Clean development mechanism in China: regional distribution and prospects

1. Introduction

In order to tackle climate change, the international community established the clean development mechanism (CDM) as one of the three flexible mechanisms under the 1997 Kyoto Protocol of the UN Framework Convention on Climate Change. It allows developed countries to provide financial and technology support for developing countries in greenhouse gas (GHG) emission reduction projects in exchange for certified emission reductions (CERs) which they can count against their own Kyoto targets benchmarked against their 1990 emission levels. From its beginnings, the mechanism was hindered by a lot of delays, political and organisational complexities, including the establishment and management of GHG inventories. It came officially into force in 2005 and since then a large number of CDM projects have been implemented across the globe. Four years later, in 2009 China became the global leader in attracting CDM projects and ever since has been the dominating player on this arena. This has contributed significantly to reducing the global GHG emissions and has also been supporting the country's transition to a low carbon economy. The CDM provides considerable joint benefits and motivation for a more sustainable development [13] and its significance and contribution were recognised in 2012 when its initial period (ending in December 2012) was extended to December 2020.

China is currently the world's top GHG emitter and its emission levels are expected to continue to increase with its growing per-capita energy consumption; however the country does not have any abatement obligations under the Kyoto Protocol. The country offers a lot of potential to the industrialised economies to locate CDM projects on its territory and an expanding number of international investors are interested in so doing, particularly as its government recognises their importance in mitigating climate change. By August 2011, over 3000 projects have been approved by the Chinese government [26] and by September 2012, this number was over 4400 [11]. The favourable policy environment for low carbon projects is also encouraged by China's commitment to 40-45% reduction (against the 2005 level) in its CO_2 emission intensity (per $GDP) by 2020. This represents a strong motivation for local governments and businesses to promote renewable energy projects. China's potential has been further enhanced by capacity building projects supported by organisations, such as the Asian Development Bank and UN, which enhanced its domestic capacity of engaging in CDM activities.

This paper investigates the progress made so far and explores issues related to future policy formulation. At the time of signing of the Kyoto Protocol, the international community had very little understanding as to how successful the CDM would be. It was difficult to predict the potential interest by investors from foreign and host countries, including government. The political, economic and business stability of the world and in individual countries is also something that could facilitate or impede the progress with CDM projects. A lot has happened between 2001, the first year when projects could be registered, and 2012, the end year of the first Kyoto commitment period. According to the World Bank, during this period CDM contributed towards a 1.5 billion tons reduction in carbon dioxide equivalent (CO_2e) [42]. However, not all countries and areas took advantage of these opportunities while China appears to be the one making the most of them. Can an analysis of CDM data help to understand the current trends and allow extrapolating into the future? Was China truly successful or were some provinces undermined in their aspirations for cleaner industrial development? What lessons can be learned from the first period as the world steps into Kyoto's new extension?

These are all issues that we attempt to explore after briefly examining previous research on CDM in Section 2. Section 3 describes the current implementation of CDM projects in China and compares the Chinese CDM market with global trends. The study then analyses the technological (Section 4) and regional distribution (Section 5) of the Chinese CDM projects. Finally, Section 6 sheds some light on the future prospects for China's CDM market.

2. Clean development mechanism (CDM)

The clean development mechanism is one of the three international cooperation mechanisms (the other two being international emissions trading and joint implementation) for GHG reduction, established under the Kyoto Protocol. It is also the only one that involves developing countries. The key stipulation of CDM is that developed countries cooperate with developing countries in providing financial support and technology to implement CDM projects on effective GHG reduction. The GHG CER volume from these projects is then used by developed countries to meet their Kyoto commitments. The Kyoto Protocol's CDM is under the management and supervision of the CDM Executive Board (CDM EB), which is authorised and guided by the Conference of the Parties (COP) serving as the Meeting of the Parties (MOP) to the Kyoto Protocol [38]. The intention of the Protocol is for developing countries to achieve environmental protection outcomes through the implementation of CDM projects approved by the EB. Most importantly, the mechanism allows for developing countries to become more energy efficient and sustainable in their production and consumption due to the adoption of new technology that has a lighter impact on the environment. Developed countries on the other hand can claim the emissions, which these CDM projects prevent from occurring in the hosting developing countries, to meet their emission reduction commitments under the Protocol. The CDM is regarded as a win-win cooperation mechanism because developed countries can dramatically reduce their domestic emissions while developing countries can obtain extra financial support and environmentally friendly technology [2]. However, the collaboration process can unfold smoothly only in the absence of disagreements and through the creation of opportunities for the developing countries to enter the new technological markets [20].

Despite being a relatively new phenomenon, there has already been a lot of research on CDM worldwide. Haites and Yamin [21] audited the key processes in CDM activities, starting with project eligibility and arranging of funding through to certification of emissions reductions achieved and use of a share of the proceeds to assist those developing countries that are most vulnerable to climate change. They concluded that there was "no one 'right' way of doing business under the CDM" [21:44] and its success would depend on the willingness of policy makers and the private sector to be practical and flexible in establishing a reliable and highly effective operating environment. Sutter [32] and Brown and Corbera [4] believe that CDM projects in principle aim to contribute for the sustainable development of the host country but in reality they encounter some major difficulties in their implementation and operation of technical nature, such as continuous sustainable biomass supply, as well as social acceptance, such as marginalisation of sectors of society. Matsuhashi et al. [26] analyse the volatility in the price of CER which impacts the countries supplying the technologies, and recommend diversification of investment as an effective way to suppress these risks. In other words, developed countries have many alternatives as to how to reduce their own GHG emissions and CDM is only one of them. They have the option to engage or not to engage with CDM activities depending on the

overall global and country-specific political, economic and social climate.

The US in particular did not ratify the Kyoto Protocol and the economic implications for its reluctance to participate in the CDM market are analysed by Dagoumas et al. [15] who show that this absence may in fact reduce the costs for the other developed countries. Much more criticism has been addressed to the mechanism because of its unpredictability and reliance on collaboration between disparate parties. The study by Olsen and Fenhann [30:2819] indicates "that left to the market forces, the CDM does not significantly contribute to sustainable development" because of the tendency to find cost efficient emission reductions. They emphasise that there is need for an international standard of sustainability assessment to counter weaknesses in existing systems of approval in individual host countries. For this purpose, they put forward a new taxonomy for sustainability assessment of small- and large-scale CDM projects and based on the analysis of the design documentation for 744 projects conclude that the most common benefits from the mechanism are employment generation, economic growth, better air quality, access to energy and welfare improvement.

While the international research community was still grasping to understand the real implications from CDM at a global, international and national level, the number of projects approved around the world continued to grow with China attracting the bulk of the investments. This also attracted the interest of the researchers. Chen [9] and Dai [14] analysed the development of the global and Chinese domestic markets for CDM projects and highlighted some potential risks related to the country's lack of experience in international negotiations. Zhang [44] examined major CDM capacity building projects with bilateral and multilateral technology donors, raising early concerns about China's management, regulation, institutional and implementation systems. The study argued for the establishing of streamlined and transparent CDM procedures as well as sound governance and regulatory changes that would attract more projects and allow more carbon credits to be generated from this country. Wang [40] further explored the management issues surrounding CDM implementation in China, while Ganapati and Liu [19] illustrated specifically the role of the Designated National Authority, set up to approve CDM projects, in ensuring the sustainable development in the country within the context of institutional structure, policy directions and the CDM market.

More recently Shin [31] observed that China's special domestic conditions, and the combination of governmental intervention and non-governmental participation, have significant impacts on the effectiveness of CDM projects implementation. Further studies include Teng and Zhang's [33] review of institutional arrangements to deal with risk and barriers faced by project sponsors; and Wang's [39] analysis of technology transfer, including issues of compatibility between CDM's institutional system, the Chinese domestic conditions and the international carbon market. Jia et al. [23] examined the impact CDM projects are having on China itself within the context of the latest policy imperatives to achieve a development that is not only economically sound but is also resource efficient and environmentally friendly. They concluded that the mechanism has played a major role in decreasing the emission intensity of carbon dioxide but also sulfur dioxide and industrial dust.

With the first commitment period of the Kyoto Protocol at its end, it is timely to analyse how CDM unfolded as a mechanism, what type of projects were generated and how the world and China benefited from this.

3. Global CDM activities and China

Since 2005 when the Kyoto Protocol became formally effective, many developed countries have been seeking opportunities to cooperate on CDM projects with developing countries. Within a short period of several years, the CDM market developed rapidly, its trade volume increased 62% between 2005 and 2007 and its trade turnover tripled [24, 40]. However in 2008 it slowed down, compared to 2007, its volume decreased by 30%, the relevant emission reduction turnover decreased by 12% and the CDM market volume in the global share of carbon market decreased from 18.5% in 2007 to 8% in 2008 [4, 5, 6]. This was due to the delay in the regulatory aspects of registration and the problems caused by the global financial crisis. The supply of CDM projects in 2009 was consequently limited [7] but since then the number of approved CDM projects has been growing quickly again. The year 2011 shows big fluctuations largely related to the uncertainties associated with the fact that the first commitment period of the Kyoto Protocol expires at the end of 2012 and the international community failed to reach an early agreement and commitment for the long-term future of CDM.

The average monthly number of CDM projects entering registration across the world over the December 2003 – October 2012 period is 103 projects, but the trend in new CDM projects presented in Figure 1 shows that many disturbing factors have had a large impact. Between 2004 and 2008, there has been an overall increasing trend but this was followed by a period of stagnation, most likely associated with the Global Financial Crisis, and a period of increase from the end of 2010. Since the second of 2012, the approach towards the end of Kyoto's first commitment period, the number of registered projects has been sharply on the decline. It is very hard to properly capture the complexity of political, economic, financial, business and risk management factors that have been influencing the uptake of CDM projects, by a statistical analysis of the limited data available. The two-month simple moving averages allow smoothing out of short-term fluctuations and highlights that the trend has remained highly dependent on factors influencing the external environment.

On the other hand, it can be seen that when there is less uncertainty, the business and technological community reacts in a very positive way to the uptake of new CDM projects. The international agreement to extend the Kyoto Protocol until 2020 [1] will no doubt give another push to the number of new CDM projects being approved. The success in negotiating the terms and conditions of this new agreement will no doubt reignite the interests by business investors and with the already existing management and certification framework we can expect a new upward trend in the near future.

[INSERT FIG.1 HERE]

The global trend in CERs is presented in Figure 2 and its strong upward slope shows that the mechanism has been a vital contributor to avoiding even faster GHG emission increases than the ones the world already witnessed between 2006 and 2012. Despite the lack of data to carry out any meaningful statistical analysis, the figures themselves are a convincing evidence about the contribution CDM is making. Against this background, it is easy to understand why the CDM was extended for a new 8-year commitment period.

[INSERT FIG.2 HERE]

Energy related technologies, namely new and renewable energy, energy efficiency and fuel conversion, represent the majority of CDM projects covering 78% of all approved projects in 2009 (see Figure 3). This is indicative of the type of activities that the industrialised countries are keen to be collaborating with the developing world. It does not necessarily represent the existing priorities in the latter but instead speaks about the opportunities for collaboration that the clean development mechanism generates. Clearly energy and energy efficiency technologies are winners within this process.

[INSERT FIG.3 HERE]

China has proven to be the most attractive location for CDM projects in the world (Figures 4 and 5) and as of 10 September 2012 is hosting 2310 projects representing more than 50% of the total registered projects and 64% of total annual CERs amounting to an annual reduction of 415,186,616 tons of CO_2e [9, 30]. In addition to helping the developed countries combat their GHG emissions, this also provides good opportunities for China to develop a low carbon economy [23].

[INSERT FIG.4 HERE]

[INSERT FIG.5 HERE]

China's CDM dominance developed gradually (see Table 1). In 2006, India was attracting the bulk of the projects (29% of the total) and the South American countries of Argentina, Guatemala and Mexico had the largest amounts of CERs. By 2008 India continued to host 29% of all CDM projects but China's share had already reached 27%. However, with many Chinese projects being large-scale, in this year the situation with CERs radically changed and China accounted for 54% of all certified emission reductions. As of September 2012, China is by far the largest world player according to both its share of the global CERs and number of CDM projects, followed by India (with respectively 11% and 19%) and Brazil (respectively 4% and 5%) [37].

[INSERT TABLE 1 HERE]

The sharp increase in the worldwide number of CDM projects and certified emissions confirms that the mechanism has been successful as an international tool. It plays a very important role in assisting developing countries in the transition towards a low carbon future and mitigating climate change [29]. China's attractiveness as a by-far preferred destination for CDM activities is due to a range of contributing economic, political and institutional factors. The country is proving to be the largest host country because of its fast economic development, open door investment policy, political stability, high educational and technological standards and reliable infrastructure.

In order to improve the efficiency of the CDM project application process, three years after the ratification of the Kyoto Protocol, China issued *Measures for Operation and Management of CDM Projects in China* – a document which provides clear descriptions of institutional arrangements, required documents, application procedures and CDM priority areas [21]. China also established national coordinating groups for climate change, CDM Designated National Authorities and projects auditing boards, which are responsible for

project application, auditing and management. The government further formulated a series of policies and regulations for the CDM market facilitating the process even more. Within just a few years, China's CDM market experienced a repaid development and maintained a sustained interest from investors ever since [28].

The very first CDM project in China was the Long Yuan wind farm project in Inner Mongolia registered in 2005 [34]. The massive location of CDM projects in China since shows the transformation of the country towards a low carbon economy with the help of the international community. Despite this, certain areas of the country, such as its western regions are still in need of development opportunities [23]. The section to follow presents a more detailed analysis of the types of projects and their location within China as supported by the institutional arrangements for the clean development mechanism.

4. CDM activities in China

The commitment and determination of the Chinese government to undertake CDM activities are manifested in the provided institutional support. In 2002, it established the National CDM Board (together with the CDM Designated National Authorities and projects auditing boards) and also reorganised the National Coordination Committee on Climate Change (NCCCC), which involves 8 key ministries and government departments. China also established 28 provincial CDM Service Centres, whose role is to enhance the awareness and interest of various CDM stakeholders at the local level. The two most important organisations in China are the National Development and Reform Commission (NDRC) and the Ministry of Science and Technology (MOST). They both exert strong coordination ensuring the implementation of CDM projects: NDRC is the pivotal governmental authority that regulates China's CDM activities and MOST influences the implementation and regulation of the CDM market.

In 2002, China also passed the Clean Production Promotion Law, which limits the carbon emission standards for oil, chemical and agricultural production. The adoption of this regulation is seen as the touchstone of China's energy saving and emission reduction strategy. In 2004, the government promulgated the Management Method for CDM Projects Implementation and in 2006, the China CDM National Guide was revised. A year later in June 2007, the State Council established a leadership group for energy saving and emission reduction and the National Climate Change Program was simultaneously released, accompanied by the Comprehensive Strategy on Energy Saving and Emission Reduction. In November 2007, a CDM founding management centre was established in Beijing, which is not only a new funding use mechanism, but also an action mechanism for energy saving. This was followed in March 2009 by the CDM-EB formally approving the accreditation of the Chinese designated operational entity (DOE), China Environmental United Certification Centre Co., Ltd (CEC). All these marked China's significant steps towards the CDM implementation. In 2011, the CDM-EB authorised the CEC to cover new sectors covering the entire range of potential technologies [12]. The CEC helps validate CDM project proposals and is responsible that they achieve the planned GHG emission reductions through the CDM implementation in China [7].

In order to formalise the financial and tax management of CDM, in 2009 China issued Finance and Tax Document No. 30 which clarifies related policies of tax deductions for CDM funding and CDM implementing organisations. In February 2012, before the first

commitment period for carbon reduction expires, China revised its Clean Production Promotion Law. The detailed measures include reducing packaging and resource consumption, strengthening the clean production auditing systems, restructuring the country's economic development model to achieve energy saving and emission reduction as well as clarifying responsibilities. Overall the country has positioned itself well to facilitate the implementation of any new commitment period irrespective of the surrounding uncertainties.

The institutional support provided at all levels has resulted in the firm uptake of CDM in China. Following the first approved project in 2004 and the standardisation and formulation of the series of policies and regulations, the Chinese CDM market developed fast. Figure 6 presents the trend in CDM projects approved by the Chinese Government in terms of actual numbers and certified emissions. In 2005, with only 18 projects approved the CDM market was still in an early developmental stage but in 2006, it grew quickly and 237 new projects were added. In 2007, the growth of the CDM market continued even more quickly; the number of the CDM projects approved in the third quarter alone was higher than the total for 2006 and the end of the year saw 773 new projects added. In all quarters of 2008, CDM projects were developing steadily, and a total of 769 projects were approved. The negative impacts of the global financial crisis and the uncertainty surrounding the international economic environment were felt in 2009 and 2010 with smaller numbers of new projects approved (419 and 355 respectively) but the upward trend resumed in 2011 with 957 new projects approved. The high approval rate continues in 2012 and overall the total number of approved CDM projects has reached more than 4,400.

The trend in the uptake of CDM projects is presented in Figure 6. It appears that as time goes on it becomes easier to register and approve projects in China. This can be explained with the constant improvements in the institutional framework as well as in the experience of investors and hosting parties.

[INSERT FIG.6 HERE]

The situation in China with the range of technologies supported by CDM in many ways resembles and influences the world trends (see Table 2 and Figure 3). The largest share (73%) of China's registered projects is in new and renewable energy. Most likely this is due to the relative easiness of the implementation methodology for renewable projects and the relatively lower need for specific technological knowledge and skills. Furthermore, in order to achieve a low carbon economy, China's government policies specifically encourage the country to consume new and renewable energy, and improve its energy efficiency and structure making the energy field a priority area for CDM approvals. Although considerably lower in numbers, energy saving and energy efficiency projects were the second largest technological area because of similar reasons, which are coupled with the implementation of the national energy saving and emission reduction plan that promotes energy conservation and improvement in energy efficiency.

The numbers of N_2O and HFC-23 decomposition projects were small, but their absolute and relative contributions to emission reduction were very high (see Table 2). What was needed to be done in many of these projects to achieve the larger volumes of CERs was to simply update the technology used. This was a major environmental contribution for the countries supplying the technologies; however, these projects are not very helpful in

increasing the employment levels and improving the environmental conditions in the host regions. Therefore the Chinese governments do not encourage them. The complexity of the methodology for the waste heat utilisation projects was a significant reason for their low uptake.

[INSERT TABLE 2 HERE]

5. Regional distribution of CDM projects in China

There is an uneven geographical distribution between different provinces in terms of approved CDM projects. According to NDRC [28], up to June 2011 over 38% of the approvals concentrated in five provinces: 327 in Yunnan, 283 in Sichuan, 223 in Inner Mongolia, 159 in Hunan and 156 in Gansu, which are all located in central and west China. This concentration can be explained with the fact that these provinces possess rich hydropower and wind power resources. The three municipalities of Beijing, Shanghai and Tianjin with their well-developed infrastructure and access to leading technologies, are ranked last (along with Tibet). This outcome confirms with the spirit of CDM to support sustainable development and encourage mutually beneficial transfer of appropriate technologies [2]. In doing so it offers technology transfer opportunities to the much poorer regions of the world to achieve a significant level of economic development and bridge the technological gap. The central and western regions of China with their less developed economies attracted over 70% of all projects and 62% of the total volume of CERs, which indicates the successful implementation of CDM projects.

Table 3 compares CDM projects and relevant CERs in the eastern, central and western regions of China. Projects in the three areas of new and renewable energy, energy efficiency improvement and methane to market account for 94% of the total and 74% of the relevant CERs in China. The new and renewable energy projects alone account for over 70% of the projects and over 50% of the CERs.

The east-west energy divide in China has been highlighted in previous research [13, 17, 43] and is also recognised by the national government. Industrialisation occurred earlier in the coastal parts of the country which have been responsible for higher levels of GHG emissions in the past. However, this is now changing with emission intensities falling consistently in places, such as Beijing, Tianjin and Shanghai [23]. There are also more pressure and higher expectations from these more developed provinces. For example, China's 2011-2015 12th Five-Year Plan stipulates for them numerical reductions targets of 17-18%, compared to an average of 16% for the country [11].

The area of HFC-23 decomposition, which has only 11 projects distributed mostly in the eastern region, represents 13% of total CERs. Unlike the economic development trend favouring east China, the development of the CDM market has been in the opposite direction with the CDM projects in the west accounting for 48% of total projects. However, the CERs of west China are approximately equal to that of east China which accounts for only 27% of the CDM projects. It is interesting to also mention that 7 out of the 49 CDM approvals in August 2011 cover unilateral projects [28] which is a sign of China's ability, willingness and ambition to tackle climate change.

[INSERT TABLE 3 HERE]

6. CDM prospects

China's fast and steady economic growth is attracting a lot of research attention [22, 41] and so is the country's exceptional performance in attracting CDM projects. The analysis of China's CDM market shows that on the one hand, there has been a steady interest and growth but on the other, there have been some hesitance and uncertainty in relation to the future of the Kyoto Protocol. We attempt to shed light on China's prospects in this environment and provide some policy suggestions.

6.1 Prospects for China's CDM market

The first Kyoto agreement expires at the end of 2012, but as the world has already invested a lot of human and financial resources as well as research methodologies, it was very difficult for CDM to be discontinued. As part of the Kyoto Protocol, CDM is a long-term mechanism that will play a constant role in the global market because it does not depend on the commitment period. Currently, the stakeholders in China's CDM market are mainly from the European Union and Japan whose regional emission trading systems are beneficial to the market development of international GHG emission rights.

Due to the relatively cheaper emission reduction costs of CDM compared with other mechanisms, China's role in the global market is becoming more important. Although the US attitude was not positive at the Copenhagen Climate Change Conference, on 26 June 2009 the American Clean Energy and Security Act (ACES Act) was passed by the US House of Representatives. It aims at establishing an economy-wide, GHG cap-and-trade system in order to tackle climate change [7]. The US has endeavoured to achieve a quantified target on reducing the intensity of CO_2 per unit of GDP in 2020 by 25% and in 2050 by 83% against the 2005 level. Despite the more advanced American emission reduction technology, it would be very expensive for this country to achieve its emission reduction targets. Due to the CDM's advantage of offering low costs alternatives for emission reduction in developing countries, in the near future US is expected to become a large potential player on the CDM market. China's major CDM partners are likely to soon be extended to include US.

It is likely that some sustainable development criteria for CDM will be applied in the future and the regulations in a new future Kyoto Protocol might be stricter. It may even be the case that developing countries are asked to also have certain commitments in emission reductions. China's National Development and Reform Commission (NDRC) is already preparing resources for the domestic buying market after the 2012 reduction commitment. From the perspective of marginal utility of GHG emission reduction, there is still considerable room for China to achieve more CERs. Therefore there are enough good reasons for the country to actively develop CDM projects.

6.2 Policy suggestions

The CDM implementation outcomes differ between developing and developed countries. The former need finance and technology and the latter pursue emission reduction. However, the original spirit of CDM is technology transfer, not financial investment and this should be taken seriously in consideration when developing countries plan to cooperate with developed countries. In fact, only a few of the previously approved Chinese CDM projects have involved real technology transfer. Therefore it is important that DOE

organisations and host countries encourage useful and practical CDM technology transfer. The following recommendations elaborate further on this issue:

Firstly, CDM implementation should consider regional resources, local industries and pollution levels and it should also contribute for regional infrastructural optimisation and energy structure adjustment. In addition, CDM implementation should be combined with imports and re-innovation because technology progress and innovation are not only the key factors for promoting energy saving and emission reduction, but are important methods for improving the local core competitiveness. During the regional GHG emission reduction and CDM implementation, a new methodology with Chinese technological characteristics and price advantages needs to be developed to achieve the respective tasks of emission reduction in the regions.

Secondly, the implementation of CDM should be in collaboration with the establishment of GHG trading markets. China needs to encourage strongly GHG trading markets and guarantee reasonable domestic GHG emission prices in order to prevent the country's emission index to become cheap goods in the international CDM markets that are taken by developed countries at low prices. Furthermore, the CDM implementation should be linked to the mechanism of contract energy management and capacity building. In fact, CDM in its capacity of a successful market operation mechanism can be used as a reference for contract energy management. This can play an important role in China's energy saving and emission reduction.

7. Conclusions

The analysis of China's CDM activities shows that the country is leading the global CDM market. This achievement is mainly credited to China's sound government guidance, reasonable organisational arrangements and positive capacity building at the macro and micro levels. The regional distribution of the CDM projects shows that the poorer western China hosts the largest number of projects. This trend is consistent with the CDM's main goal to assist less developed regions to achieve a more sustainable future. However the total amount of emission reductions in western China has not yet reached even half of that in the eastern region and this needs to be improved. In addition, China's CDM projects are highly concentrated in the area of new energy and renewable energy. The CDM mechanism should be used also to develop and encourage other types of projects, such as biomass power generation and improving energy efficiency which can help China achieve a more balanced sustainable development. There is a need for the central and local governments to provide policies that help abate this regional imbalance.

Despite the negotiated extension of the Kyoto Protocol, the future of the global CDM market remains uncertain. While the nations of the world are debating CO_2 emission responsibilities, an optimal allocation of reductions still remains only an area of theoretical interest [18]. The voice from the UN Climate Change Conferences of the Parties since Cancún in 2010 has not been impressively in favour of new emission reduction targets despite the Green Climate Fund (established in Durban in 2011 and to be based in the Republic of Korea) to offer financial support from developed to developing countries to tackle climate change. However, under pressure from the changing carbon market and increasing concerns about the deteriorating environment, the global importance and urgency of collaborative actions are recognised. The renewed Kyoto Protocol remains the

only legally binding agreement for combatting global warming but only 37 developed nations, accounting for 15% of GHG emissions, signed up to its extension.

China, as the top global emitter, is considered to be a significant player and is expected to have a vital role in cutting down the global GHG emissions, particularly through CDM projects. No matter what will be the prospects for China, both opportunities and challenges exist for the current and future owners of CDM projects. China should use its opportunities promptly by formulating more effective policies and regulations and developing quality new CDM projects to become a real winner in the global competitive CDM arena as well as in its transformation to a low carbon economy.

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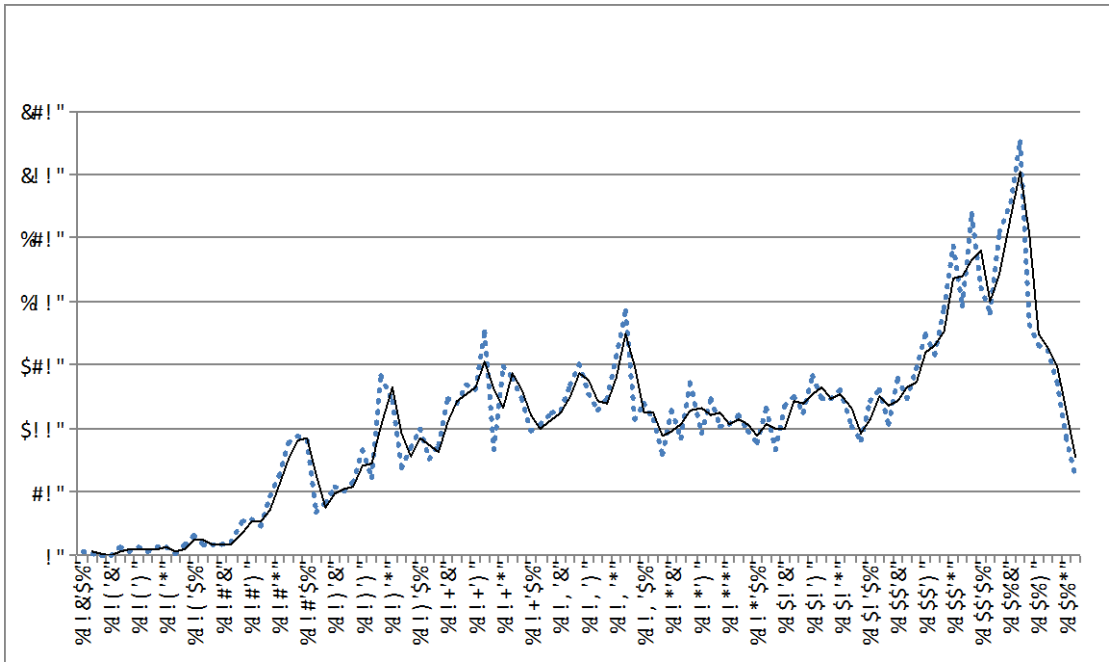

Source of data: http://cdm.unfccc.int/Statistics/img/ValidationFigures_2012_10.pdf

Fig. 1. CDM projects entering validation, as at 31 October 2012 (simple moving averages)

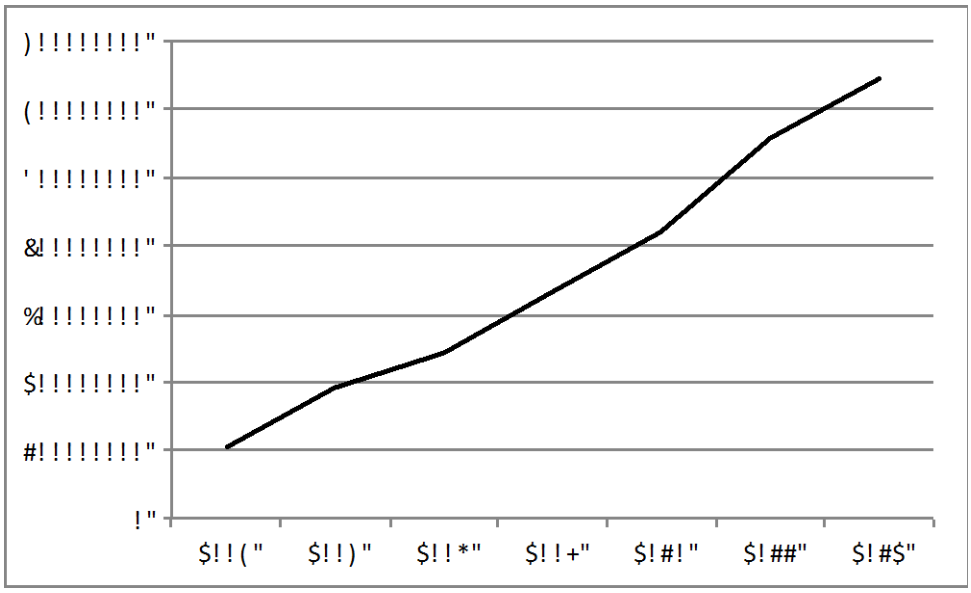

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Fig. 2. Average annual global CERs (tons), as at 30 August 2012

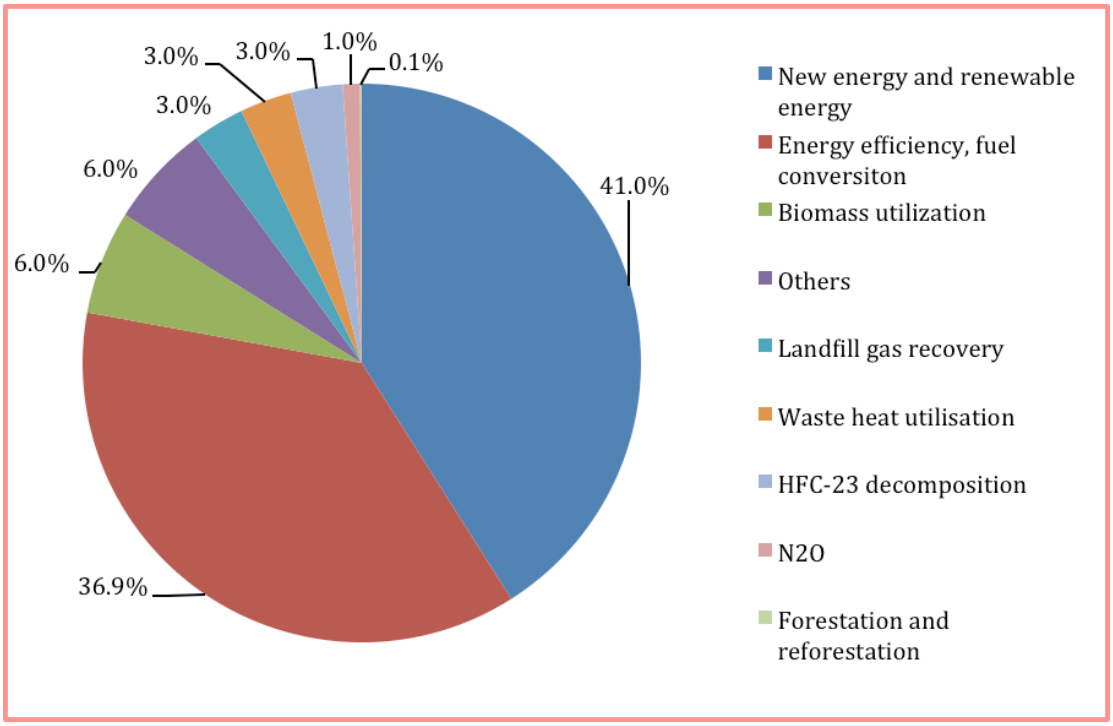

Fig. 3. Global registered CDM projects by emission reduction type, 2009

Source of data: [6]

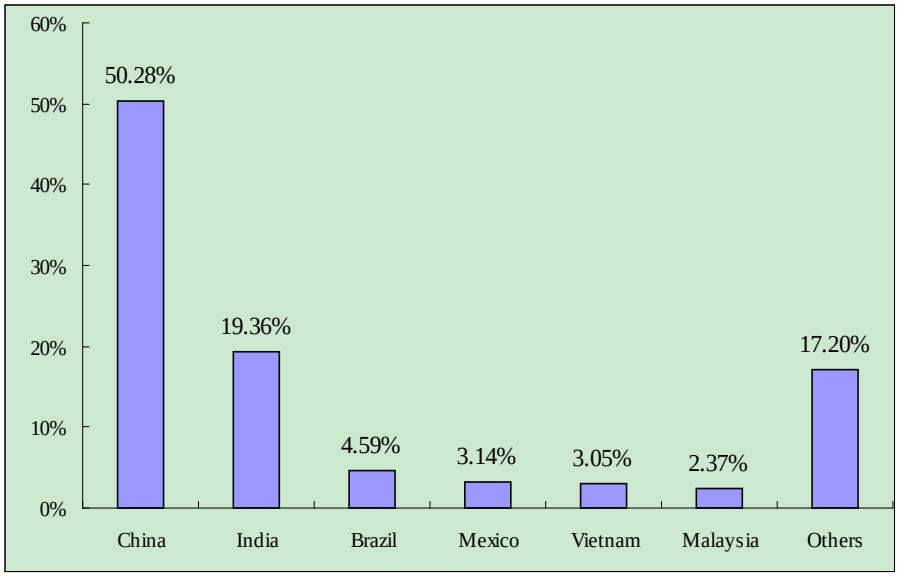

Fig. 4. Registered projects by host country

Source of data: [28] (http://cdm.ccchina.gov.cn/web/NewsInfo.asp?NewsId=6022)

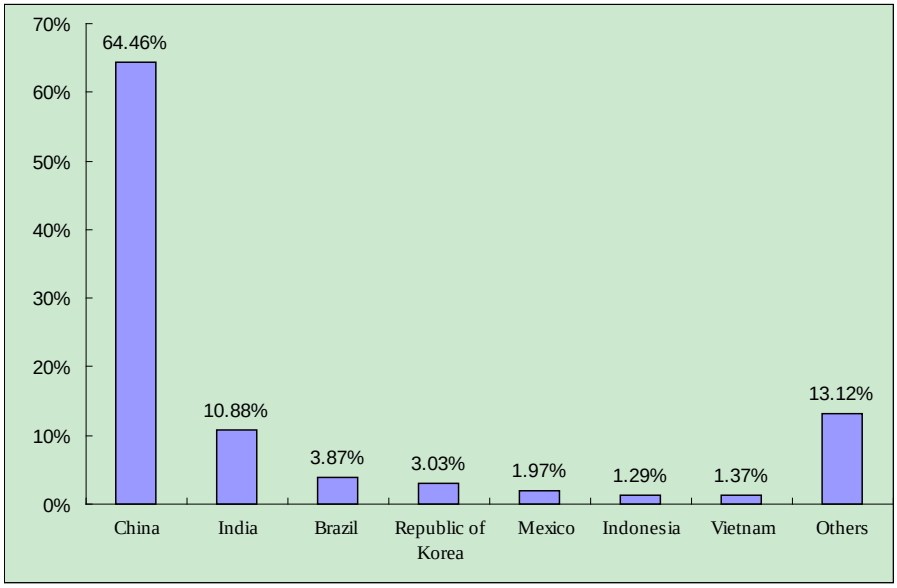

Fig. 5. Registered CERs by host country

Source of data: [28] (http://cdm.ccchina.gov.cn/web/NewsInfo.asp?NewsId=6022)

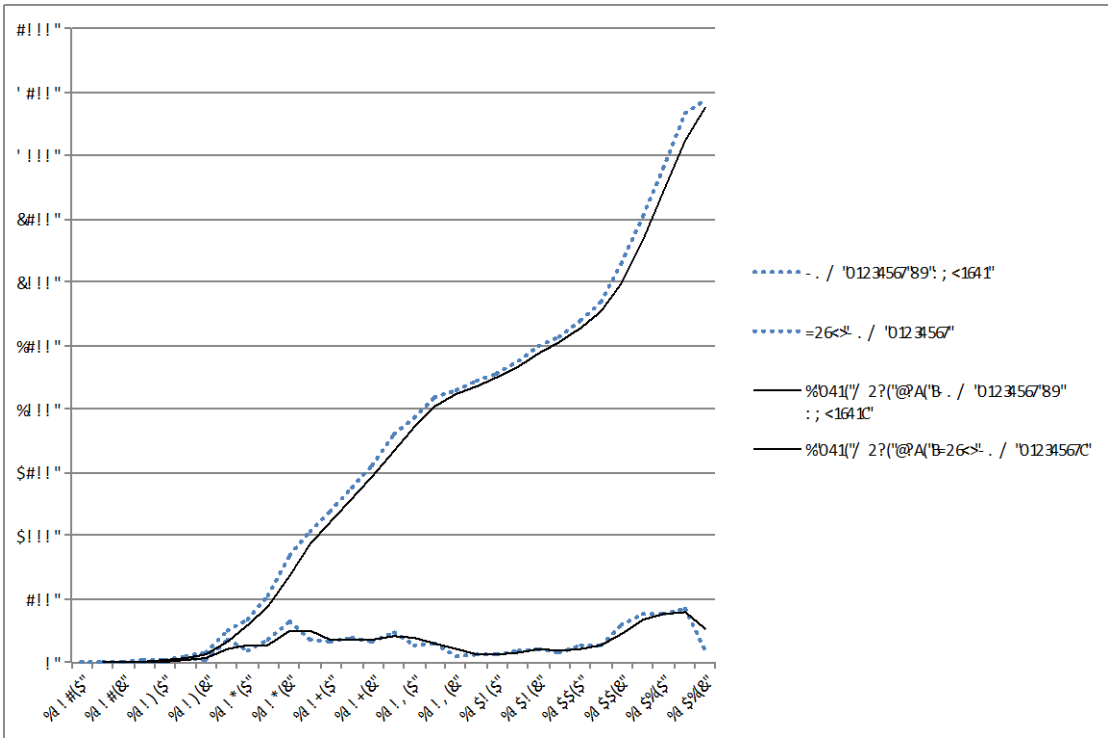

Fig. 6. Fig. 6. Approved CDM projects in China, 31 August 2012

Source of data: [28]

Table 1. Registered CDM projects activities in China, India, Brazil and Mexico

Country	**Number of Projects**			**World Share (%)**			**Average Annual CERs (10,000 tons)**			**World Share of Average annual CERs (%)**		
	2006	2009	2011	2006	2009	2011	2006	2009	2011	2006	2009	2011
China	33	616	1522	8	35	45	4604	18411	32087	44	59	63
India	125	450	707	29	25	21	1195	3600	5345	11	12	11
Brazil	80	160	194	19	9	6	1527	2070	2249	15	7	4
Mexico	63	117	129	15	7	4	4834	882	1046	5	3	2
World	428	1775	3355	100	100	100	10490	31161	50276	100	100	100 %

Source of data: [35, 36]

Table 2. Registered CDM projects in China by type, 2005-2009 and 2011

Emission Reduction Types	Projects number		Share of projects (%)		Estimated CERs(tons) tCO2e		Estimated emission reduction (%)	
	2005-2009	2011	2005-2009	2011	2005-2009	2011	2005-2009	2011
New energy and renewable energy	442	921	73.10%	81.00%	49948000	124349216.9	60.50%	60.50%
Energy saving and efficiency improvement	65	96	10.70%	8.40%	18542500	23128060	11.30%	11.30%
Methane recovery and utilisation	39	76	6.40%	6.70%	17846300	27615462.2	13.50%	13.50%
N_2O decomposition and elimination	25	14	4.10%	1.20%	24601000	8344219	4.10%	4.10%
Burning replacement	12	19	2.00%	1.70%	11726400	15283671	7.40%	7.40%
HFC-23	11	1	1.80%	0.10%	66798400	3656576	1.80%	1.80%

decomposition								
Refuse-burning power generation	4	3	0.70%	0.30%	1159800	958226	0.50%	0.50%
Forestation and reforestation	1	0	0.20%	0	20000	0	0%	0%
Others	6	7	1.00%	0.60%	1790300	1834809	0.90%	0.90%
Total	**1137**	**1137**	**100%**	**100%**	190642400	205170240	**100%**	**100%**

Source of data: [35, 36]

Table 3. Active CDM projects and CERs ($ktCO_2$) in China, June 2011

Project Type	East China		Central China		West China		Total	
	Projects	CERs	Projects	CERs	Projects	CERs	Projects	CERs
New and renewable energy	475	52398	402	43727	1252	169175	2129	265301
Energy saving and efficiency improvement	188	30244	204	31775	86	10893	478	72911
Methane recovery and utilisation	54	9440	105	36731	46	9309	205	55481
Alternative fuel	26	21733	15	2978	6	765	47	25476
Garbage burning power	21	6040	1	95	16	4737	38	10872
N_2O decomposition	8	12081	8	9094	12	4134	28	25308
HFC-23 decomposition	10	64733	/	/	1	2066	11	66798
Forestation and reforestation	1	1	/	/	3	116	4	117
Others	25	3408	12	1449	13	3087	50	7944
Total all types	808	200076	747	125849	1435	204282	2990	530208

Source of data: [28]