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

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1. Introduction

In India, demand for electricity is increasing significantly, along with its rapid growth of industry and population. To meet this demand while curbing greenhouse gas emissions, low-carbonisation of the power generation sector needs to be pursued via a multi-pronged approach. The CDM is one of such approaches, and IGES (Institute for Global Environmental Strategies), in corporation with TERI (The Energy and Resources Institute), has conducted consultations with project participants in the sector to support development of their CDM projects as part of their CDM capacity-building activities. Through these consultations, problems and challenges related to CDM project development in the Indian power generation sector have surfaced.

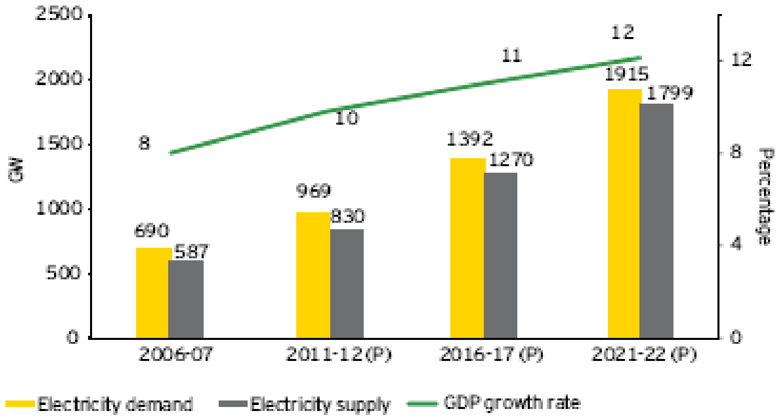
This paper aims to assess the reasons behind the current problems and offer possible mitigation measures, with the goal of further enhancing GHG emission reductions in India's power generation sector. The IGES CDM Project Database and IGES CDM Review/Rejected Project Database, in addition to up-to-date information acquired from the project participants, were utilised for this purpose. This paper focuses on thermal power plants, which are expected to maintain their dominance as the major source of power generation in India, and is structured as follows. The first part provides background information on the sector, such as the amounts of GHG emissions generated. The second part describes the current status of CDM project development in the sector, including registration, CER issuance, review and rejection. The third part lists the findings and proposals for enhancing GHG emission reduction projects in the sector, which is followed by a conclusion.

2. Background to the Power Generation Sector in India

2.1 Present Demand, Capacity and Generation

Electricity is a key component of infrastructure—it is inextricably linked to the economic growth and well-being of nations. In India, which is experiencing robust economic growth, energy demand is increasing at 8% per annum, a demand the power generation sector has kept pace with through a series of leaps and bounds since the start of planning. Nevertheless, a gap of over 100 GW in power supply-demand is expected to remain over the next decade, as shown in Figure 1. By 2012, India's annual energy requirement is expected to reach about 969,000 MWh, representing an increase of 40% since 2006-2007 (Bakshi, 2010). The current average per-capita consumption of electricity in India ranges between 620 to just over 704 kWh, which is much lower than that of other countries (such as the U.S., at 15,000 kWh, China at 1,800 kWh, and Europe, Australia and Japan). The world average stands at 2,300 kWh (Ministry of Finance, 2009).

Figure 1. All-India Forecast of Supply and Demand



Source: Bakshi, 2010

The total power generation in the country during the year 2009-10 was 771,173 MWh, whereas the installed capacity, as of July 2010, was 163,670 MW (Ministry of Power, 2010). As of 2007 India had the fifth largest capacity in the world, at about 4%, the rank and percentage of which are projected to remain the same in 2015. The top four countries, i.e., the U.S., Japan, China and Russia together account for about 40% of the global total installed capacity, which is projected to increase to about 50% (EIA, 2010).

Thermal power generation dominates the power sector in India, and has consistently accounted for over 64%, with coal maintaining its primacy as the source of energy generation. Coal-based thermal power plants account for 86,003 MW (53.3%) of the total installed capacity, as shown in Table 1 below. However, the share of thermal power of the total power generation has been progressively declining over the years, with the rise in hydro (24.7%), nuclear (2.9%) and other renewable energy sources (7.7%) as other major power generation sources (Ministry of Power, 2010).

Table 1. Contribution to the Total Installed Generating Capacity of India, by source (July 2010)

Fuel	MW	%
Total Thermal	104423.98	64.6
Coal	86,003.38	53.3
Gas	17,220.85	10.5
Oil	1,199.75	0.9
Hydro (Renewable)	36,953.40	24.7
Nuclear	4,560.00	2.9
Renewable Energy Sources *	16,429.42	7.7
Total	163669.80	

* Renewable Energy Sources include Small Hydro Projects, Biomass Gasifiers, Biomass Power, Urban & Industrial and Wind Energy
Source: Ministry of Power (2010)

2.2 Transmission and Distribution

In India, the installed transmission capacity is currently only 13% of the total installed generation capacity. The country is divided into five regional grids; North, Northeast, Southern, Eastern and Western regions, with each region comprising an interconnected transmission system. While the predominant technology for electricity transmission and distribution has been based on alternating current (AC) technology, high-voltage direct current (HVDC) technology has also been used to knit together all the regional grids for bulk, long-distance power transmission. With a focus on increasing the generation capacity over the next 8-10 years, corresponding investments in the transmission sector are also expected in the near-term (Infraline Energy, 2010).

Distribution is considered the weakest link in the Indian power sector due to the large energy losses incurred. Distribution losses occur on both sides of the energy meter—the utility side as well as the consumer side. While some progress has been made at reducing the Transmission and Distribution (T&D) losses, these still remain substantially higher than the global benchmark of approximately 33%. Globally, T&D losses are anywhere between 7 to 20% or more of the electricity generated, compared to 7 to 8% in North America and Europe to 15% or more in Central and South America (World Bank, 2010). In order to address some of the issues in this segment, reforms have been undertaken through unbundling the State Electricity Boards into separate generation, transmission and distribution units. Privatisation of power distribution has also been initiated (Infraline Energy, 2010).

2.3 GHG Emissions and Potential Areas of Reduction

India’s total GHG emissions increased by 58% between 1994 and 2007, from 1.2 billion to 1.9 billion t-CO_2, primarily resulting from the nearly doubled share of emissions from coal-based power generation. The power generation sector contributes to 37.8% of the total GHG emissions of the country and accounted for 719.30 million t-CO_2 in 2007, as against 355.03 million t-CO_2 in 1994, which represents an overall growth of around 102% (Ministry of Environment and Forests, 2010).

Further, the power generation sector of India is well poised for significant growth in the coming few decades as it holds 10% of the world’s coal reserves. It plans to add 78.7 GW to the power generation capacity during the five years ending March 2012, with most coming from coal, a growth that will inevitably expand its carbon footprint in the sector. According to projections, India’s GHG emissions could be anywhere between 4 and 7.3 billion tonnes in 2031, although per-capita emissions would still be half the global average. The reason for the typically high carbon-intensity profile of India’s power generation sector over the past few decades is due to the dominant use of low-efficiency fossil-fuel-based power generation technology—coal-based power generation via relatively low-efficiency sub-critical technology has dominated the generation mix for an extended period of time (Infraline Energy, 2010).

The ultimate goal for sustainable growth of the sector is a shift in energy profile from fossil fuel to renewable energy-based sources, thus emission reductions from coal-based power generation will be a key element in the short- and mid-term GHG mitigation strategy of India. Without doubt, the power generation sector of India needs to focus on reducing auxiliary consumption, by following new avenues of technology deployment and upgrading, and switching to supercritical/ advanced-supercritical power generation and other clean coal technologies.

However, there are several issues that hinder the implementation of above strategy. One is that power plants in India’s thermal power generation sector have to utilise very poor quality coal, the ash content of which varies from 35 to 45%, compared with around 15% for coal in other parts of the world (Ramachandran, 2008), which could be a limiting factor when considering future technology issues. The simple fact that there is very little washing of coal exacerbates the issue. Another problem this sector faces is the astounding level of financial losses it incurs, due to commercial theft, non-billing and poor metering. This issue needs to be dealt with in order to ensure future profitability of the industry and investment in technologies for higher energy efficiency or lower carbon intensity. Additionally, the extent of the financial investment required to enable the power generation sector to grow is a key constraint shaping the policies related to coal power. The installation of new power plants requires an enormous financial investment, both for the initial capital expenditure during construction and for operations and maintenance throughout the plant’s lifetime.

Another important economic factor to consider when choosing between various technologies is the cost of electricity generation (COE). Such financial constraints in the power generation sector mentioned above, particularly in the State Electricity Boards/Public Sector Units, naturally lead to consideration of technologies that produce electricity at the lowest cost; hence, cost of installation (primarily capital cost) and of operations and maintenance are key constraints to new technology development and deployment.

Last but not the least is the limiting factor of lack of indigenous technical capacity development and deployment—market pressure is the prevailing driving force, which usurps any concepts of self-reliance that existed in the past. Market-driven technologies generally favour commercial technologies with minimal capital investment and little regard for bolstering indigenous technology innovation capacity, thus a key constraint for the development and deployment of new technologies in India is the low level of innovative technological capacity, particularly in R&D – both in terms of expenditure and institutional support.

By providing economic incentives to reduce GHG emissions in project implementation, the CDM could overcome some of the issues described above and contribute to realisation of the potential GHG mitigation in the thermal power generation sector. Power generation based on higher efficiency technologies such as supercritical/ultra-supercritical technology, Integrated Gasification Combined Cycle (IGCC) and Fluidised Bed Combustion (FBC), renovation and modernisation (R&M), switching to fuels with a lower carbon-to-hydrogen ratio such as from coal to oil or natural gas, and from oil to natural gas, and cogeneration and combined cycle plants are some of the potential candidates for CDM in the sector. In the following section, the extent to which the CDM has succeeded in encouraging the utilisation of these technologies and measures, and reasons therefore, will be assessed.

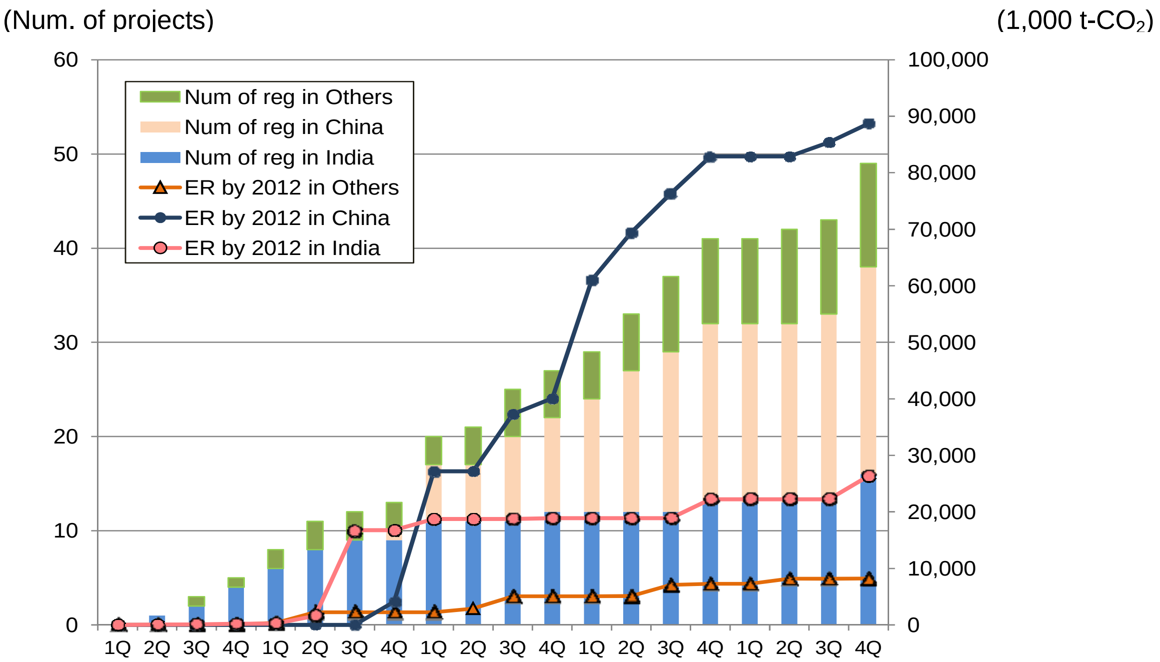
3. Current Status and Issues of CDM Projects of the Sector in India

3.1 Registered Projects

There are two types of CDM project implemented at grid-connected power plants[1]: energy efficiency and fuel switch. As of 1 January 2011, 49 projects in total had been registered with five different approved methodologies. Figure 2 is a chronology of the number of registered projects and their emission reductions expected by 2012. It shows that India pioneered project development in this sector and has the second largest number of projects after China.

Registered projects of the energy efficiency type mainly utilise waste heat to produce steam for a turbine (conversion to combined cycle). Others employ different measures to improve energy efficiency, including construction and operation of a supercritical coal fired power plant. Regarding the fuel switch type, almost all registered projects involve construction and operation of a new natural gas-fired grid-connected electricity generation plant. There is also one registered project involving fuel switch from coal and/or petroleum fuels to natural gas in an existing power plant. A brief description of registered project types and corresponding approved methodology, as well as number of registered projects in India and other countries are shown in Table 2, below.

Figure 2. Cumulative number of registered CDM projects and expected emission reductions in power generation sector in the world



Source: IGES (2011a).

[1] In this paper, projects of cogeneration, transmission and distribution, renewable energy power generation is excluded from analysis.

Table 2. Project types and the corresponding approved methodologies in power generation sector

Type	Details	Approved Methodology	Number of Registered Projects
Energy efficiency	Conversion from single cycle to combined cycle power generation	ACM0007	India: 0 Others: 4
	Measures to improve efficiency of fossil fuel power generating units	AMS-II.B.	India: 7 Others: 3
	Construction and operation of new power plant with higher energy efficiency (e.g., supercritical coal fired power plant)	ACM0013	India: 3 Others: 0
Fuel switch	Fuel switching from coal and/or petroleum fuels to natural gas in existing power plants	ACM0011	India: 0 Others: 1
	Construction and operation of a new natural gas fired power plant	AM0029	India: 6 Others: 25

Source: IGES (2011a).

India has a total of 16 registered projects in this sector, second to China which has 22. To date, India is the only host country to have registered projects of more than one type in the power generation sector, with seven energy efficiency projects using AMS-II.B, six fuel-switch projects using AM0029, and three using ACM0013. All the projects in China involve the construction and operation of new natural gas-fired power plants using AM0029 and the other 11 projects are each located in 11 different countries.

3.2 Prospect of Future Project Development

While there are no approved methodologies other than ACM0011 and AM0029 that can be applied to fuel-switch projects at power plants, there are seven approved methodologies in total for energy efficiency at power plants. However, project development will concentrate on projects applying ACM0013 and AM0029, both of which involve construction and operation of new power plants. ACM0013 is applicable to new power plants with higher energy efficiency and AM0029 to ones using alternative fuels. Table 3 and Figure 3 show that projects under validation in the power sector predominantly use AM0029 and ACM0013 and that India, followed by China, together account for the largest number of these projects and emission reductions in place up to 2020. The rapid increase in demand for electricity in these host countries can be considered as one of the major drivers in developing these greenfield projects. Regarding ACM0013, however, project development utilising certain technology, such as supercritical coal power plants, will likely be limited. As per the methodology, baseline emission will be the lowest value between i) the emission factor of the technology and fuel type identified as the most likely baseline scenario, and ii) the average emissions intensity of the top 15% performer power plants (UNFCCC, 2010). As the technology becomes more common and increasingly accounts for more of the top 15% performer power plants, emission reductions and thus the incentive to develop a project of the same technology diminish.

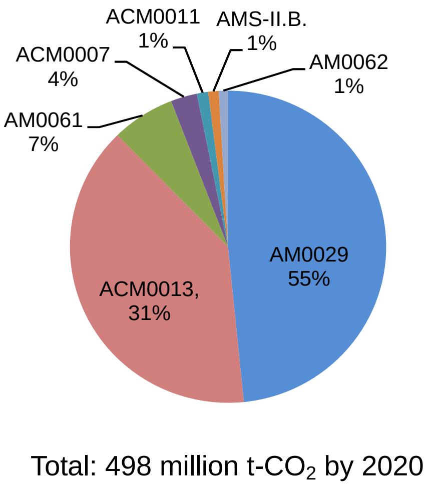
As opposed to greenfield projects, CDM project development in existing power plants such as those using ACM0007, AMS-II.B and ACM0011 is unlikely to proceed. Some of the possible reasons for this were identified through consultations with project participants in India. First of all, the latest energy-efficient technologies and equipment are not compatible with some of the older power plants with obsolete technologies and thus limit the possibility of developing projects at such existing power plants. While such plants have very low efficiencies, they cannot be shut down until either a replacement is built because of the severity of power shortages in India. Even with power plants that are relatively new and which utilise the newest technologies, proving additionality is becoming increasingly difficult with diminishing technological barriers to the application of energy-efficient technologies and changes in the baseline with rising market penetration of such technologies. Such circumstances are commonly experienced by other CDM host countries, especially emerging economies with burgeoning power industries that are making rapid improvements in related technologies. Further, the projects at existing plants require huge reinvestment—sometimes of a level comparable to that required to set up a completely new unit, making its implementation less attractive. Furthermore, for countries like India, which face serious power shortages as mentioned above, executing projects at existing power plants means shutting them down, which leads to further power crises. Project participants are thus likely to be reluctant to develop a project at an existing power plant.

Table 3. Number of projects under validation and expected emission reductions by 2020 in power generation sector

Approved methodology	Number of Projects under validation				Expected emission reductions by 2020 (t-CO_2) *			
	India	China	Others	Total	India	China	Others	Total
AM0029	18	8	11	37	137,416,407 (57%)	48,397,551 (20%)	53,779,794	241,069,729
ACM0013	14	9	4	27	148,680,883 (76%)	42,333,876 (22%)	4,609,004	195,623,763
ACM0007	0	1	6	7	0	2,047,050	11,300,939	13,347,989
AMS-II.B.	8	1	5	14	3,353,438	619,651	1,298,884	5,271,972
ACM0011	3	0	0	3	5,849,870	0	0	5,849,870
AM0061**	0	2	1	3	0	2,018,380	30,262,988	32,281,368
AM0062***	0	2	1	3	0	4,297,964	387,150	4,685,114
Total	**43**	**23**	**28**	**94**				**498,129,805**

Source: IGES (2011a).
* Based on IGES projections.
** Methodology for rehabilitation and/or energy efficiency improvement in existing power plants
***Energy efficiency improvements of a power plant through retrofitting turbines

Figure 3. Percentage of expected emission reductions from projects under validation by 2020 by approved methodology in power generation sector

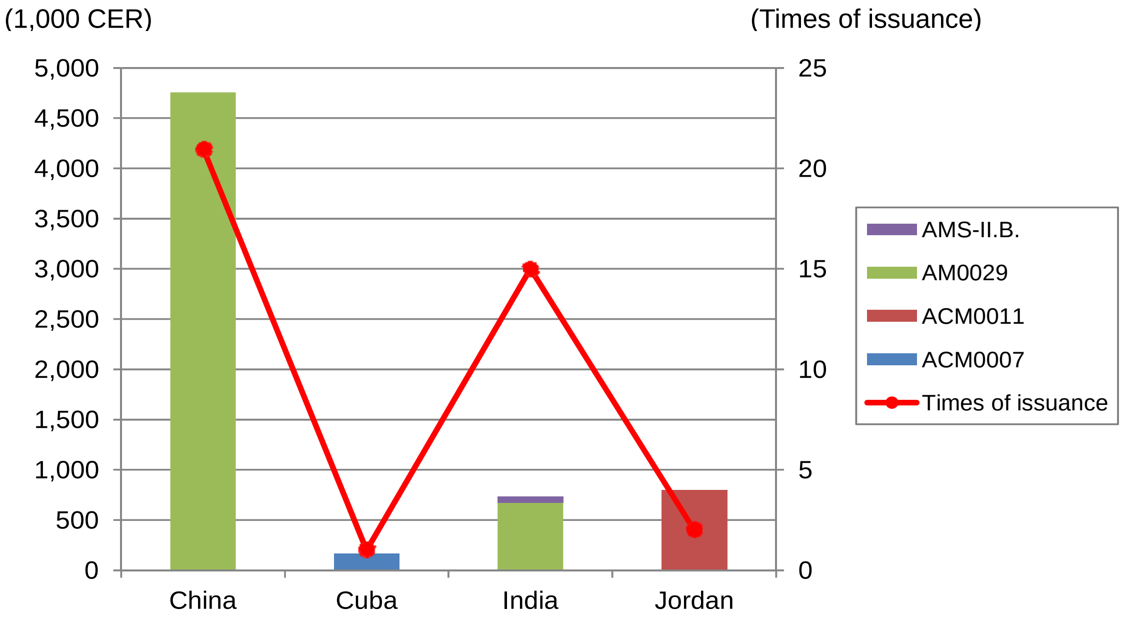


Source: IGES (2011a).

3.3 CER Issuance

As of 1 January 2011, about 6.5 million CERs had been issued in the world in the power generation sector. Most of the CERs were issued relatively recently, with about 90% in 2009 and after. Issuance was made 39 times in total from 22 projects, about 80% of which relates to projects using AM0029—construction and operation of new power plants using natural gas. As shown in Figure 4, the amount of CERs per issuance is particularly small in the case of India. While India accounts for about 40% of the total issuances, the amount of CERs issued is only 10% of the total. This can be attributed to the fact that the projects in India for which CERs have been issued are generally smaller than those in other host countries; the average installed capacity of power plants in projects using AM0029 with CER issuance is 699MW in India versus 383MW in China. Further, the monitoring period per issuance of these projects is longer for India than China (534 versus 219 days) and the issuance rate is about the same, 46% for India and 43% for China (IGES, 2011a).

Figure 4. Amount of issued CERs and times of issuance by country in power generation sector



Source: IGES (2011a).

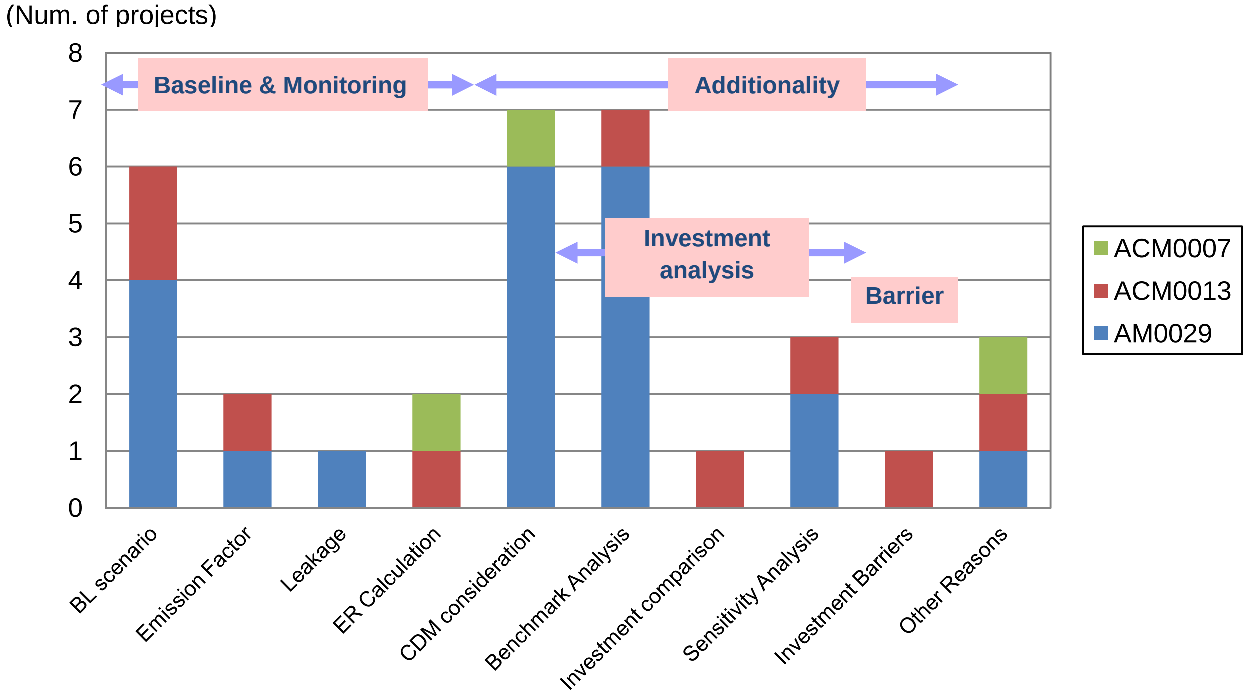
3.4 Review/Rejection for Registration and Its Reasons

Twenty of the projects registered in the power generation sector throughout the world have been reviewed, and five of these have been rejected. Figure 5 is a graph of frequency of reviews for each reason category in the power generation sector. India has three reviewed projects, one of which concerns AM0029; the other two concern ACM0013. For AM0029, the reason for review was unsuitability of the applied emission factor, which is a specific case for this project. One of the major reasons for review or rejection of projects of AM0029 in other countries, mostly China, is related to determination of the baseline, as shown in Figure 5. In particular, it was not sufficiently substantiated that the selected baseline scenario provides the same level of outputs and/or services as those of the project activity. While no AM0029-related projects have been reviewed for this reason in India, it should be considered as one of the bottlenecks in using this methodology. Since the above case only refers to greenfield projects, where there are no exiting activities to refer to, it is difficult to identify all the baseline scenario candidates available to not only project participants but also other stakeholders within the grid boundary as described in the methodology, and further, it is also difficult to demonstrate that the selected baseline provides the same level of outputs and/or services.

India is the only host country to have a project reviewed using ACM0013. Both of its two such projects are new grid-connected fossil fuel-fired power plants with a coal-fired supercritical boiler, and one of them was rejected as a result of the review. They were reviewed from both aspects of baseline and additionality, as shown in Figure 5, but the reason for rejection was related to additionality. That is, the project participant failed to substantiate that CDM revenue was essential to enabling the project and that an investment barrier existed. This reflects the concerns expressed by Indian project participants in the consultations that it is difficult to prove additionality for a new supercritical coal power plant project by investment analysis, and that there are barriers and uncertainties which hamper the development of such projects. For the power industry in India, which is in a state of profound financial loss, high initial cost is a significant barrier. In light of the capital-intensive nature of the implementation of supercritical coal power plants, the project participants face difficulties in reaching financial closure with lenders, and feel that more financial incentives (in terms of tariff support, etc.) should be provided by the domestic regulators and policymakers. There is also a situation-specific concern about the operation of supercritical coal power plants in India. This relates to the quality of domestically produced coal in India, which is poor due to the high ash content, requiring equipment such as boilers and steam generators specifically designed to operate with such coal, which further necessitates the training of staff and close operational monitoring.

To demonstrate additionality, under the current CDM rule, project participants can use either investment analysis or barrier analysis, or both if so wished (UNFCCC, 2008). However, investment analysis has tended to be more influential in proving additionality than barrier analysis, especially over the last few years. According to the IGES CDM Project Database as of 1 January 2010, 56% of the large-scale projects registered to date used only investment analysis. Since 1 January 2010, this figure has now risen to 78%. While investment analysis shows whether financial additionality exists or not – thereby in effect making it the most crucial element of information – it does not take into consideration the risks and barriers in preparation and operation of funds. Owing to this actual practice of demonstration of additionality, barriers, including country-specific ones, are not sufficiently evaluated.

Figure 5. Frequency of reviews conducted in power generation sector, by category of reason



Source: IGES (2011b).
*Projects can be reviewed and/or rejected for more than one reason.

3.5 Other Bottlenecks in the CDM Project Development Cycle

Consultations with project participants in India's power generation sector revealed that they have experienced difficulties with certain procedural and operational complexities of the CDM, in addition to the challenges and issues discussed above which are specific to the power generation sector. Project participants felt that the overall procedures involved with the CDM are too time-consuming, cost-intensive, inconsistent, lacking transparency and uncertain. Some of the issues relate to the capacity of Designated Operational Entities (DOEs), which validate proposed projects and verify GHG emission reductions. Some of the local DOE branches have little comprehension of the technical intricacies of projects, hence they simply follow the details given in the approved methodologies and are inflexible. Further, such DOEs are not from India itself, which causes further difficulty for project participants in terms of increased transaction and personnel costs. In addition, in the case of large-scale methodologies, there is a requirement to hire different DOEs for validation and verification, which makes the process cumbersome. Another major problem is the lack of a direct communication channel between project participants and the UNFCCC secretariat. This results in significant delays in the project cycle since even small changes in the Project Design Document (PDD), such as a change in contact person within the project participant, take a long time. There are also concerns about the effects of changes in the baseline and uncertainty surrounding the continuity of the CDM itself after 2012. These issues in total have the effect of weakening the prospects for further development of the CDM from potential project participants.

4. Issues Identified and Proposals for Future Project Development

Through consultations with project participants in India's power generation sector and from the discussions above, challenges to developing CDM projects in this sector were identified. Below are some proposals to enhance project development in India's power generation sector, both within and beyond the CDM scheme.

- India faces severe power shortages, which thus prohibits even very small power plants with outdated and inefficient technology from being shut down. Methodologies for construction and operation of new power plants such as ACM0013 and AM0029 would therefore be especially beneficial for the circumstances in India. By adding generation capacity, scrapping of old, low-efficiency power plants that would not benefit from application of new technologies could take place.

- While an eventual shift in India's power generation sector from fossil fuel-based to renewable energy sources is envisaged, it is inevitable to pursue emissions reduction from coal-based thermal power plants as a short- to mid-term strategy for GHG mitigation in India. ACM0013 could play an important role in this regard and supercritical coal power plant projects have actually been developed using this methodology. The development of such projects, however, is problematic in terms of proving additionality while barriers such as high capital costs remain. This is because more priority is placed on investment analysis—which has been in effect the main route for demonstrating additionality—than evaluation of such barriers. In addition, there are practical limits to CDM project development using this methodology. As per the methodology, the baseline can be based on the top 15% performing power plants and therefore the gap between baseline emissions and project emissions will close as more and more CDM projects with better performance are implemented, leading to less incentive for further CDM project development. Taking these facts into consideration, financial incentives provided by the government would be needed to continue development of supercritical coal power plants.

- CDM project development in the field of improving energy efficiency should be enhanced at existing power plants which are compatible with recent energy efficiency technologies. Project participants in India are increasingly facing difficulties in identifying appropriate energy efficiency technologies for developing CDM projects, which require support mechanisms including the CDM, to be disseminated into the market. Furthermore, on top of such barriers, certain technologies that are becoming more common can also make registration of CDM difficult. Under such circumstances, a certain level of reassurance could be provided to developers of CDM projects if a standardised baseline were to be applied in terms of determination of additionality via type of technology selected as a criteria. More concretely, criteria could be provided in the form of a list of eligible technologies for each energy efficiency methodology at existing power plants, and projects applying for such listed technology could automatically be considered as additional. This list would need to be updated periodically at EB meetings to reflect the current situation.

5. Conclusion

While thermal power generation is an important area to focus on in terms of GHG emission reductions in India, there are numerous difficulties in actual application of technologies and other measures. The CDM has, to some extent, contributed to the development of energy efficiency and fuel-switch projects in India's power generation sector. However, there are also certain types of projects which have not been or will not be able to fully utilise CDM, such as improvement of energy efficiency at existing power plants and construction and operation of new supercritical coal power plants. CDM energy-efficiency project development at existing power plants could, however, be enhanced by clarification of which technologies are eligible, but implementation of CDM for supercritical coal power plants is limited as expected emission reductions will decrease with further implementation of such projects. Modification of methodologies could overcome some of the specific difficulties in CDM project development in India's power generation sector, and, where project development is limited under CDM, a support scheme to provide incentives—financial in particular—should be put in place by the government.

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