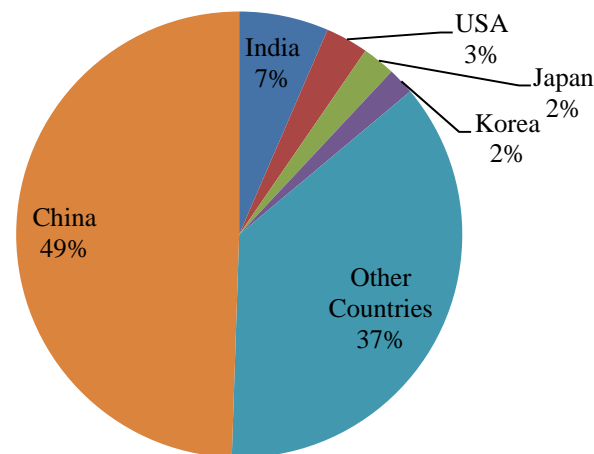
2. Background to India's Cement Sector

2.1 The Cement Market and Energy Efficiency Policy in India

India is the world's second largest cement market after China, and cement production in India is about 6% of the world total as seen in Figure 1. There are 148 large cement plants in India, with a combined installed capacity of about 350 million t per annum. The demand for cement has been growing at about 8% per annum. Most of the production is consumed locally and just 6 million t of cement is exported (CMA, 2009).

Along with its rapid expansion, India's cement industry has made tremendous strides in upgrading and assimilating state-of-the-art technologies, with nearly 97% of production based on the dry process technology. A small percentage of cement (about 2%) is accounted for by the wet process and semi-dry process, which are inefficient when compared to the dry process (TERI, 2010). The wet process consumes about 1.3 to 1.6 kcal/t of clinker whereas the semi-dry process consumes about 0.9 to 1.1 kcal/t of clinker and the dry process consumes about 0.65 to 0.75 kcal/t of clinker.

Figure 1. World cement production for 2008



Source: CMA(2009)

The different types of cement produced in India are OPC (Ordinary Portland Cement), PPC (Portland Pozzolana Cement), PSC (Portland Slag Cement), Oil Well Cement, Rapid Hardening Portland Cement, Sulphate Resisting Portland Cement and White Cement. OPC comprises about 25% of the total cement production in India, while PPC accounts for 67% and PSC accounts for 8%. Other varieties of cement constitute the remaining small balance of cement production as seen in Figure 2.

In recent times, the Government of India has formulated policies to reduce cement prices and increase its availability, so as to encourage infrastructure development. The Energy Conservation Act, 2001 has made energy auditing and filing of energy consumption patterns mandatory. This measure was intended to boost the energy efficiency of the sector, though further initiatives and tougher policies had been anticipated according to interviews conducted with representative cement manufacturers.

2.2 Energy Use in Cement Manufacturing (TERI, 2009)

Cement production is highly energy intensive and energy costs account for about 40% of the total manufacturing cost. The specific energy consumption, which is total energy consumed per tonne of cement production, of Indian cement plants varies over a wide range, which may be attributed to a number of factors, such as technology, age and production capacity. The sector's average consumption in 2005-06 was 725 kcal/kg of clinker thermal energy and 71 kcal/kg of cement electrical energy. Those of the newly built state-of-the-art cement plants in India are as low as 667 kcal/kg of clinker and 58 kcal/kg of cement, respectively, figures comparable with other world-leading plants in terms of energy efficiency. For example, the most energy efficient cement plants in Japan have a thermal energy consumption and electrical energy consumption of about 650 kcal/kg of clinker and 56 kcal/kg of cement, respectively. Various energy audit studies have estimated that an energy saving potential in the range of 5-10% is possible in both thermal and electrical energy consumption in cement plants via the adoption of various energy conservation measures (TERI, 2008 and 2009).

2.3 Energy Saving and CO₂ Emission Reductions in India's Cement Sector

CO₂ emission during cement manufacture is caused by calcination of raw materials (45-55%) and fossil fuel combustion (35-40%) as direct sources (Sethi, 2011). Some of the energy-efficient and new technology measures available for the Indian cement industry are roller process, vertical roller mills and process control equipment. According to the estimation (Sethi, 2011) shown in Table 1, using alternative fuels and increasing the production of blended cement (hereafter defined as "blended cement") have a CO₂ emission reduction potential in the range of 10-15% in the cement sector.

Table 1. Potential CO₂ reduction through various measures

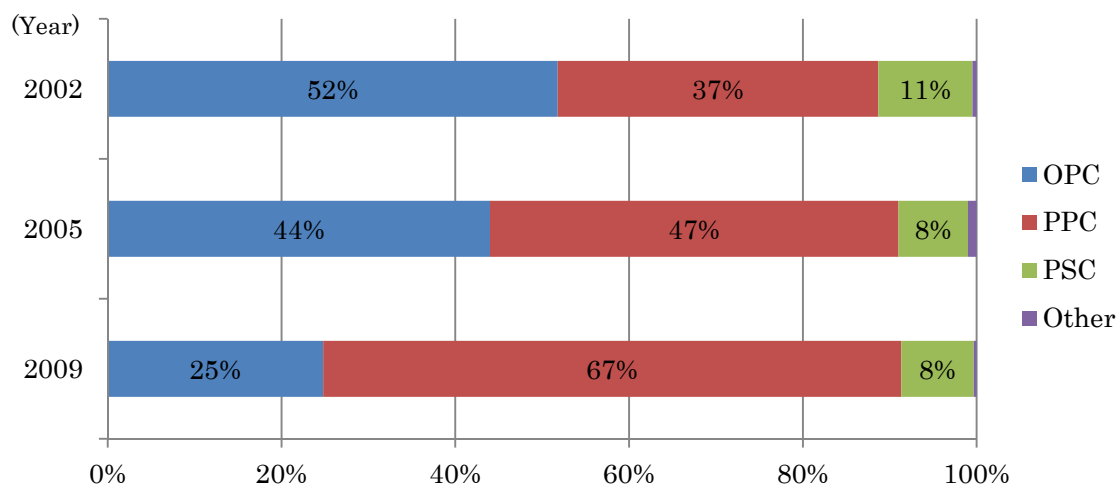
Measure	CO ₂ emission reduction (%)
Energy efficiency improvements via: Energy efficient equipment/system Best operating practices Use of mineraliser & grinding aids	4 – 6
Use of alternate fuels, biomass and SRM (25-35%)	10 – 12
Production of blended cement (fly ash; 35% average and slag; 60% average) (PPC: 85% and PSC: 10%)	10 – 15
Cogeneration of power	5 - 8
Use of non-conventional energy sources (wind energy; 10%)	2
Production of low lime cement	2 - 3
Tree plantations	~1

Source: Sethi (2011)

The manufacture of blended cement such as PPC, which uses fly ash (a by-product of coal-based power plants), and PSC, which uses slag (a by-product of steel plants) reduces overall energy consumption. The percentage of PPC has increased over the years as seen in Figure 2. Each tonne of PPC and PSC production reduces limestone consumption by 0.8 t and 1 t respectively. The energy saving using PPC production results in a saving of 32% in thermal energy as compared with the

production of OPC.

Figure 2. Variety-wise cement production



Source: CMA (2009)

Use of alternate fuels in the cement manufacturing process is also gaining importance. Options such as the use of low ash coal and petroleum coke as well as tyre-derived fuel and agricultural waste are being explored.

Waste heat utilisation from cement kilns is another important area that would assist in reducing the specific energy consumption of cement plants. Technological options such as the organic Rankine cycle and Kalina cycle could be applied to the pre-heater or cooler exhaust gases to recover the low-grade heat in cement plants.

Advancements in pyro-processing with options such as self-aligning rotary kiln designs with friction drives, fluidised bed clinkerisation, radiation synthesis of cement clinker and ultra-high temperature pyro-processing by plasma torch are expected to improve the energy efficiency of the cement manufacturing process (TERI, 2009).

3. Current Status and Issues of CDM Projects of the Sector

3.1 Registered Projects

89 CDM projects related to the cement production process had been registered throughout the world by the end of 2010. There are 4 project types; alternative fuels, blended cement, energy efficiency and waste gas/heat utilisation. Though some cement companies conduct CDM projects outside of cement production processes, like wind power and biomass projects, they are excluded from the scope of this paper. As Table 2 shows, most of the blended cement projects were developed in India. India has led in terms of project development in the cement sector since 2007; however, currently, the emergence of waste gas/heat utilisation projects in China since 2008 have led to China claiming the top share in terms of number of registered projects as seen in Figure 3.

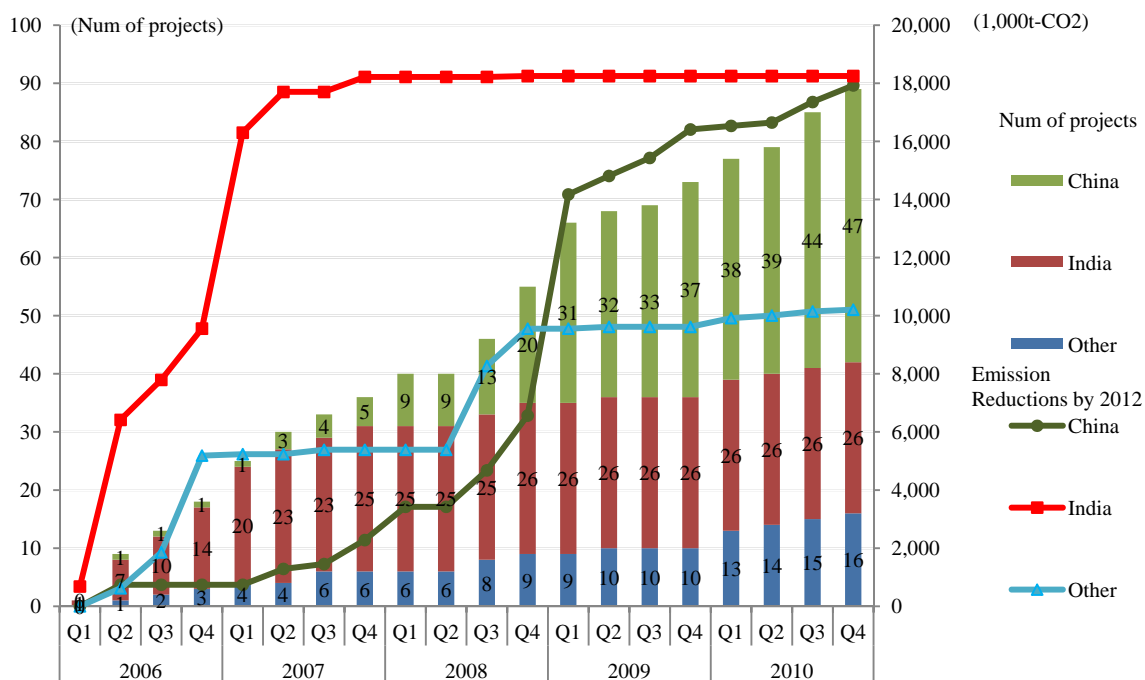
Table 2. Project types and corresponding approved methodology in cement sector

Type	Details	Approved Methodology	Registered		
			India	China	Other
Alternative fuels	Emissions reduction through partial substitution of fossil fuels with alternative fuels or less carbon intensive fuels in cement manufacture	ACM0003	4	0	8
Increasing blended cement production	Consolidated Methodology for Increasing the Blend in Cement Production	ACM0005	13	0	1
	Consolidated baseline and monitoring methodology for project activities using alternative raw materials that do not contain carbonates for clinker production in cement kilns	ACM0015*	0	5* (AM0033)	0
	Emission reductions in hydraulic lime production	AMS-III.AD.	0	0	1
Energy efficiency (Factory)	Energy efficiency and fuel switching measures for industrial facilities	AMS-II.D.	5	0	1
Waste gas/heat utilisation (Cement production line)	Consolidated baseline methodology for waste gas and/or heat and/or pressure for power generation	ACM0004	2	24	0
	Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects	ACM0012	0	9	0
	Baseline methodology for greenhouse gas reductions through waste heat recovery and utilisation for power generation at cement plants	AM0024	2	4	3
	Waste gas based energy systems	AMS-III.Q.	0	5	2
Total			26	47	16

Source: IGES (2011a)

*AM0033 (Use of non-carbonated calcium sources in the raw mix for cement processing) replaced by ACM0015

Figure 3. Cumulative number of registered CDM projects and expected emission reductions by 2012 in cement sector



Source: IGES (2011a)

3.2 Reasons for stoppage of registration of Indian Cement Projects

As Figure 3 shows, though the number of Indian cement projects registered was over 10 in 2006 and 2007, only one project was registered in 2008, the last project for the Indian cement sector. Half of the registered projects in India are blended cement projects that utilise methodology ACM0005 (consolidated methodology for increasing the blend in cement production), in which fly ash (11 projects) and slag (2 projects) are blended as additives. Another type of blended cement project registered utilises methodology AM0033 (use of non-carbonated calcium sources in the raw mix for cement processing, and replaced by ACM0015), which was developed in China. The methodology for blended cement projects depends on type of additives or alternative materials that are available in the areas where the projects are being implemented. Benchmarks and other means of support offered by the Cement Manufacturers Association (CMA) to set the baseline have made ACM0005 a popular tool for the project proponents in India, all of which utilise this data.

Based on interviews with Indian project proponents in the IGES CDM capacity building programme, it was learned that developing projects with the ACM0005 methodology became difficult at the time of registration due to changes in the market. First, the baseline emission reductions in the projects, decided by the clinker contents rate, became more stringent due to the high availability of blended additive components in the Indian market. In addition, fly ash availability is decreasing in India because thermal power plants, which previously disposed of the fly ash for free, have recently attached a price to it due to increased demand. Moreover, purchasing from suppliers located far away from project sites has an impact on the transport cost and the leakage emissions, and declining market demand for blended cement has also changed the project baselines. Moreover the changes of baseline affect not only planning a project at the registration but also requesting CER after starting a project activity. There is a possibility that project activity emissions would surpass the baseline emissions.

These aspects also explain the reasons for review and rejection decisions by the CDM executive board meeting in the registration process. The main reason of review and rejection of projects applying the methodology ACM0005 is that there are no significant additional technological or market acceptability barriers to demonstrate additionality. As mentioned above, technologies which increase the additive share in cement have been disseminated and became common practice in India. Though investment analysis is a popular tool use to demonstrate additionality in CDM projects, barrier analysis including technological and market acceptability were the only means approved in this methodology prior to 2009 (UNFCCC 2007b).

The 46th CDM Executive Board Meeting in March 2009 decided to put methodology ACM0005 on hold due to the difficulties encountered in demonstrating the barriers requested, as a result of which the Methodology Panel prepared a revised version of ACM0005 to address the issue of barrier analysis (UNFCCC, 2009a). In the revised version, technological barriers were eliminated from the methodology. Other barriers, such as first-of-its-kind in barrier analysis and investment analysis, were newly added to demonstrate additionality. Even after this revision of methodology, none of the Indian projects have applied for registration or validation using this methodology. This

implies that improving the means by which additionality is demonstrated is insufficient, since setting of the baseline is now more difficult for Indian project proponents.

In addition, expectations for other types of CDM projects being developed in the Indian cement sector are low. Use of alternative fuels such as tyre-derived fuels and municipal solid waste has the potential to reduce CO₂ emission by 10-12%, as shown in Table 1. However, socio-economic issues such as transportation of waste are proving to be hurdles to these projects. Small energy-efficiency projects are difficult to register since the CER revenue generated is low compared with overall costs associated with the registration of such projects.

3.3 Reasons for the Lack of Penetration of Waste Heat/Gas Utilisation Projects in India's Cement Sector

Although a number of waste heat/gas utilisation projects have been registered in India in sectors such as iron and steel, the small amount of emission reductions obtainable in the cement production process discourages these types of project. The average expected annual emission reductions obtained from registered projects in the cement sector is approximately 80,000t-CO₂, while that for all sectors is approximately 200,000t-CO₂.

The reason for the lower emission reduction for cement production lines is considered to be that the temperature of waste heat from cement production lines is much lower than that in steel manufacturing. Also, the waste gases in the cement plants contain more particulates, which need to be removed before feeding the waste gases into the boiler. Therefore, the costs associated with the waste heat/gas utilisation projects is very high after factoring in the economic benefit of CERs, which results in a disincentive for project proponents to develop these type of projects.

China's government has promoted the installation of waste heat utilisation technology in cement plants under China's National Climate Change Programme (NDRC, 2007), and Japan has also contributed some, to aid in its dissemination. Use of this technology, together with the related equipment produced by Chinese companies, has resulted in halving the installation costs when compared with those of Japan (Ueno, 2009). Though blended cement technology¹ was native to India, waste heat utilisation technology, which was absent in India², requires transfer from foreign countries with experience in this technology. Moreover, this technology requires a huge capital outlay for installation. In view of these circumstances, almost all registered Chinese waste heat utilisation projects are developed with partners in Annex I countries under the Kyoto Protocol, while most projects in India are developed as unilateral projects. This level of support for waste heat utilisation technology in China has resulted in 135 projects in the country, while India has 6, out of the 157 waste heat utilisation projects under validation as of January 2011.

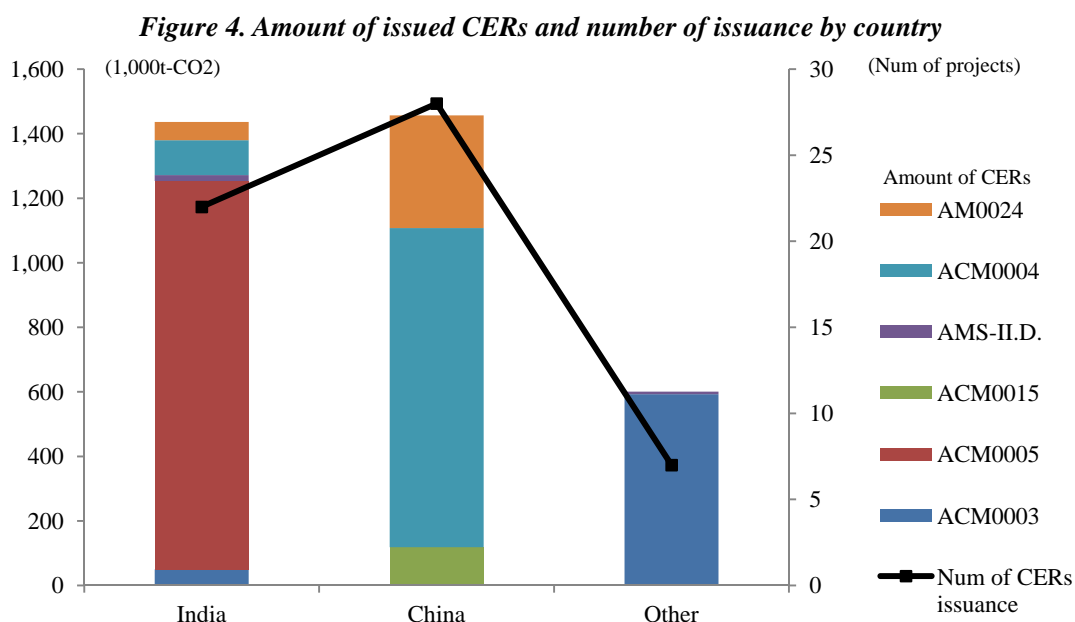
¹ Percentage of projects involving international technology transfer for this technology in India is 0% (Dechezlepretre et al. 2008). In this study, the rates of CDM projects involving international technology transfer are, respectively, 12%, 40% and 59% for India, Brazil and China.

² PDD of the second registered waste heat utilization project in India, entitled "India Cements WHR project" described there were no other cement plants using this technology, which was confirmed by the Cement Manufacturers' Association (The India Cements Ltd. and Agrinergy Ltd. 2006).

3.4 CER Issuance

As of January 2011, 3.5 million t of CERs had been issued from 38 cement projects throughout the world. China is leading with number of issuances while the total amount of CERs issued is almost the same for both China and India, as seen from Figure 4. This means that the amount of CERs per issuance is higher for India than China. This is because the monitoring period per CER issuance is over 2 and half years for Indian projects, while for Chinese projects it is about 8 months. Most of the Indian projects that received issuance were registered in the early era of CDM as validation for these projects started before 2006, and retroactive crediting was allowed for such projects. Therefore, such projects benefited from acquiring more CERs than projects validated after 2007.

Another reason why China has a smaller amount of CERs per issuance is that China received CERs mainly from waste heat utilisation projects, which generate smaller emission reductions than the blended cement projects, from which India obtained most of its CERs.



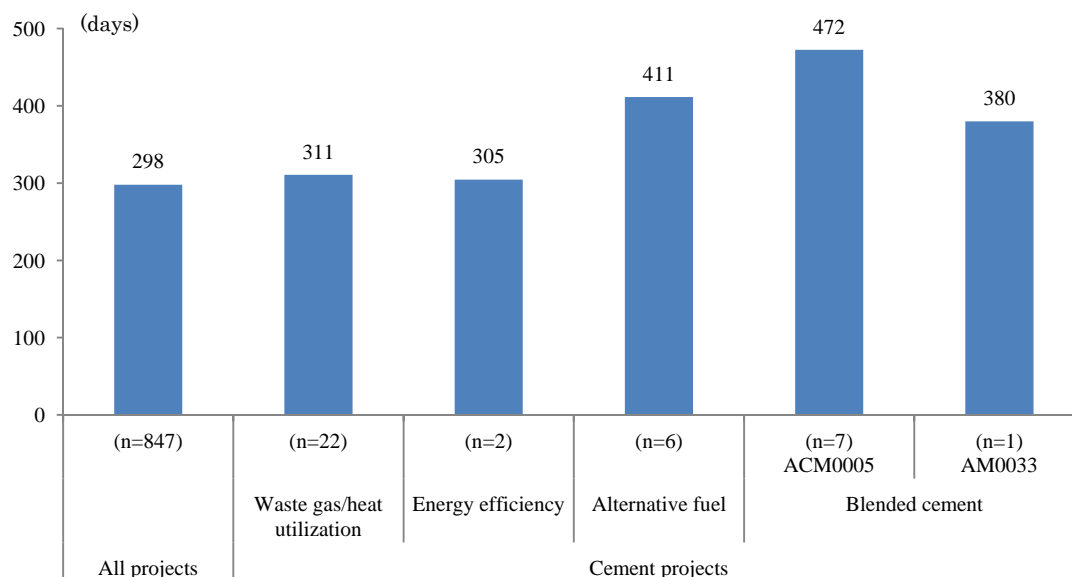
Source: IGES (2011a)

There are 14 projects out of 26 registered projects from the Indian cement sector which have not been issued CERs yet. The amount of time passed since the registration of these projects, (except for one), was 1,000 days as of 1 January 2011, while the average duration from registration to first issuance of all projects in the world is 500 days. There are 6 non-issued projects, which are those of blended cement based on ACM0005. As discussed in section 3.2, it is also a matter of concern that for ACM0005-registered projects, project activity emissions will surpass baseline emissions. If this imbalance occurs, emission reductions will be regarded as negative and any further CERs will only be issued when emission increases have been compensated for by subsequent emission reductions by project activities (UNFCCC, 2005a). For this reason, some of the non-issued blended cement projects dropped out from the CDM project cycle.

3.5 Status of Procedures for CER Issuance

On the whole, the duration for CER issuance for cement projects is longer than for others. Procedures for CER issuance include monitoring-report preparation by the project proponents, verification by Designated Operational Entities (DOE) and review and CER issuance by the CDM Executive Board. The average duration from the end of the monitoring period to first CER issuance for all types of projects in the world is 298 days, while cement projects take 358 days. Among the cement projects, the average duration for blended cement projects applying ACM0005 (all of which are from India) is 472 days as seen in Figure 5. Of the procedures, monitoring-report preparation and verification take especially long. As mentioned in section 3.4, one of the reasons for this could be that Indian projects require long monitoring periods. However, the monitoring methodology depends on the type of project, which is an issue. The monitoring methodology of ACM0005 requires many parameters to be monitored and calculated. For instance, Version 2 of methodology ACM0005 (which has 4 issued projects) requires 65 parameters to be monitored (UNFCCC, 2005b), which requires a tremendous amount of effort to collect the data, including even measuring for default values of the cement sector. This can impose economic burdens on project proponents in areas such as securing human resources, installation of calibration devices and obtaining specialised monitoring services. However, in the latest version of the methodology the number of parameters has been lowered³.

Figure 5. Average duration of procedures (from end of monitoring period to CER issuance) for the 1st CER issuance of issued projects



Source: IGES (2011a)

Alternative fuel projects using biomass also involve difficulties in monitoring. The Project Design Document (PDD) cannot precisely describe the project activity due to instability of yield amounts and price of biomass. The type of biomass available in a particular area depends on the

³ ACM0005 Version 5 requires 29 parameters monitored and 19 parameters not monitored (UNFCCC, 2009).

cropping pattern for the season and any other changes in the overall demand and supply of biomass in the area, which causes a deviation in the CDM project scenario and failure of CER issuance. According to a project proponent, it requires additional financial and human resources to request specialised institutions to establish the availability of biomass—a procedure required by the monitoring methodology. This requirement was set up for calculating leakage emissions in the monitoring methodology of ACM0003 (Emissions reduction through partial substitution of fossil fuels with alternative fuels or less carbon intensive fuels in cement manufacture) up to Version 4. However, it was eased from Version 5⁴.

Nevertheless, the benefits from such revisions in monitoring methodologies can only be availed by new project proponents.

3.6 Other Issues Related to CDM Project Development in India

There are a number of corollary issues which have been identified by Indian cement project proponents and which are related to specific circumstances in India and United Nations Framework Convention on Climate Change (UNFCCC) rules:

- (a) Country-specific consideration needs to be given to CDM projects by the UNFCCC. Most of the projects depend on site conditions. This being a variable, judging similar projects with a common yardstick will set difficult targets for certain projects. This would also avoid rejection of projects based on experiences in other countries.
- (b) The capacity of local DOEs is also an issue. Some DOEs do not understand the technical intricacies of projects and rigidly adhere to approved methodologies, providing no flexibility. Also, the DOEs are not of Indian origin. This causes further difficulty for the project proponents in terms of increased travel, time and money.
- (c) Designated National Authorities (DNAs) play an important role in CDM projects. The support given by the Indian DNA is limited compared to counterparts in China. The capacity-building activities in India need to be continued on a regular basis.
- (d) Due to non-availability of approved methodologies the project developers find it difficult to acquire CDM benefits in several projects. There are no incentives for developing methodologies for project developers because of high cost and time requirements. All these are barriers to CDM project development.
- (e) There are no direct communication channels between project developers and the UNFCCC secretariat. This results in significant delays in the project cycle since even small changes in PDD.
- (f) Complicated documentation requirements have become a major barrier for project proponents. The costs involved in the entire CDM project cycle, such as PDD development, validation and verification are also very high. Further, for large-scale methodologies, there is a requirement to

⁴ ACM0003 Version 4 required that the amount of alternative fuels available for the project is at least 1.5 times the amount required to meet the consumption of all users consuming the same alternative fuels, using reliable source and information. This measure was replaced with 3 new options in Version 5 (UNFCCC, 2006 and UNFCCC, 2007).

hire different DOEs for validation and verification, which makes the process cumbersome.

4. Proposals for Future Project Development

Indian cement project proponents were pioneers in developing the CDM projects and their experience, summarised below, provides much insight towards CDM reforms.

- Some of the issues regarding collecting data and leakage emission in monitoring methodology have been revised and improved. However, project proponents who previously implemented projects at the outset, particularly existing Indian project proponents, cannot obtain the benefits. The applied methodology cannot be changed after registration, even if the revised version is more useful for project proponents. It would therefore be helpful for existing project proponents to be allowed to choose the latest version of the methodology during the requisition for CER issuance. Under the present rule, revisions to the monitoring plan are allowed in cases in which the monitoring plan does not reflect the actual monitoring activity based on the registered PDD. Requests for revisions to monitoring plans are submitted by DOEs along with related opinions (UNFCCC, 2009c). In addition to this, if project proponents wish to adopt the latest version of the methodology they apply in a registration and obtain the DOE's endorsement for revisions to monitoring plans, requests need to be accepted.
- India has the top share of unilaterally developed CDM projects, which is one reason why it became a leading country in the early era of CDM. A small number of project proponents made decisions early, which aided in getting the lengthy CDM-related processes rolling. However, unilateral development of projects without external cooperation tended to involve overreliance on easily available technology, which limited the growth of some projects. Though adopting advanced technology is not easy, China has shown successful implementation of waste heat utilisation projects through use of technology not native to China. One of the keys to success in adopting foreign technology is cooperation with stakeholders, including technology providers and strong support from the government and equipment suppliers. International technology transfer is one of the CDM's objectives and as such should be utilised to a greater extent.

5. Conclusion

Taylor et al. (2006) project that cement demand in India will drastically increase and in 2050 will account for a quarter of global cement production, equal to China. This suggests that the Indian cement sector is not only economically promising but also requires more efforts in the area of emission reductions, as there is potential for CO₂ emission reductions. The CDM is thus presently underutilised in this sector.

Based on interviews with project proponents in India and the discussions outlined above, it has become apparent that there are issues concerning CDM rules and governmental support systems,

which need to be resolved. Blended cement, which previously acted as a booster technology for CDM projects in India's cement sector, is now common practice and difficult to further develop as a CDM project. On the other hand, waste heat utilisation technology, which is non-native to India, still has development potential. As it is difficult for project proponents to develop these types of projects by themselves, they need financial and technological support via international technology transfer. Further, in order to enhance CER issuance, it is needed to reform the rules of related monitoring methodologies. The availability of the latest revised methodology could prove useful and would offer project proponents an incentive to continue conducting CDM projects.

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