IEG Working Paper 2019/1

Changes in Carbon Markets and Regulatory Systems from Kyoto to Paris and How the World Bank Group Responded to these Changes

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Summary

This study provides a structured review of the existing literature on changes in international market mechanisms for greenhouse gas reductions and related regulatory systems. The assessment period 1997 to 2016 starts with the signing of the Kyoto Protocol and ends with the entry into force of the Paris Agreement. It can be differentiated into a period of emergence of market mechanisms until 2005, a "gold rush" from 2006 to 2011, a fragmentation of markets lasting until 2015, and a (brief) post-Paris period of "relaunch," of a new climate policy agreement. A key aspect of the review is how the World Bank Group responded to changes. The review includes about 300 peer-reviewed articles and about 40 articles from "gray literature" coming from highly-reputed sources. A large share of the literature examined covers the flexible mechanisms of the Kyoto Protocol with a strong focus on the Clean Development Mechanism (CDM). This is a consequence of the unexpected success of the CDM in the carbon market, at least until 2011–12, as well as the transparency of the mechanism that has facilitated research. As topics and issues related to the international carbon market emerged, the Bank Group tried to address them, focusing on developing countries to enhance their participation in the market. However, there is only limited peer-reviewed literature that assesses the Bank Group strategies and operations.

Key changes in markets and regulatory frameworks as well as the responses of the Bank Group can be grouped into four main periods that are briefly discussed below.

Emergence of Carbon Markets until 2005

This period is characterized by the introduction of market mechanisms as a climate change mitigation tool. Parties to the UNFCCC negotiated the definition of the flexible mechanisms that were included in the Kyoto Protocol (1997) and their operational rules and procedures that were included in the Marrakech Accords (2001). The operationalization of the CDM required the establishment of officially approved baseline and monitoring methodologies and piloting activities in different sectors. The nascent carbon market was characterized by the lack of demand, making the initial participation of the public sector crucial.

The Bank Group responded to these challenges by defining a new environmental strategy in the 1990s taking into account the establishment of UNFCCC and the need for mitigation activities. As the market instruments emerged, the Bank Group responded by establishing, first, the Prototype Carbon Fund and, then, other carbon funds (for example, Biocarbon Fund) that were seen as groundbreaking models for accessing low cost GHG emission reduction credits and aggregating demand. The Bank Group also supported the emergence of carbon markets through the development of CDM methodologies and capacity building for developing countries.

"Gold Rush" Period from 2006 to 2011

After the initial testing period, the carbon markets entered a phase of great expansion. This period is characterized by significant changes in markets and regulatory frameworks as the EU ETS became operational, in relation to implementation of the Kyoto Protocol for the period 2008–12 and was linked to the CDM creating a large source of demand for carbon credits from the private sector adding to the demand from other governments, for example, Japan. Large developing countries, China, India, Brazil, Mexico, and the Republic of Korea, became the largest suppliers of carbon credits. This raised concerns about the uneven distribution and limited participation of LDCs, on the project host side of the CDM. The introduction of the PoA concept was aimed at addressing this issue. In terms of the sectoral breakdown, the supply of carbon credits was initially dominated by industrial gas projects that provided low-cost GHG abatement opportunities but raised concerns about the integrity of these offset projects for creating perverse incentives and not contributing to sustainable development. In the second part of the "gold rush" period, regulation regarding assessment of CDM project additionality and verification was strengthened significantly, with validators and verifiers becoming more careful following suspensions of accreditations by the regulators due to low quality work.

The Bank Group continued its involvement in carbon markets through various funds (Umbrella Carbon Fund, Carbon Delivery Guarantee) and the IMF contributing to increasing demand for carbon credits, mitigating project risks and providing capacity building in developing countries to strengthen the carbon market. However, criticisms were raised regarding the Bank Group's carbon finance operations and its role in the carbon market, not prioritizing poverty alleviation and acting as a commercial intermediary, for example, by engaging in HFC-23 reduction projects. The Bank Group partially responded to these criticisms, by switching focus to specific sectors that, especially in the early period, have only marginally benefited from the carbon markets. This refers for instance to the Community Development Carbon Fund (CDCF), focusing on low-income countries and low-income communities and the Biocarbon Fund, targeting biodiversity protection.

Fragmentation and Decline of Carbon Markets in 2011–2015

This period is characterized by a sharp decline in carbon prices between 2011 and 2013 and a resulting decline in the development of new carbon projects. This is related to both domestic and international regulatory regimes. At the domestic level, the issuance of carbon credits started reaching the quantitative limits on the use of offsets in the EU ETS effectively eliminating the largest source of demand. The qualitative limits on the use of offsets introduced by the EU from 2013 therefore did not really matter. At the international level, the uncertainty surrounding the second

Kyoto Commitment Period resulted in decreased offset demand from Annex 1 governments.

The Bank Group responded to these changes in markets by continuing its efforts to support projects in LDCs through Ci-Dev focusing on underrepresented sectors, as well as innovative and transformational projects, including rural electrification, improved energy efficiency, and waste management. The Bank Group thus provided a lifeline to activities that otherwise would have been stalled given the market conditions. The Pilot Auction Facility targeted the non-bank-supported CDM methane project, which were at the risk of discontinuation. Finally, the Bank Group responded to the decline in international carbon markets by focusing on domestic carbon pricing initiatives through the Partnership for Market Readiness. Besides providing financial support to projects in the times of crisis, the Bank Group actively engaged in the policy dialogue to support regulatory reforms, notably the CDM Policy Dialogue.

Post-Paris Period of "Relaunch" of Market Mechanisms

The post-Paris period is characterized by significant changes in the international climate regime that will affect the development of carbon markets in the future. Unlike the Kyoto Protocol that only covered developed countries, the Paris Agreement adopted in 2015 involves global participation, which comes, however, at the cost of increasing complexity. Instead of a uniform formula of "carbon budgets," the Paris Agreement allows Parties to voluntarily define their Nationally Determined Contributions (NDCs) indicating the mitigation and adaptation targets for each Party. While the Paris Agreements includes provisions for market mechanisms through Articles 6.2 and 6.4, their modalities and procedures have not been adopted yet and the practical implementation remains uncertain. Principally, their scope could be upscaled to cover policy instruments or even entire sectors. While the international carbon market remains uncertain, an increasing number of domestic carbon pricing initiatives have been launched around the world in the past several years.

The Bank Group responded to these changes in the international regulatory framework by launching new initiatives to identify pilot activities for scaled up crediting in the context of the Paris Agreement, for example, TCAF, and to support the design and development of domestic carbon pricing initiatives, for example, the CPLC, the NCM and the PMR.

Overall, this literature review demonstrates that the Bank Group has contributed substantially to the establishment and development of the carbon market since the 1990s. Throughout this period it has remained a key player in this market; for capacity building; for supporting mitigation activities that has been at risk of being discontinued; and is likely to play an important role in the operationalization of market mechanisms under the Paris Agreement at both domestic and international

levels. The review found that several positive impacts have been generated by the Bank Group activities:

- Establishment of carbon funds that were seen as groundbreaking models for accessing low cost GHG emission reduction credits, aggregating demand and through the Bank Group ability to manage them.
- Focus on specific sectors that, especially in the early periods, have been only marginally benefited from the carbon markets. This refers for instance to the CDCF, focusing on low-income countries and low-income communities and the Biocarbon Fund, targeting biodiversity protection.
- The Bank Group was able to successfully deliver capacity building support to developing countries and to the market as a whole. It focused on mitigation project design, implementation and monitoring, including support for CDM methodology development and review.
- When the crisis of the carbon market erupted, Bank Group continued to support mitigation activities through the Ci-Dev initiative and the Pilot Auction Facility. Also, capacity building remained one of the main pillars of the World Bank's strategy: substantial efforts are put in supporting the development of new market mechanism approaches on the national level through the PMR and the CPCL.

However, criticisms have been raised regarding the Bank Group strategy and operations in the carbon markets. While the Bank Group's initial participation in these markets was seen as positive, questions have been raised regarding the Bank Group's role in the carbon market. One issue of concern is that the Bank Group has to a large extent acted as a commercial intermediary, rather than supporting market development and capacity building. Concerns have been raised also regarding the Bank Group's contribution to poverty eradication, one of the key goals of the Bank Group, through carbon markets. In other cases, researchers highlight the risk of Bank Group–supported projects in the forestry sector regarding environmental integrity, permanence of the carbon sinks, adverse impacts for indigenous peoples and leakage issues.

1. Introduction

As the international community embarked on practical actions for combating climate change, it will need to use the full range of instruments—including market-based instruments. One of these instruments was the emergence of the carbon markets which has been facilitated using carbon finance. The emergence of the international carbon markets in the early 2000s was indeed an important development for the implementation of the GHG emission reduction targets committed under the Kyoto Protocol. The supply of low-cost carbon credits through the carbon markets linked to the flexible mechanisms of the Kyoto protocol provided impetus to the countries with commitments to work toward reaching their targets. While the creation of the carbon markets has opened unprecedented opportunities for global climate mitigation and sustainable development in host countries, it faced multiple technical, administrative and regulatory challenges. The World Bank Group was one of the first movers for creating carbon markets and has launched various initiatives to support international regulatory entities established under the UNFCCC in their efforts to reduce market risks and transaction costs and enhance efficiency and effectiveness of these markets.

The objective of this particular study is to review the existing literature and evidence on changes in international market mechanisms and related regulatory systems for climate change mitigation. The review also identifies the main responses of the Bank Group to address the market and regulatory challenges under the different phases. The review uses IEG's Structured Literature Review (SLR) protocol. The search criteria, procedures, the search results as well as number of selected materials from review from journals and from other sources used in the SLR is presented in appendixes A–C. In terms of period of coverage, the assessment starts with the signing of the Kyoto Protocol, in 1997, and ends with the entry into force of the Paris Agreement in late 2016. The review identified four periods in the evolution of markets and regulatory systems: the emergence of market mechanisms until 2005; a "gold rush" period from 2006 to 2011; a period dominated by the fragmentation of markets and lasting until 2015; and the post-Paris period, for "relaunch" of carbon markets.

A key aspect of the review is to perform an analysis of the role of the World Bank Group (Bank Group) in this process: how the Bank Group influenced the development of the market mechanisms, methodologies and investment practices (through the CDM and JI); how it responded to changes and challenges arising over this development period; and what can be considered to be the legacy of the Bank Group by the end of the period.

to ensure the high quality of the review, the literature review follows approaches normally used by the IPCC. Peer-reviewed literature will therefore be the backbone

while non-peer-reviewed sources will only be used if they are published by an institution that has credible internal quality control process. Evaluating the quality of "gray" literature is outside the scope of the assignment. Literature coming neither from peer-reviewed publications nor published by institutions with a credible internal quality assessment procedure was excluded.

As a next step, we scanned through the abstracts of the retained papers and extracted key messages. Using expert review of the abstracts, about 300 peer-reviewed articles were retained in addition to about 40 papers from "gray literature."

The remainder of the report presents the findings using a synthetic narrative along the four stages in the evolution of carbon markets: emergence, "gold rush," fragmentation, and post-Paris perspectives. Specifically, for each of the four stages we discuss three components: (i) main features of the period, (ii) key market and regulatory challenges and (iii) how the World Bank responded to these challenges. The report then concludes with remarks highlighting key evidence, lessons and implications for the future regarding the role of market mechanisms in implementing the Paris Agreement.

2. The Emergence of Carbon Markets: Pre-2005

Main Features of the Period: Conception and Emergence of Carbon Markets

At the Origins: The UNFCCC and the Kyoto Protocol

The concept of carbon markets emerged in the 1990s. The starting point was Article 4.2 of the UN Framework Convention on Climate Change (UNFCCC) with its rule on "Joint Implementation" (JI) for greenhouse gas mitigation by several countries. This was seen as a window to develop market mechanisms by several European and North American countries. An early assessment of the U.S. Initiative on JI (IJI), for instance, elaborated on the experience with 31 pilot projects in South-East Asia (for example, carbon sequestration in Indonesia through reduced impact logging, and rural electrification in Sri Lanka), and derived recommendations for market mechanisms (Dixon 1998). Given opposing views between developing and industrialized countries on whether such mechanisms made sense COP 1 in 1995 decided to start a pilot phase of the "Activities Implemented Jointly" (AIJ) lasting until 2000 without generation of emission credits. This allowed countries to test different market mechanism design options (see Dutschke and Michaelowa, (2003) for Costa Rica, which was a pioneering host country, and Springer (2003) for the Swedish approach to invest in the Baltic states). Costa Rica was the first developing country to implement AIJ in several sectors including conservation, reforestation and renewable energy (wind and hydro). An assessment of 11 AIJ projects from the Swedish pilot program (energy efficiency and renewable energy in the Baltic countries) showed that project implementation costs were higher than projected, while GHG emission reductions were lower than ex ante estimations. It was also suggested that such project risks can be mitigated by carbon funds through aggregation of demand (Springer 2003).

While the economic rationale for industrialized countries to invest in activities in developing countries due to lower mitigation costs was not challenged, Zhang (1997) and Swisher, (1997) identified various benefits and risks for developing countries. Presaging debates that fully erupted in the 2010s, some authors (Michaelowa and Schmidt 1997) supported carbon crediting[1] for JI to ensure efficient mitigation in the short term and mobilize technology transfer but proposed to progressively reduce the crediting in the long term to ensure innovation and research and development on low-carbon technologies/measures through increasing domestic carbon prices.

The Kyoto Protocol (KP), adopted in 1997, set GHG emissions reduction targets for 38 industrialized countries and economies in transition (EIT) – Annex B Parties to the Protocol. These mitigation targets were defined through emissions allowances – assigned amount units (AAUs) – allocated to countries. to maximize the economic

efficiency of achieving their emission targets, Annex B Parties were allowed to use three flexible mechanisms.[2] They could exchange AAUs through international emissions trading (IET) and use carbon credits resulting from emissions reduction projects – Joint Implementation (JI) in Annex B countries (generating ERUs) and the Clean Development Mechanism (CDM) in non-Annex B countries (generating CERs) (Shishlov et al. 2016).[3] The CDM arose from the Brazilian Proposal's Clean Development Fund, and the concept was developed jointly by Brazil and the United States in the weeks preceding the Kyoto Conference of Parties in 1997. G-77 countries and China pushed the Annex B countries to comply with their mitigation goal and accepted the CDM as an alternative mean of compliance (Cole 2012).

Expected Benefits and Challenges to International Carbon Markets

In the late 1990s and early 2000s, many researchers foresaw significant benefits of the flexible mechanisms of the Kyoto Protocol. Jepma and Van Der Gaast (2003) stressed the potential of the three flexible mechanisms (IET, JI and the CDM) to achieve considerable mitigation cost savings and foster a multibillion-dollar market for carbon credits, depending on content of the COP decisions; possibility to carry over AAUs, CERs and ERUs beyond 2012; and participation of the United States in the carbon market (Chen 2003).[4] The size of the carbon market would be driven by Annex I demand, on the one hand, and institutional barriers in host countries, on the other (Michaelowa and Jotzo 2005). The CDM was seen as a cost-effective tool to achieve mitigation, effectively support dissemination of renewable energy (RE) technologies in developing countries (Duic et al. 2003), provided that problems arising from inflated baselines, additionality and carbon leakage[5] when using this mechanism are avoided (Bollen et al. 1999). Dutschke and Michaelowa (2003) emphasized the need for sufficient economic incentives for investors from developed countries investing in CDM projects in developing countries, since the carbon credit price has a strong impact on the economics of different CDM projects (Shrestha and Shrestha 2004). For example, an early assessment of the power sector in Sri Lanka, Thailand, and Vietnam, (Shrestha 2004) concluded that CER prices of $4-5 per tCo2e would support fuel switch from coal to gas and oil but were insufficient to mobilize renewable energy (RE).

to maximize their potential benefits from this mechanism, the non-Annex I countries should participate more actively in the rule design process for the flexible mechanisms (Painuly 2001). With regards to compliance costs, a combination of different carbon pricing mechanisms, based on the case of Germany, was explored. JI combined with an environmental tax reform could reduce overall costs as compared with the tax reform alone, as JI would reduce the level of tax needed to reach mitigation targets domestically (Böhringer et al. 2003). Other researchers highlighted capacity building and technology transfer benefits of the mechanisms, as well as co-benefits for biodiversity protection (Fehse 2003).

In terms of the geographical potential, China emerged as potential frontrunner due to the high carbon intensity of the power sector and large potential for improving energy efficiency (EE) (Vrolijk and Jinze 2005). An improved institutional set up and increasing awareness could help further increase attractiveness of Chinese CDM activities (Zeng and Yan 2005). This highlights the importance of factors that are not only related to investment costs or potential for mitigation but that affect attractiveness of CDM activities.

Key Market and Regulatory Challenges in This Period

In the phase of emergence of the mechanisms, concerns were raised regarding low demand and low credit prices (Jotzo and Michaelowa 2002). Specific challenges of the CDM and JI identified by the early literature include the need to generate sustainable development (SD) benefits, and also the need for capacity building and data collection (Begg et al. 2001). Carbon leakage and the need for monitoring, reporting and verification (MRV) were also identified as relevant issues, regardless of the specific sector of implementation, to be explored in detail (Chomitz 2002; Geres and Michaelowa 2002). The risk that "hot air,"[6] that is, surpluses of the domestic emissions budget could be "laundered" through JI was raised early on (Bollen et al. 1999; Jotzo and Michaelowa 2002). For the CDM, multinational corporations could artificially argue that baseline investments would be highly carbon-intensive to maximize credits (Schreuder and Sherry 2001). A solution for that problem would be clear rules for baseline determination to ensure environmental integrity (Dutschke and Michaelowa 2003). These topics are further discussed below.

Generic Project Risks

CDM investments in developing countries aim at cheap emission reductions, but in many cases, they have to face a difficult business climate, that is, functioning of the institutions, regulatory systems and political stability (Fankhauser and Lavric 2003). Methodological issues regarding the rules of the CDM/JI increased risks for investors in carbon projects, and diversification tools were therefore suggested to manage these risks. In some views (Springer 2003) reduction of project risks, that is, technical, political and economic, was to be achieved through diversification and thus carbon funds could be effective in reducing private company risks. More sophisticated financial products, such as call options for buyers and sellers of carbon credits, were suggested (Tucker 2001) as another option. Initial uncertainty and lack of precedents on carbon transactions also led to concerns that legal disputes could become frequent (Brown 2003).

Contribution to Sustainable Development (SD)

While the CDM can be an effective tool to lower emission reduction costs, it does not necessarily lead to the maximization of social and environmental development

benefits in host countries (Motta 2003). Projects would need to strike a balance between aspiration to deliver SD benefits and their economic rationale (Fichtner et al. 2002; Kim 2004). Contribution to SD of the CDM thus became one of the main challenges to the mechanism from the outset.

Additionality and Baselines

Two of the key regulatory elements of the Kyoto Mechanisms discussed in the literature are baseline and additionality determination (Gustavsson et al. 2000; de Coninck and van der Linden 2003). Inflated baselines result when project hosts are able to exaggerate the "baseline" or starting point for calculating the amount of creditable emissions reductions. Such perverse incentives leading to overestimation of baselines to maximize emission reductions potential lead to difficulties in identifying credible baselines (Anagnostopoulos et al. 2003). An "additionality" problem follows when an emissions reduction project would have been implemented even without support from CDM credit payments – if so the project is not additional, does not contribute to emissions reduction in the respective host country, and should not receive credit. When these problems occur, global emissions are led to increase via these mechanisms: countries with commitments are given permission to increase their emissions (within the bounds of their emissions reduction targets), while less than equivalent emissions reductions take place in low-income countries.

In the context of project-based mechanisms, the "baseline" is the reference scenario that is identified as the most likely in absence of the proposed project, and against which emission reduction can be claimed. Illum and Meyer (2004) stressed that project-based activities could only be seen as additional if the baseline was referring to the national energy system where the project is implemented, capturing the real impacts of other projects implemented in the same energy system. Thus, a broader sectoral baseline was proposed. Inappropriate baseline settings ultimately lead to either missing "good" emission reductions opportunities that meet additionality requirements or to compromising the environmental integrity (Zhang et al. 2005).

As indicated above, the additionality concept indicates that the project would not have occurred in the absence of the revenue from sale of the emission credits. This concept become one of the most contested issues for CDM activities starting from this initial period. Case studies from the power sector in non-Annex I countries in 2001 highlighted the high risk for crediting activities that would be implemented anyway, also in the absence of the CDM, that is, nonadditional projects, which called for the definition of strong rules on additionality to ensure environmental integrity (Bernow et al. 2001). An assessment of 37 early CDM and 12 JI projects raised concerns on consistency and additionality (de Coninck and van der Linden 2003).

Transaction Costs

Developing the project documentation, especially regarding additionality determination and baseline setting as well as third-party validation and verification, were seen to generate transaction costs that could limit the scope of the CDM (Jotzo and Michaelowa 2002). Small-scale projects were found to have disproportionally higher transaction costs, and special rules for such projects were therefore suggested as a potential solution (Spalding-Fecher et al. 2002; Michaelowa et al. 2003). Simplified rules and procedures were subsequently introduced from COP7 in Montreal, 2005 onward (UNFCCC 2006).

The Inclusion of Forestry Activities

Many researchers supported the inclusion of forestry under the CDM and JI, to unlock the mitigation potential in this sector, especially through reduced logging and deforestation (Olschewski and Benitez 2005; Osborne and Kiker 2005). The following main benefits were identified: high mitigation potential in terms of delivering large volumes of emission reductions (Pearson and Bloomfield 2000; Bernoux et al. 2002; Pelley 2003), high cost-effectiveness and additionality (Subak 2000), support for local communities, rural development and forest conservation (Klooster and Masera 2000; Hardner et al. 2000), especially if a high share of the carbon revenues reaches local people and if local communities can manage the land rights (Gundimeda 2004). A case study of Panama (Dale et al. 2003) found that reduced or avoided deforestation is a more efficient way to reduce emissions than afforestation. The former however is not eligible under the CDM. Concerns however emerged on the inclusion of forestry projects in the first commitment period (2008–2012) of the Kyoto Protocol: it was expected that it would deliver only limited impacts, with major benefits for Annex I countries, Latin America and the Caribbean, and Africa, while China would be negatively affected (Jung 2005). The study was based on the development and assessment of marginal carbon sequestration cost curves, resulting in the forecast of a limited role for forestry in the first commitment period.

A number of potential issues were identified including baselines, leakage, carbon accounting, and use of the wood products (LeBlanc 1999). Land use change models were proposed to identify the baseline. Complexity of the flexible mechanisms under negotiations regarding carbon sinks was also raised as a factor of inefficiency and potential discrimination for developing countries (Bettelheim and d'Origny 2002). Significant concerns arose especially regarding the contribution to sustainable development in the commercial forestry sector, partly because of the lack of sufficient supporting available data (Cullet and Kameri-Mbote 1998), regarding potential negative impacts on the local communities and biodiversity conservation (Lindegaard and Segura 2001; Nelson and de Jong 2003; Peter et al. 2005). Improving local communities' participation and integrating socioeconomic concerns was suggested as a solution (Peter et al. 2005). Subak (2002) suggested stringent criteria (for example, Forest Stewardship Council) to ensure sustainable forest management

and avoid leakage to minimize these risks. Case studies on rehabilitation of degraded forests in the Czech Republic and Uganda demonstrated that additionality and sustainable development contribution can be ensured in the forestry sector if clear rules are defined (Verweij and Emmer 1998). Finally, leakage of timber extraction toward developing countries could occur if forestry related carbon market activities implemented in Annex I countries (JI) are credited under the Kyoto Protocol (Niesten et al. 2002).

A key strand of literature discussed the issue of permanent vs. temporary sequestration of carbon in forestry (Marland et al. 2001). The concept of temporary CERs was adopted in 2005 (UNFCCC 2005). The use of temporary credits, coupled with insurance or reserves could maintain the incentive for long-term sequestration and also guarantee a multiyear obligation (Subak 2003; Vöhringer 2004). Another option to ensure environmental integrity would be the introduction of stringent MRV procedures. This option however would result in higher MRV costs that can negatively affect the viability of forestry projects (Stuart et al. 2000; Robertson et al. 2004).

Response and Contribution of the World Bank Group in Addressing the Challenges

Since the 1990s, the World Bank Group (Bank Group) increased its actives in the environmental protection sector. In this period, the Bank Group prepared its first environmental strategy and enhanced its cooperation with other UN agencies, which was seen as an improvement in the system for the international cooperation (Mucklow 2000). The UNFCCC commitment to reduce carbon emissions had an impact on the emergence of the new Bank Group environment strategy. The new strategy was developed taking into account the achievement of GHG emissions reductions, integration of environment and economic development and the definition of new lending mechanisms to Parties (Shih 2000).

Launching Carbon Funds to Catalyse Carbon Markets

The Bank Group initiated its involvement with climate finance in the 1990s, with the negotiation of the Kyoto Protocol, and launched the Prototype Carbon Fund in 2000. The purpose of this and subsequent carbon funds was to pioneer and demonstrate that carbon markets could serve as an effective and efficient global offset mechanism, reducing global mitigation costs by shifting mitigation activities from high-income countries where abatement costs are high to developing countries where such costs are lower. This was also expected to promote sustainable development in developing countries, consistent with Bank Group development goals. Carbon funds aimed at mobilizing private and public investments to achieve low cost emission reductions and at the same time contribute to sustainable development in developing countries.

The Bank Group developed its carbon finance strategy in 2003, comprising the following three main goals: (i) expand support for carbon market development and increasing the viability of project-based mechanisms, (ii) extend the benefits of carbon finance to the smallest, poorest countries and poor communities, (iii) demonstrate carbon finance for carbon sinks (sequestration).

(i) Prototype Carbon Fund

Starting in the 1990s, the Bank Group explored options for, among others, the use of the emission reduction achieved through projects to leverage financing for implementation of mitigation activities in developing countries. The emission reductions achieved by the JI activities would be used against the legally binding targets of developed countries (Masood 1997). The Prototype Carbon Fund (PCF) launched in 2000 was a move toward the development and support for market mechanisms (Mucklow 2000) and an example of innovative partnership and public-private cooperation (Streck 2004). It was launched as a vehicle for catalyzing carbon markets and mobilizing private and public resources for purchasing emission reduction credits and to support technology transfer. This is seen as a pioneering experiment to support the creation of the carbon market and to identify suitable mechanisms to allocate emission reduction credits to the fund participants.

One of the goals of the PCF was to test new approaches to support developing countries to access the carbon market and generate know-how on carbon transactions in a "learning by doing" fashion. From the assessment of CDM and JI projects it financed, the PCF was able to deliver the expected results in supporting market development and providing a concrete example of management of carbon transactions that paved the way for other funds to enter the market. The PCF was able to purchase high-quality credits and at the same time support and leverage mobilization of additional finance into mitigation projects that may not have happened without carbon finance (Lecocq 2003).

The PCF also demonstrated that developing countries offer lower cost opportunities for emission reductions compared with the OECD countries. Among the most prominent needs identified for supporting developing countries, assistance with project development and government legal and institutional capacity building were identified (Kiss et al. 2002). The PCF had a strong impact after its launch as it provided a new approach combining private and public participation to mitigation investments. It was not only a pilot for the flexible mechanisms of the KP but also for the creation of new private-public international trust funds and also new securities (Smyth 2005). Its role was recognized as a model for the following carbon funds blending public and private finance with innovative approaches (Streck 2004). Given the governance arrangements and enhancement of structures of voting and participation, the PCF had many elements of legitimate decision-making (Matz 2005) and increased transparency. The PCF, as an example of public-private partnerships,

was identified as a potential model of financing global public goods through a trust fund model (Matz 2005). The PCF also aimed at developing expertise from its pilot activities that could support the development of the carbon market: from development of transactions with private companies (for example, agreements with the private steel company Plantar SA to reduce the use of mineral charcoal with wooden charcoal (Reis 2003)), to generation of practical experiences on the issues associated with development of new project types, for instance issues with biomass projects (Hosier and Sharma 2000) or dissemination of "clean coal"[7] technologies (Masaki 2003). The PCF also supported the development, together with other partners, of methodologies and software for identification of baselines and potential for GHG reductions, increasing the ability to quantify potential for carbon finance in each specific project (Anonymous 2005b). But many of the methodologies proposed by the PCF were not approved by the CDM regulators (Michaelowa and Michaelowa 2011).

(ii) Biocarbon Fund and the Community Development Carbon Fund

Following the establishment of the PCF, the Community Development Carbon Fund (CDCF) and Biocarbon Fund were established in 2003 and 2004 respectively, both aiming at exploiting synergies between mitigation and other topics related to sustainable development, such a biodiversity, arresting land degradation, and local community development in low-income countries (Kiss et al. 2002). The Biocarbon Fund had the objective of supporting low-income countries to participate in carbon markets and more specifically the rural communities in these countries to benefit from carbon credits sales generated by forestry and agricultural projects. It involved also public-private partnership similar to the PCF (Anonymous 2002). The CDCF provided developed countries with a tool to effectively support mitigation efforts in low-income countries through CDM for poor/vulnerable communities (Anonymous 2003) that otherwise would not be able to attract carbon finance. The creation of the PCF is acclaimed by the literature as innovative and pathbreaking and, based on the case of China, as an effective contributor in delivering capacity building that, together with sound governance and transparent procedures, can strengthen the carbon market (Zhang 2006a; *for China*: Zhang 2006b)

Using these funds, the Bank Group started the testing of new approaches for directing revenue flows as payments for the resulting emission reductions to the local communities that are actually making the land use decisions, as a mechanism to overcome the lack of any compensation for activities that reduce emissions while also providing the biodiversity protection and environmental conservation service. For example, the Regional Integrated Silvopastoral Ecosystem Management Project (in 2005) from the Bank Group, financed by the GEF, was piloting the use of Payment for Environmental Services related to biodiversity protection and GHG reductions (Pagiola et al. 2005) with three projects in Colombia, Costa Rica, and Nicaragua.

Limitations of the Bank Group Carbon Market Responses

While the Bank Group early actions in the carbon markets contributed to the creation of carbon markets by establishing and piloting a tradable carbon asset and enhanced the functioning of the carbon markets, the literature also contains criticism. Some authors (Michaelowa and Michaelowa 2011) have argued that the Bank Group did not leave the market as initially promised once it picked up but started to compete with private sector market players. Another criticism was related to the potential for increasing pressure on forests and worsening of local communities' livelihoods through programmes funded by the Bank Group in the forestry sector (Anonymous 2005a). Eight environmental NGOs officially requested the Bank Group to shut down the PCF as it was supporting projects that have negative impacts on biodiversity and human rights and living conditions (Anonymous 2004). Specifically, the Forest Safeguard Policy of the Bank Group was not met in many forestry projects, especially in Indonesia and Brazil: the Multilateral Investment Guarantee Agency and IFC did not adopt the Forest Safeguard Policy and also the transparency of the External Advisory Group was questioned (Anonymous 2005a).

Summary of the Period until 2005.

Table 1. Summary of the Period (until 2005)

Time Period	Main Features of the Period	Key Challenges	Bank Group Responses
Until 2005 (that is, initial negotiations on flexible mechanisms and enter into force of the Kyoto Protocol)	• Parties negotiate for the definition of the flexible mechanisms and for the definition of their operational rules and procedures • After initial testing through AIJ, the CDM, JI and IET are agreed • Initial implementation of activities in different sectors • Carbon markets created and catalysed to demonstrate the potential for low cost emission reduction and compliance with Kyoto targets • Environmental integrity and economic efficiency of the mechanisms are studied in detail	• Evaluation of the cost-effectiveness and associated risks for investors • Initial testing of different design models • Environmental integrity and contribution to Sustainable Development • Baseline setting and additionality concerns • Provision of incentives for technology transfer and innovation • Definition of eligible activities and associated issues for the forestry sector • Forestry projects are criticized for the negative impacts on SD at local level and for indigenous peoples	• Definition of a new environment strategy in the 1990s taking into account the establishment of UNFCCC and the need for mitigation activities • Introduction of carbon funds as innovative models for catalysing carbon markets, pilot Kyoto mechanisms and public-private partnerships for project-based emission reduction • Bank Group funds to reduce project risks and access cheap emission reductions. They also deliver significant capacity building activities for developing countries • CDCF supports low-income countries and communities within developing countries • Biocarbon Fund links climate change activities with SD benefits and biodiversity protection • Support to new methodologies development (capacity building) •

3. The "Gold Rush" Period of 2006–2011

The period 2006–11 saw a strong growth of the international carbon markets, triggered by the 2004 decision of the EU on the "linking directive" allowing the use of credits from CDM and JI for compliance under the EU ETS. Under these circumstances, the flexible mechanisms gained sudden popularity and carbon markets grew much more than originally expected. However, the "gold rush" also exposed problems that were discussed intensely in the research literature.

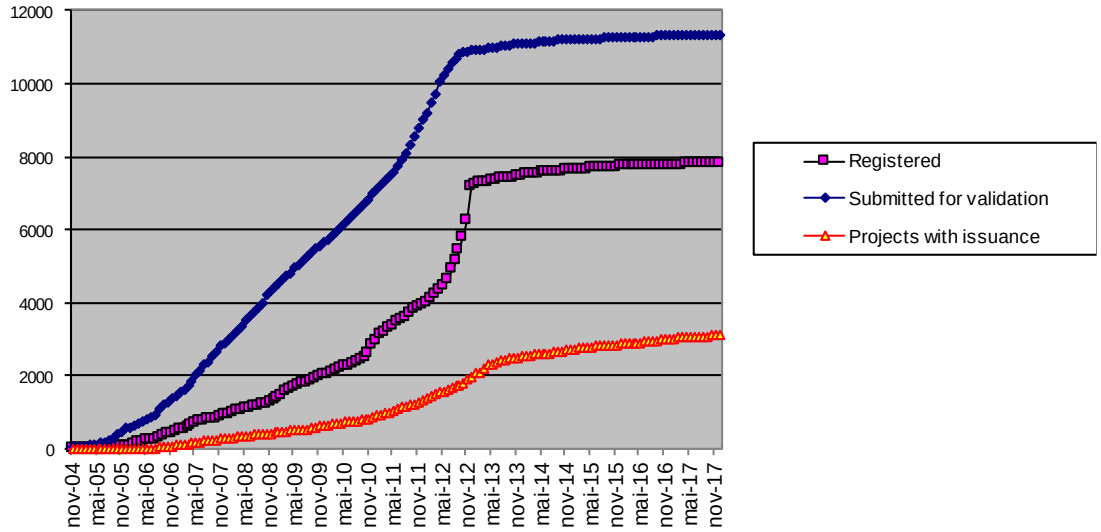
Main Features of the Period: Growth and Expansion of Carbon Markets

Supply and Demand for Carbon Credits

The CDM was initially seen as a mechanism for countries that could support governments to significantly reduce the cost of compliance with the KP (Bréchet and Lussis 2006). But in practice both supply and demand for CERs were largely privatized and the CDM capacity to attract large private capital on an annual basis was an unprecedented and unanticipated feature of the mechanism (Shishlov and Bellassen 2012). On the demand side, this privatization was largely achieved thanks to the EU ETS, which provided a large and reliable source of demand for CERs (Shishlov and Bellassen 2012).

While the initial use of offsets in the EU 2008–2009 was rather limited (Trotignon 2012), market actors from 2004 realized the cost-saving potential through the use of credits thanks to the difference between EUA and CER prices (Vasa 2012) and the demand from the EU ETS grew in leaps and bounds leading to a "gold rush" period of the CDM. The following graph shows the trend in the pipeline of CDM projects submitted for validation, registered and those that issued CERs (Figure 1).

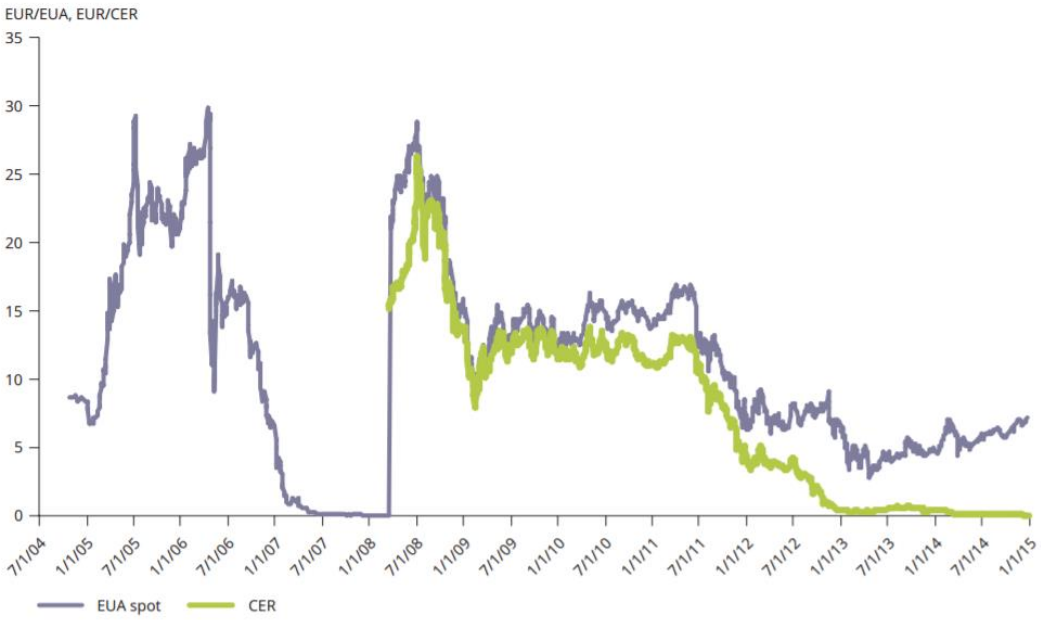
Figure 1. Accumulated Number of CDM Projects.



Source: UNEP DTU (2017a)

The reduction of GHG mitigation compliance costs for firms in the EU and Japan was estimated at least around 2.3 billion USD for the period 2008–2012 based on the difference between CER and EUA prices (Spalding-Fecher 2012). Additionally, for the same period (2008–2012) it was estimated that for the public sector, the use of CERs by Annex I governments to meet their Kyoto commitments yielded an additional 1.3 billion USD in savings (ibid.). Figure 2 demonstrates the evolution of EUA and CER prices from the beginning of the EU ETS in 2005. The CER prices refer to "secondary" prices quoted on exchanges; actually, over the counter trades directly from project developers happened since 2005.

Figure 2: EUA and Secondary CER Price Evolution.



Source: European Environment Agency (2015)

In 2005 it became also clear that the so-called "unilateral CDM"[8] approach could be used, where stakeholders from developing countries are investing in a mitigation project in anticipation of potential carbon credit buyers and sell emission credits as a commodity. Unilateral CDM had the potential to attract investment in a more efficient manner compared with "bilateral" activities in specific circumstances, for instance through a reduction of transaction costs and low need of technology transfer (Michaelowa 2007; Bayer et al. 2013a). Potential for unilateral CDM varied from country to country, depending on the domestic context and with African countries still depending on international support to a much higher degree than other developing countries in Latin America and Asia (Michaelowa 2007).

While the regulatory uncertainty about the CDM did not allow CER and EUA prices to fully converge (Mizrach 2012), a clear correlation was observed (Sadefo Kamdem et al. 2016). It was demonstrated how price volatility was exacerbated by the decisions of the European Parliament and suggested the need for policymakers to improve communication of long-term strategies for the EU ETS (Deeney et al. 2016). Moreover, concerns about price volatility in the primary market due to imperfect information were also raised (Zavodov 2012).

Carbon Finance: Learning by Doing through Expansion of the Market

Being the first-of-a-kind climate change mitigation instrument, the CDM followed a "learning by doing" pattern, whereby the transparency of the mechanism allowed for scrutiny by researchers and NGOs leading to numerous reforms (Shishlov 2012). The CDM, as well as voluntary offset schemes, helped developing countries in building technical capacity regarding structuring of emissions reduction projects and carbon accounting (Mehling and Mielke 2012). Indeed, a common view among stakeholder inputs to the CDM Policy Dialogue was that capacity building for the low-carbon transition in developing countries was one of the most important impacts of the CDM (Spalding-Fecher 2012). Especially in large emerging economies like India, China and Brazil very rapidly an "ecosystem" of CDM consultants emerged that quickly made the role of the Bank Group superfluous (Michaelowa and Michaelowa 2011).

In this phase, private financial institutions were actively participating in the carbon markets as intermediaries, enhancing liquidity of the market (Weber and Darbellay 2011), especially in large countries like China (Fan et al. 2011). But they did not contribute actively to rule setting for CDM regulatory mechanisms (Haigh 2011) while carbon funds can play a fundamental role in pooling demand for credits. The increase in the number of carbon funds should however slow down, given the regulatory uncertainties with the post-2012 period (de Dominicis 2006). Carbon funds are one of the main drivers that enable DFIs to support CDM dissemination especially in low-income countries in Africa (Karani and Gantsho 2007).

Carbon Finance and Domestic Climate Policies

The CDM and international carbon finance were also assessed against domestic mitigation policies. In the context of the Sub-Saharan agricultural sector, the use of a carbon payment system can be a reasonable alternative to subsidies aimed at improving soil fertility (Marenya et al. 2012). In China, based on the successful CDM experience, a domestic "inter-provincial CDM" was suggested (Jacques et al. 2013). Strand (2011) identified a perverse incentive of the CDM to weaken domestic energy and environmental policies to leave sufficient potential for emission credits sales through the CDM. Such considerations led to the definition of the so-called E+ and E− policies to be taken into account when identifying the baseline. According to the UNFCCC (2005), E+ policies are "National and/or sectoral policies or regulations that give comparative advantages to more emissions-intensive technologies or fuels over less emissions-intensive technologies or fuels," while the E-policies are "National and/or sectoral policies or regulations that give comparative advantages to less emissions-intensive technologies over more emissions-intensive technologies (for example, public subsidies to promote the diffusion of renewable energy or to finance energy efficiency programs)". The E− rule stated that mitigation policy instruments introduced after the Marrakech Accords do not need to be taken into account in assessing additionality of CDM projects.

Carbon Capture and Storage

One new topic that emerged during this period was Carbon Capture and Storage (CCS) as an eligible project activity under the CDM at COP 17 in Durban 2011. However, at the time of writing, no baseline and monitoring methodology for CCS has been approved and no activity has been registered. In the view of some observers, there was a need to explore potential trade-offs between the gains from mitigation through CCS, and negative local impacts at storage sites (Ebeling and Yasué 2008). Other authors stressed the need to review the existing CDM framework to introduce new concepts to address long-term liability and CER cancellation (Lotz and Brent 2008). Opposite views on this topic have been raised by a number of authors arguing that concerns with this technology could be addressed with available methodologies (see Boute 2008 for a typical assessment). Pollak and Wilson (2009) and Kalkbrenner (2010) stressed that long-term responsibility, local environment protection and safety are posing a serious obstacle to the inclusion of CCS in the CDM. Other concerns were discussed regarding potential impact of large volume of credits generated by CCS projects under the CDM and repercussions on credit prices (Zakkour et al. 2011).

Key Market and Regulatory Challenges in This Period

Economic efficiency, environmental integrity and contribution to sustainable development are among the key challenges faced by the international carbon market in this period (Shishlov 2012; Lewis 2009). CDM has been depicted as an ineffective instrument with limited results for reducing GHG emissions in non-Annex I countries, required for delivering "true" offsets (Wara 2007). It was also widely understood that other instruments than the CDM, such as carbon taxes, are likely to be preferable climate policy instruments (Michaelowa 2011).

Other main concerns refer to possible "low-hanging fruits" project types, project risks, contribution to SD in host countries, uneven geographical distribution, challenges for forestry projects, additionality and baselines, technology transfer, and capacity building needs, and governance. These issues are presented in the following sections.

Mobilizing "Low-Hanging Fruit"

One of the challenges raised for the CDM was the issue of "low-hanging fruits": CDM projects in developing countries with particularly low implementation costs. It was of course natural that the CDM would capture such projects; there is nothing wrong with it in principle as this would lead to large cost savings. However, a number of authors argued that such revenue opportunities potentially preclude countries from taking on more ambitious targets (Akita et al. 2012; Peter and Bumpus 2012). Quantitative assessments however demonstrated that a project-based mechanism like the CDM could only capture a small share of cheap abatement opportunities, with a notable exception of China, where it captured almost a third of theoretical low-cost abatement potential (Castro 2012). Difficulties in the equalization of marginal abatement costs across sectors were identified by Millard-Ball and Ortolano 2010).

Some sectors have benefited more than others from the CDM: industrial gases, renewables including large hydro (Whittington 2007). Fuel switching projects were leading, while energy efficiency and transport were lagging. to reorient investments toward projects in the latter sectors, with a strong SD component, governments could do upfront CER purchase or pool activities to limit market distortions (Lof 2009). Research focused on reasons for the problems of the energy efficiency sector. Improvement of the institutional capacity at UNFCCC level, and setup of a working group to develop baseline and monitoring methodologies were suggested (Niederberger and Spalding-Fecher 2006). The financial support from CDM was identified (Ren et al. 2011) as an incentive for the dissemination of distributed energy resources through energy service companies (ESCOs) in urban areas (China case) (Ren et al. 2011).

Concerns were raised on the effect of inclusion of unrestricted trading of carbon credits from reducing emissions from deforestation and forest degradation (REDD) projects as it could significantly depress carbon prices. However, it was also argued that the inclusion of such cheap abatement options in the international carbon market can help encourage governments to adopt tighter emissions reduction targets (Anger et al. 2012).

Going Beyond Projects

One significant evolution of the CDM beyond single projects is the introduction of the concept of Program of Activities (PoA) in 2005. This option allows the registration of multiple activities of the same type without any limit on its number, over a period of 28 years. PoAs reduce transaction costs (Matschoss 2007), which has been confirmed by empirical studies, such as in the case of CFL dissemination in Chile (Karakosta and Askounis 2010).

Over this period, the project focus of CDM gradually also became increasingly seen as outdated due to its high implementation costs and difficulty in ensuring full integrity of projects. Various authors proposed alternative solutions, including sectoral crediting mechanisms, and explained their design using the case of use of associated gas (Suykens 2010; Duan 2011).

Performance Risks and Delivery Risk

The CDM performance risk associated with the discrepancy between estimated and issued carbon credits was identified as one of the key challenges to development of projects. One study on 227 renewable energy projects, including hydro and wind of different scales and in different countries found large variations in terms of project performance risks, with projects generally not generating the level of emissions estimated in the PDDs. On average, hydro and wind projects performed in a similar manner (Balatbat et al. 2012). An attempt to differentiate the risks incurred by CDM projects in terms of expected CERs that will never be issued found 29 percent due to failure of projects (negative validation, project withdrawn, and so on), 12 percent due to delays during the approval process (validation and registration), 27 percent due to delays at issuance, and only 1 percent due to underperformance of projects in terms of CER delivered per day. Only around 30 percent of the CERs was issued according to PDD forecasts. This results in only 576 million CERs issued by April 1, 2011 against an expected volume of 1.8 billion CERs (Cormier and Bellassen 2013). Technology (project type) was identified as a key driver for all these risks: some technologies are riskier than others, in the sense that project costs can differ widely and are not easily observable for parties providing project finance. Securitization of the CDM investments and a CDM guarantee trust were proposed to address delivery risk (especially for remote areas and new promising technologies) (Rajan 2009). The International Finance Corporation, a member of the Bank Group, established a Carbon Delivery Guarantee to reduce delivery risks and increase returns from

carbon credits. Under the Carbon Delivery Guarantee, ICF signed three deals for a cumulated volume of around 2.2 million CERs, from three projects located in India, South Africa (Bank Group 2010b).

Ensuring Sustainable Development Contributions

The CDM was designed to address the need for cost-effective greenhouse gas mitigation and promote sustainable development (SD) benefits in host countries at the same time (Cole 2012). Overall, the system of sustainability assessment under the CDM placed the principle of national sovereignty on top, as the CDM is part of the development strategy of host countries. Therefore, there have been no standardized criteria and monitoring methods for measuring the impacts and contributions to sustainable development. The structure of the CDM, and the possibility for host parties to define the SD priorities at the national level creates an incentive for a "race to the bottom" regarding the requirements related to SD for CDM projects (Rindefjall et. al. 2011). van Asselt and Gupta (2009); Nguyen et al. (2010) find that the CDM EB gives little consideration to sustainable development in its accreditation procedures and called for reform of the CDM. This is mainly due to the fact that there is a perverse incentive for developing countries to allow also projects with limited or without SD benefits to attract investments: investors from developed countries select projects based on the cost of the carbon credits, with little or no consideration for the implications on the SD in the host country. In addition, there is a perverse incentive for host countries to delay implementation of more stringent environmental and climate policies to avoid reducing the potential for generating CERs from CDM activities and therefore losing potential investments.

The case of Chile is used to identify a deliberate strategy to attract foreign investments and "export" emission reductions, marginalizing the SD component. There is a general trade-off between the GHG emissions reduction and contribution to sustainable development in the CDM (Wittman and Caron 2009; Bakker et al. 2010; Macdonald 2010b). This is supported by an analysis based on taxonomy for sustainability assessment of text analysis of 744 PDDs submitted until May 2006 (Olsen and Fenhann 2008), as well as another assessment of 40 projects from India (Alexeew et al. 2010). Similar conclusions have been identified through a small sample of ten projects (Boyd et al. 2009) and by a literature review up to 2007 (Olsen 2007). Contribution to SD in host countries is mixed and largely depends on national context and can result in trade-offs between GHG emission reductions and SD contributions (Shishlov 2012). An assessment of 16 registered projects rating their performance on SD, and on the likelihood of delivering real and measurable emission reductions, found that while around 72 percent of the projects can deliver real emission reductions, only 1 percent is capable of delivering SD benefits, while none of the currently registered CDM activities actually does so. This is mainly due to the existence of projects delivering large volumes of CERs, which scored poorly when assessed against SD criteria (Sutter and Parreño 2007).

Issues with large-scale dams and indigenous peoples's rights have been raised (Finley-Brook and Thomas 2010) and in general hydro projects are questioned for their negative impacts on SD at local level (Shishlov 2012). The SD benefits of the CDM are limited to economic benefits with little environmental benefits beyond cleaner production (Thomas et al. 2011). In other views, renewable energy projects can benefit from support of the CDM in delivering SD benefits and in their inclusion in the priorities of developing countries (Doukas et al. 2009). China was seen as giving preference to CDM projects in poorer and less developed provinces and provinces that lack foreign direct investments (FDI) to maximize economic co-benefits (Bayer et al. 2013b; Hong et al. 2013). However, an assessment of selected hydropower projects in the Chinese Province of Yunnan argued that while the CDM might have contributed to boosting hydropower development, the project benefits were often not channeled to local communities (Rousseau 2017). Energy-related CDM activities in China were seen to deliver substantial health benefits and monetary savings (Vennemo et al. 2006). While the CDM did not explicitly focus on co-benefits, "add-on" standards, such as, for example, the Climate, Community and Biodiversity or Gold Standard used by certain projects have delivered over-proportional co-benefits for poor populations (Crowe 2013).

Some authors proposed the development of sophisticated tools to prioritize activities from a SD contribution standpoint that could also be used as a verification protocol for DOEs for MRV on SD impacts (Lenzen et al. 2007; Olsen and Fenhann 2008). The CDM adopted the SD tool, which is used on a voluntary basis by project participants to assess the SD contribution of their CDM activities. An attempt to develop a tool to define models for SD contribution that can support both government planning and private company participation was carried out in Chile (Karakosta et al. 2009) and also in Vietnam (Huge et al. 2010).

Uneven Geographical Distribution

A main criticism of CDM and JI has been the uneven distribution of projects across host countries (Hultman et al. 2009). Accounting for host country attractiveness under the CDM at the height of the "gold rush" found India, China, Mexico, Brazil and Chile at the top, while for JI New Zealand, Denmark and Sweden were leaders on the demand side (Oleschak and Springer 2007). When assessing bilateral CDM projects, "familiarity factors" (colonial history; bilateral trade; and bilateral aid) were found to strongly influence CDM location decisions (Dolšak and Crandall 2013). Evidence of the CDM projects following closely the traditional FDI patterns was identified (von Unger and Streck 2009). Availability of human capital, mitigation potential, which is indicated by the carbon intensity, existence of profitable markets for CDM co-products (for example, electricity) increases the chances of hosting CDM activities (Winkelman and Moore 2011). A comparative analysis of the CDM experience in China and South Africa demonstrated that a strong industrial and energy policy in the host country has played a crucial role in the development of

CDM (Fay et al. 2012). Policies fostering a low-carbon development pathway encourage the CDM uptake, rather than CDM driving a low-emission development pathway. This at least in part reflects that CDM has, for most countries, been operating at too small a scale to matter substantially for the country's development. In addition, the active engagement by key government and private sector stakeholders and the presence of a friendly business environment are crucial. Lack of capacity of local actors, aggravated by limited access to finance, was identified as key barriers to entrepreneurship for the CDM in South Africa (Dolles et al. 2013).

According to some views, PoAs can support a more balanced distribution of CDM activities (van der Gaast and Begg 2009). The successful use of PoAs is contingent on establishing an appropriate institutional framework, building local capacity, increasing institutional learning around project development, and harmonizing evolving carbon finance mechanism (Schomer and van Asselt 2012). These activities are also proposed for underrepresented countries (Hwang and Kim 2011). Combining financial instruments, for example, carbon crediting and micro-finance, can help scale household programs, such as for example in the case of the diffusion of solar lanterns through micro-loans (Hogarth 2012) and thus open new opportunities also for underrepresented countries.

Challenges for Forestry and Land Use Projects within and without the CDM (REDD+)

The debate on forestry projects continued in similar fashion as in the preceding period. CDM can lead to forest protection but also to negative impacts on forests and local and indigenous communities. Four key elements were identified as relevant for the delivery of real local SD development: ownership, price, transaction costs, and use rights. Land use–based mitigation activities are legitimate in the long term if they also provide biodiversity protection (Kerr et al. 2006). Concerns were raised about potential conflicts that could emerge with production of bioenergy and increased use of wood products (Dutschke 2007). Potential solutions are also available, such as to consider existing rural development strategies, enhance local stakeholder participation and design projects in a flexible manner (Boyd et al. 2007). However, other authors saw the chance to harness combined mitigation and adaptation benefits and to maximize the revenues for small landowners (Bryan et al. 2010).

A number of concerns have remained important. While recognizing the potential to generate a large volume of emission reductions, interactions of forestry projects under the CDM and other land uses, such as agriculture, were highlighted by several researchers as crucial for delivering SD benefits to local and indigenous communities (Groen et al. 2006; Dulal et al. 2011; Zomer et al. 2008). Murthy et al. (2006) stressed the importance of proper boundary identification, while Corbera and Friedli (2012) criticized the frequent use of inaccurate carbon accounting methods. The introduction of remote sensing monitoring can help overcome information

asymmetries according to Brandt and Svendsen (2013). Cacho et al. (2013) stressed high transaction costs as an important barrier. In the case of Cameroon, lacking data availability was found to be a major barrier to forestry projects (Minang et al. 2008). Building on a case study in Vietnam, a closer involvement of local communities in the design of afforestation projects would help address the risks of nonpermanence of emissions and leakage, due to the limited availability land for tradition uses (Yamanoshita and Amano 2012). The assessment of two Payment for Environmental Services projects in Ecuador found positive results through focus on targeted environmental services and high level of concessionality (Wunder and Albán 2008).

The debate on permanence continued intensively. In some views, temporary credits are seen as a good solution to balance environmental integrity and financial attractiveness allowing their inclusion under the CDM, even if additional rules are suggested to strengthen the concept (Marechal and Hecq 2006). Other observers (Galinato and Uchida 2010) criticized the approach due to the fact that impacts of carbon release due to timber harvest are not internalized by the project owner. Moreover, over-crediting occurs as accumulated carbon is counted instead of marginally sequestered carbon.

In an attempt to mobilize new mechanisms for reducing GHG emissions from the forestry sector, the concept of Reducing Emissions from Deforestation and land Degradation (REDD) was introduced in the UNFCCC in 2005, but it did not become part of the CDM. The final definition of REDD+, adopted in 2010, includes the concept of sustainable management of forests and enhancement of carbon stocks. During the assessment period there was an enhanced debate on whether REDD+ should be integrated into the CDM. Ensuring additionality was seen as key. It was recognized that appropriately checking REDD+ projects for additionality can be extremely difficult, as true implementation costs are often very hard to come by. This problem is exacerbated by the fact that nonadditional REDD+ could generate a very large amount of "bogus" emission reductions (Pirard and Karsenty 2009). Given the noneligibility of deforestation activities under the CDM, and the uncertainty whether its inclusion would create positive incentives for investors, a Conservation Carbon Mechanism as part of the CDM was proposed as a potential solution to overcome the lack of a system that gives a value to standing forests. The mechanism introduces a stock-based accounting approach and trading mechanism with the goal of rewarding also SD benefits delivered to local communities (O'Sullivan and Streck 2008). It is clear, as other researchers have shown, that REDD+ *can* have positive impacts, but it is necessary to balance the interests of financiers, local communities, and the global society in terms of truly delivered emissions reductions. For example, REDD+ can benefit from existing positive experiences from both CDM activities and voluntary projects in the forestry sector (such as in Uganda) to support the structure of these activities and of direct payments between buyers and local communities (Peskett et al. 2011).

An assessment of 34 quantification methods for REDD under the CDM and other voluntary schemes found that the Voluntary Carbon Standard has been identified as the only carbon accounting standard to fulfil all leakage quantification requirements (Henders and Ostwald 2012). To address indirectly technical and administrative challenges related with leakage, permanence and additionality, a project-specific "iREDD" insurance is proposed, to be negotiated upfront based on the evaluation of risk depending on governance quality, the integrity of management plans, liquidity, monitoring and evaluation frameworks, and political acceptability. A certain share of the price of CERs is set aside as insurance premium and whose volume depends on the risk assessment of the project (van Oosterzee et al. 2012). REDD+ mechanisms were suggested to provide local authorities with enough flexibility to address the local development trade-offs, and ensure that local demand for goods and services related to the forestry sector is taken into account (Dyer et al. 2012). Newton et al. (2012) argued that a differentiated payment scheme for avoided primary forest conversion, rather than a uniform carbon credit payment, could be more effective in reducing deforestation, while Cairns and Lasserre (2006) proposed an accounting method based on observable data.

Going forward, REDD+ governance can easily become a major barrier (Bhullar 2013) due to the poor current level of governance in many of the countries with the highest REDD+ potential; a situatio, which may persist for a long time in many countries. Success of reduced deforestation projects seems to depend on supporting incentives for government, local communities and business sector (Ebeling and Yasué 2008; Corbera and Brown 2008). Boyd (2009) called for effective institutions at local and national level, enhanced communications between stakeholders, and better integration of local relationships. Sathaye et al. (2011) called for capacity building as a precondition to harness the substantial mitigation potential of REDD+ As discussed in section 3.3, Bank Group established the Forest Carbon Partnership Facility to address these capacity building for developing countries.

Additionality

Similar to the earlier period, the additionality of CDM projects was also severely criticized during the 2006–2011 CDM "gold rush" period (Streck and Thiago 2007; Streck 2011; Koo 2017b).

An assessment of projects in India and Brazil found that due to the uncertainty of CDM revenues, project developers preferred projects viable without CDM credits (Hultman et al. 2012). Doubts were raised on the additionality of small hydro projects in China (Yunna and Quanzhi 2011) and for wind projects (He and Morse 2013) (*in general for China*: Lewis 2010). An assessment of bagasse power CDM projects in Brazil, India and Thailand (Amatayakul and Berndes 2012) found that power purchase agreements rather than carbon credit sales were decisive for project implementation. Both articles ignore the E− rule due to which revenues from feed-in

tariffs are not accounted for under the CDM. Fearnside (2013) argues that large hydro projects in Amazonia would have likely been implemented without the CDM. For small hydro, Martins et al. (2013) found that, among the 431 projects which became active in Brazil since 2001, 339 were not CDM projects and thus the role of CDM revenue as an incentive was uncertain. Looking at renewable energy projects, Gilau et al., (2007) suggested that CDM should move away from a purely "market-oriented" perspective toward barrier removal.

It was acknowledged that in practice, it is virtually impossible to verify correctly whether a given project is additional or nonadditional, in 100 percent of the cases (Shishlov 2012). The natural contradiction between strict additionality and not impeding new environmental policies at the national level partly explains this. The higher transaction costs which come together with a stringent case-by-case scrutiny are another explanation. More stringent baselines and performance benchmarks can help ensure net emissions reductions that could compensate for nonadditional projects that manage to slip through. Ultimately, the additionality test becomes a matter of finding the right balance between: "false positives and false negatives" (Carmichael et al. 2016). Relaxing the additionality demonstration on a project basis, but at the same time strengthening additionality on a technology level is one potential option to address the additionality issue (Chung 2007; Castro and Michaelowa 2010). The CDM would have to move away from a pure offset mechanism through discounting the volume of CERs generated (that is, allowing crediting for only a certain share of total CERs generated, thus rendering not tradable the remaining share) to deliver net mitigation benefits for the world as a whole and ensure additionality at an aggregated level (Schneider 2009).

Baselines

Like additionality, baseline determination continued to be controversial during this phase. The asymmetry of information between the regulator (the CDM EB) and CDM hosts can be anticipated to raise emissions baselines beyond what would happen without CDM crediting (Strand and Rosendahl 2012). A similar issue also applies to the voluntary carbon market looking at energy efficiency for buildings in the United States (Liu and Cui 2017). Conservative baselines depending on uncertainty of baseline setting and credit price levels have been proposed as a possible solution (Bento et al. 2016). Other options such as standardization of baselines have been suggested to address these issues (Murtishaw et al. 2006; Zhang et al. 2006). Standardized baselines were calculated for the South African Power Pool (Randall 2011). This was taken up by the regulators in the post-2010 period.

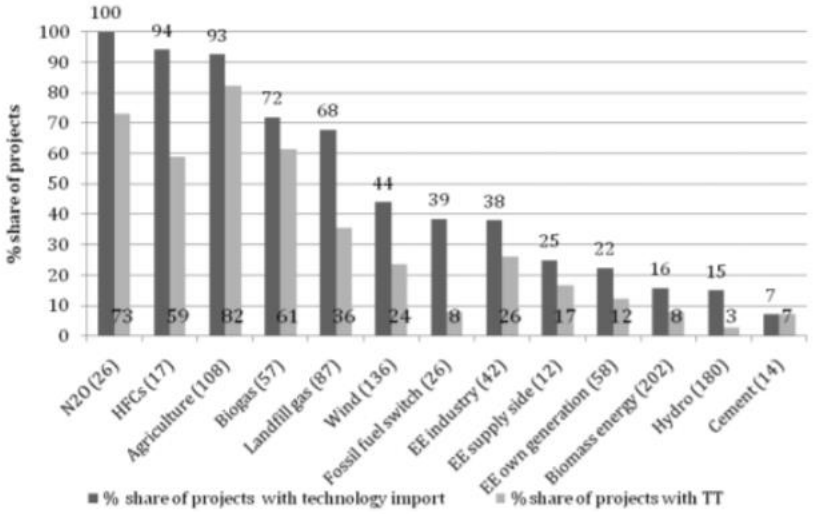
In some sectors, that is, coal bed or coal mine methane recovery and landfill gas (LFG) recovery, approved baselines methodologies have been using inconsistent assumptions on the global warming impact of the CO_2 emission from oxidization of

methane. In the case of LFG it leads to overestimations of the mitigation impact (Moellersten and Grönkvist 2007).

Technology Transfer

Unlike the contribution to sustainable development, technology transfer is not an explicit objective of the CDM, but represents an important co-benefit for host countries and has been widely researched (Schmid 2012; Cox 2010; Youngman et al. 2007). In contrast to other co-benefits, the existing evidence which started emerging during this phase is particularly inconsistent. While by some views (Schneider et al. 2008) CDM is seen as effective in supporting technology transfer, lowering existing barriers and enhancing the quality of the transfer, other assessments (Youngman et al. 2007) concluded that around 50 percent of CDM projects and 62 percent of JI involved hardware from outside the host country by 2007. However, other researchers (Doranova et al. 2010) came to an opposite conclusion with a majority of CDM activities using domestically produced technologies. Heterogeneous technology transfer results have been identified across CDM project types with different degrees of reliance on imported technology (Karakosta et al. 2012). Others (Das 2011) reported that technology transfer impacts depend largely on the project type/technology, as shown in Figure 3.

Figure 3: Technology Import and Technology Transfer by Project Type



Source: based on an assessment of 1,000 CDM projects by Das (2011).

An empirical assessment of the barriers that may slow down technology transfer through carbon markets identified high tariffs on environmental goods and services as well as burdensome administrative procedures to launch new businesses as key factors. Other findings indicated that technology transfer is driven by minimization of the abatement cost rather than actual alignment with host country priorities and needs (van der Gaast et al. 2009).

A case study of wind power CDM projects in China and India (Lema and Lema 2013) demonstrates that while technology transfer does occur, it is based on mechanisms available prior to and independent of CDM projects. This means that CDM projects tend to use technology transfer mechanisms and options already available in the country and independent of the CDM component, not the other way around. In China the proportion of total income generated by CERs is high and the domestic availability of the technology is low, drives the choice of project owners to use foreign technologies (Wang 2010). On the other hand, only limited incentives are identified for technology transfer in the Chinese renewables sector (Wang and Chen 2010).

Governance

During the gold rush period, governance issues became highly relevant, especially under the CDM with a strong participation of private companies. Governance is relevant both at the international and national level. Regarding the former, CDM project developers highlight the issue of lack of transparency of the CDM EB decisions on projects, lack of a mechanism to review or appeal EB decisions, and limited possibility for interaction along the process. This is a consequence of the unique nature of the CDM, where the UN directly interacts with the private sector. An econometric assessment of 250 CDM methodologies and around 1,000 registered projects shows that the EB's final decisions are determined by both formal quality criteria and political economy variables (Flues et al. 2010). Likewise, business and industry NGOs influenced decision-making on CCS under the CDM (Vormedal 2008). Developed countries and emissions-intensive companies are effectively influencing the negotiation and the actual implementation of the flexible mechanisms (Vlachou and Konstantinidis 2010). But some authors also see a very limited NGO influence on the CDM and other carbon markets (Lederer 2012).

The governance structures of CDM and voluntary markets carbon offsets are often criticized as subject to capital-accumulation strategies without public oversight (Bumpus and Liverman 2008; Lövbrand et al. 2009). The CDM criticism is reflecting the effectiveness and legitimacy of the environmental governance at international level (Jacur 2009). Other authors expressed fears regarding the fact that in the context of oppressive societies market mechanisms can lead to harmful effects for the indigenous communities and it is thus necessary to introduce a mechanism for protecting their rights under the CDM (Finley-Brook and Thomas 2011). The case of hydropower development in Yunnan Province in China shows that CDM did not contribute to delivering SD benefits but it rather consolidated existing power structures (Rousseau 2017). However, there is room for improving interactions between the various stakeholders and regulators and increase participation (Millar and Wilder 2009; von Unger and Streck 2009). Governance reforms could allow the CDM a more effective and credible international instrument (Purdy 2009). Several proposals were brought forward, such as professionalization of the EB and

appropriate administrative rule with an appeal process to increase transparency (Lin and Streck 2009; Streck and Lin 2008). While an appeal process was not introduced to date, several improvements such as granting the possibility of discussing directly through a phone call with the UNFCCC Secretariat the outcome of PDD evaluation to clarify issues, were introduced. An assessment of the commercial activities of the participants to UNEP Risoe's CDM Bazaar shows that different regulatory designs have strong implications on value chain creation, for example influencing the role of specialized CDM consultancies (Schneider et al. 2010).

When assessing the differences among host country domestic CDM governance structures, links can be identified to the specific governance structure in each country (Newell 2009). A combination of CDM and carbon tax for developing countries (where emission reductions achieved under the carbon tax can be exported) was proposed by Timilsina (2009) to increase host country welfare; actually a number of countries are now combining carbon taxes with the CDM. On the buyer country side, the initial no-cap option under the EU Linking Directive was pushed by EU Member states but the EU commission prevailed (Flåm 2009).

Voluntary Markets Capacity Building

Regarding capacity building, the CDM and the carbon markets delivered limited results. In the case of Africa and LDCs, donor agencies provided 45 million USD for CDM related capacity building until 2009, equivalent to 8 percent of the total carbon revenues from these countries. Training activities, for instance support in establishment of the Designated National Authorities, were more successful than activities targeting project mobilization. Efficiency of assistance was higher when the full CDM process and cycle is supported rather than parts of it (Okubo and Michaelowa 2010).

Auditing and Conflict of Interest

Another regulatory issue which became clear during this phase was the issue of auditing GHG emission reduction through the CDM framework. The auditing functions under the CDM scheme are performed by third parties accredited by the CDM EB, the so-called Designated Operational Entities (DOEs). These entities are hired by the project owners for performing the validation and, except in the case of small-scale projects, the DOE validating projects cannot verify the emission reductions generated by the projects. DOEs need to check the conformity of proposed activities against the set of requirements and rules defined by the EB. Researchers emphasized the inherent flaws of delegating authority under the CDM to private actors (Hickmann 2013), while others pointed to the fact that the risk of losing accreditation outweighs the potential benefits of gaming the system (Shishlov 2012). Third-party auditors also faced challenges in safeguarding environmental integrity, due to lack of clear guidelines on how to interpret existing rules and requirements for CDM activities, hiring of DOEs by the project owners and resulting

in pressures on projects registration, time and ability of the DOEs in developing sufficient internal expertise (Dyck 2011). Researchers pointed out that interactions between buyers and verifiers, including disputes, should be regulated in a stable legal framework (Simonetti 2010). Introduction of a materiality threshold for verification at UNFCCC level might reduce transaction costs and increase DOEs' objectivity in validations and verifications, reducing inconsistencies (Cole 2011).

Response and Contribution of the Bank Group in Addressing the Challenges

During this period, acknowledging the challenges in successfully redirecting finance flow toward low-carbon alternatives (World Bank 2010a), the Bank Group established new carbon funds and initiatives with different goals: the Umbrella Carbon Fund in 2006, with the mandate to purchase large volumes of emission reduction units; the Carbon Delivery Guarantee in 2007, that aims at reducing the delivery risks of carbon projects; the FCPF in 2008, whose goal was to provide capacity building for developing countries regarding the forestry sector; the Carbon Partnership Facility in 2009, to support development of large-scale projects and programmes. The PMR was launched in 2010, to support countries and to provide technical assistance for the design and implementation of carbon pricing initiatives at domestic level.

The only peer-reviewed article assessing the role of the Bank Group in carbon markets in depth is (Michaelowa and Michaelowa 2011) which finds on the basis of an econometric analysis of over 2000 CDM projects registered until May 2010 that the Bank Group did not differ from the standard CDM market players, that is, there is no strong focus on pro-poor projects. However, in comparison with the entire set of CDM projects, the Bank Group's portfolio shows an orientation toward low-income countries. It is stressed that, still, hardly any of the CDM projects can be considered as strongly pro-poor. Nevertheless, in comparison to the rest of the CDM projects, the World Bank's portfolio shows a relatively clearer orientation toward poor countries. Within these countries, however, the World Bank does not show any particular pro-poor focus, and tends to implement those projects that are commercially most attractive. Moreover, there was no evidence of the World Bank phasing out its activities once the market became fully operational (Michaelowa and Michaelowa 2011), which goes against its professed pioneering and catalytic role in carbon markets.

In the context of REDD, Bank Group positioning helped get an agreement on forest at the COP 13 in Bali held in 2007 (Potvin and Bovarnick 2008). However, its engagement in large infrastructure projects infringing on forests was seen as inconsistent (Horta 2011). An analysis of one forestry project financed by the Biocarbon Fund in Madagascar finds that without integration of agricultural policies, involvement of local communities and channeling of the maximum share of carbon

revenues to them and appropriate land use rights, the project will adversely impact natural forests and biodiversity (Pollini 2009). It was asked the Bank Group to enhance involvement of indigenous peoples in the decision-making process of projects under the Forest Carbon Partnership Facility (FCPF) (Anonymous 2011). The Bank Group replied to this critic arguing that all projects that would be financed by the FCPF will gain support from indigenous communities after their prior, free and informed consultation (Bosquet 2011). A review of the FCPF found that it was delivering positive results in assisting countries in achieving emission reductions in the forestry sector and in generating and disseminating knowledge among participants. Less progress was made on enhancing livelihood and biodiversity conservation, and piloting a performance-based payment system (World Bank 2012).

A review of the IEG (World Bank 2010b) on climate related activities of the Bank Group found that investments in renewables were targeting mostly hydropower, then solar power and limited investments on wind power. Regarding EE, Bank Group mainly provided guarantees and technical support to intermediaries with the goal of supporting lending to companies seeking funds for the implementation of EE projects. Regarding climate finance, the IEG recognizes that the Bank Group activities played and important demonstration role on carbon markets and contributed also to the strengthening of the market infrastructure. It recognizes however that, instead of progressively exiting the carbon markets after having invested in high risk pilot area, the Bank Group continued to increase its carbon finance activities moving also toward lower risk segment of the carbon market, such as low-cost HFCs projects in China. Finally, support to technology transfer delivered mixed results.

An assessment of different CDM projects promoting local SD benefits beyond mitigation, including those under the Gold Standard and those supported by the CDCF (Nussbaumer 2009), finds that labelled activities tend to have better performance regarding contribution to local SD, even if this is not the case for all projects. It also sees the CDCF as a potential contributor to addressing existing concerns on issues related to SD contribution of CDM activities and unbalanced distribution of projects (Nussbaumer 2009). Technical assistance is an important component for the development of carbon markets. The IFC provided both technical assistance and supported loan guarantees to establish a market for financing energy efficiency investments under JI in Hungary.

Summary of the Period 2006–2011

Table 2. Summary of the Period (2006–2011).

Time Period	Main Features of the Period	Key Challenges	Bank Group Responses
2006–2011 "Gold rush" of the carbon markets, with increasing numbers of mitigation projects implemented and credit prices rising	• After the initial testing period the carbon markets commences a phase of great expansion. EU is the main source of demand for CDM credits, while China and India dominate the carbon market • Improvements of the rules of the CDM, with operationalization of the PoA concept • Governance and institutional set up, including capacity building needs, emerge as a key element for the carbon market functioning	• Additionality and baseline setting face significant issues affecting the environmental integrity of the CDM • Questionable contribution to SD and technology transfer • "Low-hanging fruits" and uneven geographical distribution, penalizing Africa • Forest sector under close scrutiny also during this period, to avoid adverse impacts and ensure delivery of local SD benefits • Projects risks are assessed in more details, through analysis of several years of operations • PoAs are seen as a positive development for reducing transaction costs of small-scale projects and contribute to a more balanced distribution	• Carbon Funds are seen as a positive element that can reduce project risks and support investment mobilization • Bank Group, through its Funds (Umbrella Carbon Fund, Carbon Delivery Guarantee) and the IMF, contributes to increasing demand for carbon credits, mitigating project risks and capacity building in developing countries to strengthen the carbon market • CDCF is in a good position for contributing to addressing the issues related with forestry projects • FCPF launched to support target countries in the REDD+ readiness and large-scale crediting in the forest sector • Establishment of new initiatives to support high-quality activities (for example, Ci-Dev) and promote large-scale projects under PoA approach (for example, CPF) • IFC launces the P12CF to help buyers and sellers mitigate carbon market risks in 2013–2020 (but was short-lived) • World Bank launches the UCF – T2 to boost the post-2012 demand for credits and support carbon markets • Questions are raised on Bank Group carbon finance operations regarding its operation on the carbon market, not prioritizing poverty alleviation and acting as a commercial intermediary

4. Fragmentation of Carbon Markets in 2012–2015

Main Features of the Period: Volatility and Decline of Carbon Markets

Falling Demand for Carbon Credits

The main source of demand for CDM and JI credits—the EU ETS—started to fade in 2011–12 as the issuance of CERs and ERUs started reaching the quantitative limits on the use of offsets. This limit was set to ensure that at least half of the emissions reductions necessary under the KP would be achieved domestically. This is often referred to as "supplementarity principle" (Michaelowa 2014). The total demand for international carbon credits from the EU ETS was thus estimated at around 1.6 billion tCO_2e until 2020 (Bellassen et al. 2012).

Another important source of demand for carbon credits came from governments of countries – most notably Japan – that required them for compliance under the KP. Indeed, the analysis of the final data for national GHG emissions and exchanges in carbon units during the first KP Commitment Period demonstrated that overall, the Annex 1 parties to the KP surpassed their aggregate commitment and that all individual countries were in compliance, with 9 of 36 countries – Austria, Denmark, Iceland, Japan, Lichtenstein, Luxembourg, Norway, Spain and Switzerland – achieving it only thanks to the use of flexibility mechanisms (Shishlov et al. 2016). This source of demand was estimated to be around 300 million tCO_2e between 2008 and 2015 (Bellassen et al. 2012).

Heindl and Voigt (2012) estimated that should the OECD countries fulfil the "Copenhagen Pledges" and seek cost containment, the potential demand for carbon offsets would be 627-667 $MtCO_2e$ per year. However, the "Copenhagen pledges" were never translated into binding emissions reduction targets, for example, under the second Kyoto Commitment period. Moreover, the Doha Amendment that prolongs the Kyoto Protocol into its second Commitment Period (2013–2020) never entered into force, since it was not ratified by a sufficient number of countries.

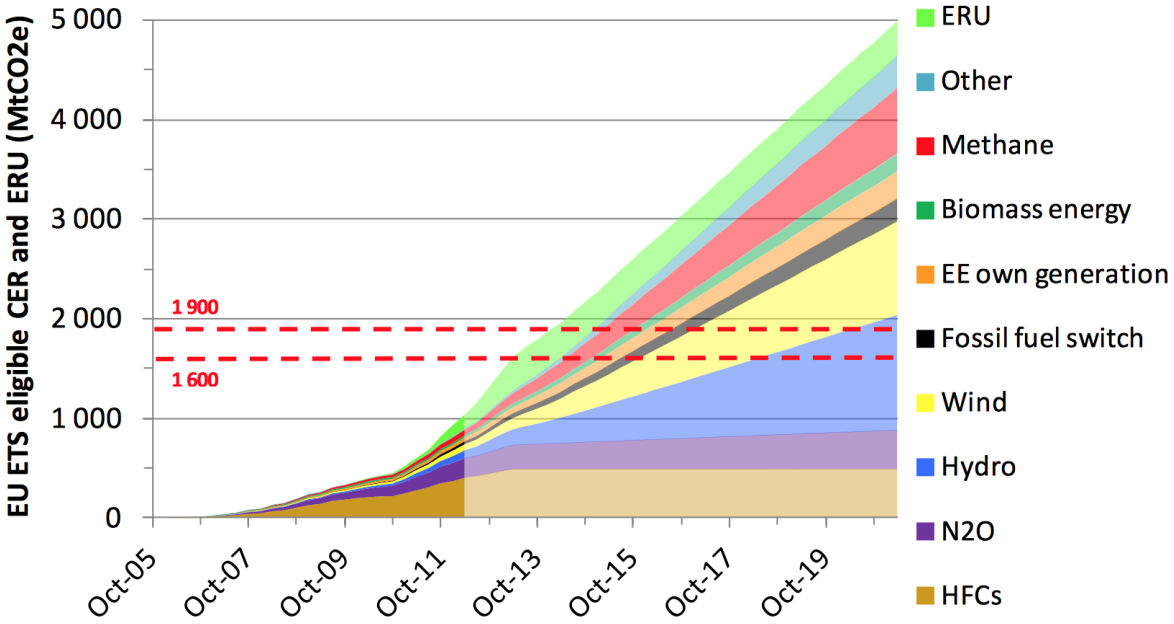
Increasing Supply of Carbon Credits

On the supply side, the CDM was stably delivering CERs. The supply of offsets is weakly sensitive to prices in the short run: once the initial investments in a project are undertaken, it makes sense to issue CERs as long as carbon revenues exceed marginal operational and transaction costs (Shishlov 2012). It was demonstrated that transaction costs for CDM projects range from less than USD 0.1/tCO2e for large industrial gas projects to USD1.5/tCO2e and above for small-scale projects (Shishlov and Bellassen 2016). Toward the end of the first Commitment Period there was a

large increase of issuance of carbon credits from JI projects in the Russian Federation and Ukraine, which is usually explained by the rush to sell credits before the demand fades. This "flood" of JI credits further contributed to the oversupply of the market although this was forecasted ex ante (Korppoo and Gassan-Zade 2014).

Steadily increasing supply of carbon credits was thus rapidly saturating the aggregate demand – from the EU ETS and national governments – which was estimated at between 1.6 and 1.9 billion tCO_2e until 2015 (Figure 4). Based on this supply-demand disequilibrium Bellassen et al. (2012) forecasted that CER and ERU prices would collapse, which proved prophetic.

Figure 4. Issuance and Forecasted Issuance of EU ETS-Eligible Kyoto Offsets.

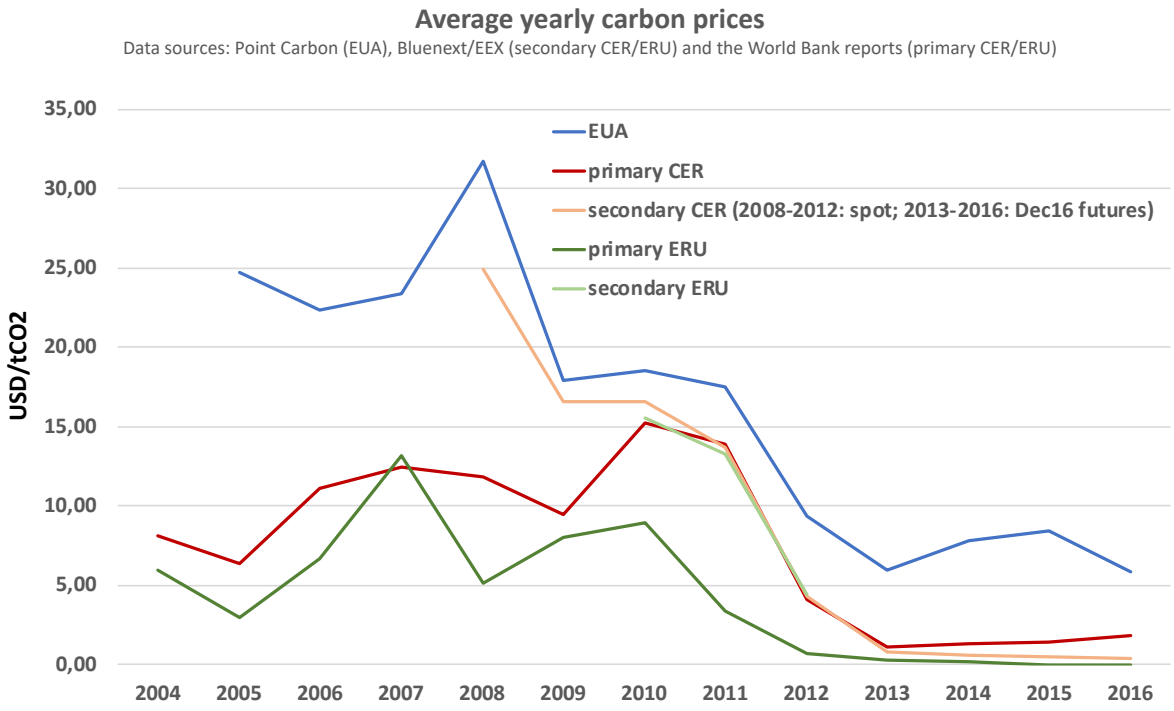


Source: Bellassen et al. (2012)

Falling Carbon Credit Prices

CER prices were largely correlated with the EUA prices until late-2011 (see figure 5 below). EUA prices have been following an overall downward trend following the economic recession, emissions reductions due to other policies (for example, renewable energy), as well as the inflow of international offsets (Koch et al., 2014). As the CER import limit was filling up, starting in late-2011 an increasing decorrelation between EUA and CDM credit prices could be observed culminating in CER prices collapsing below EUR 1/tCO_2e.

Figure 5. Development of Carbon Prices in Different Submarkets



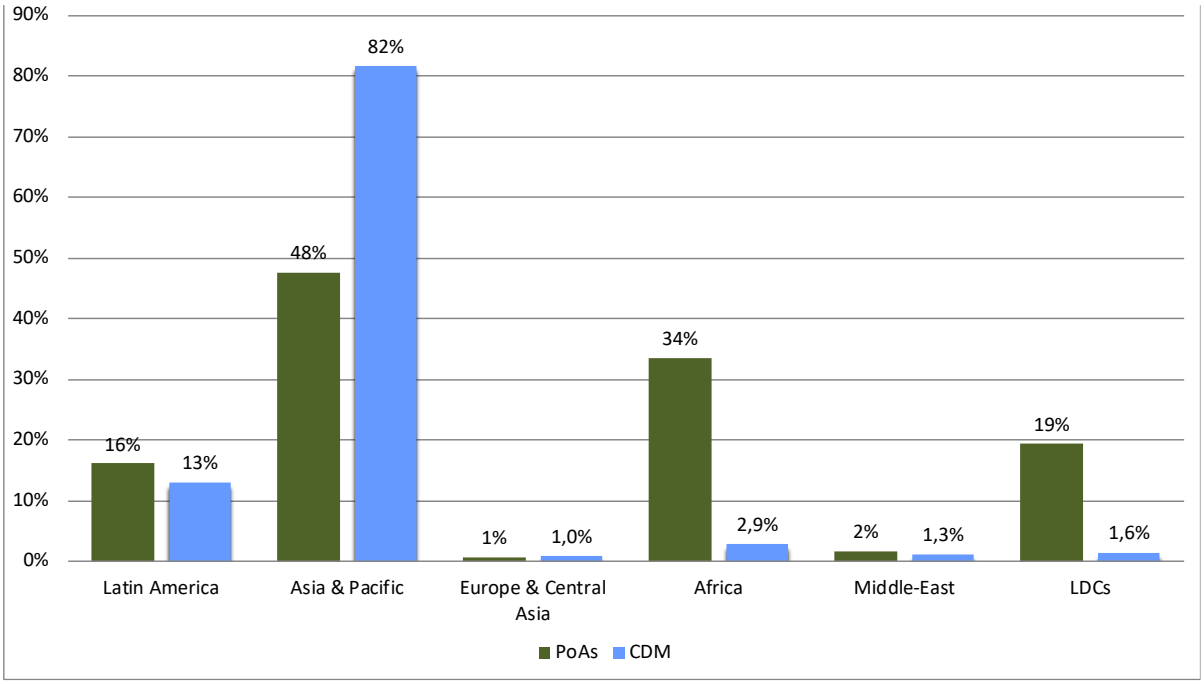
Key Market and Regulatory Challenges in This Period

Lack of Demand for Credits to Sustain Projects

While the CER prices were falling, the costs of mitigation actions under the CDM were going up with time as project developers started to exhaust the "low-hanging fruits" or cheap options (Rahman et al. 2015). The fall in carbon prices was the result of several factors: regulatory uncertainty on the future of the CDM in the post-2012 climate regime; reduced demand for CERs; and increased supply of offset projects. The price increase in turn led to a large reduction in the number of new CDM project registrations.

The fall in carbon credit prices was particularly painful for LDCs where Programmes of Activities (PoAs) had finally started to foster many new projects and where past capacity building had started to bear fruit (Kreibich et al. 2017). Africa represents 34 percent of PoAs compared with only 3 percent of regular CDM projects, while LDCs account for 19 percent of PoAs compared with only 1.6 percent of regular CDM projects (figure 6). The declining market, however, threatened the gradual loss of this accumulating capacity of low-income countries to develop low-carbon projects.

Figure 6. Geographical Distribution of PoAs And CDM Projects until 2017.



Source: UNEP DTU (2017b)

Uptake of Household-Level Technologies in Developing Countries

The accumulating experience with PoAs focused on household appliances in developing countries demonstrated that the uptake of new technologies might be much lower than expected. This was confirmed by case studies of projects focused on improved cookstoves in India (Aung et al. 2016) and Kenya (Freeman and Zerriffi 2014) and water filters in Kenya (Pickering et al. 2017) raising issues about ex post monitoring of emissions reductions and other co-benefits. It was suggested that more rigorous research was needed to be able to verify underlying assumptions and monitoring approaches for household water treatment projects (Summers et al. 2015) and cookstoves (Lee et al. 2014). For cookstoves, it was additionally suggested that not enough effort has been directed to assessing the improved air quality (Balakrishnan et al. 2015).

However, these results are not unequivocal, as at the same time, a case study of improved cookstoves and water filters in Rwanda demonstrated very high uptake rates. It was suggested that continued engagement with households contributed to high adoption rates (Barstow et al. 2016).

An important challenge in using carbon finance for low-income households is that the current consumption may not reflect the real need for basic services. The CDM rules have evolved to include the consideration of this "suppressed demand" in baselines, but challenges remained to balance simplification with maintaining environmental integrity (Randall 2015). The PoA structure also supported the

dissemination of such household technologies more efficiently than project-based activities.

Accelerating CDM Reform

At its 63rd meeting in September 2011, the CDM EB decided to establish a High-Level Panel to conduct a policy dialogue involving the civil society, policymakers and market participants. The intent was to review past CDM experience and prepare the mechanism for the post-2012 period. The Panel was composed of 11 leaders of companies, NGOs and governmental bodies not directly involved in the CDM. The policy dialogue consisted of 58 public input submissions, 18 consultations with stakeholders and 17 informal meetings. In September 2012 at the 69th meeting of the CDM EB, the Panel published the final report consisting of 51 recommendations that address not only the CDM EB, but also other stakeholders including national governments, the UNFCCC and project participants (UNFCCC 2012).

Key issues addressed in the CDM Policy Dialogue were (i) streamlining the project cycle; (ii) changing the methods for determining additionality; (iii) modifying the role of the secretariat; (iv) improving the validation and verification model; (v) professionalization of the EB; (vi) implementation of an appeals mechanism; and (vii) strengthening the current stakeholder consultation system (Classen 2012).

As discussed earlier, during the CDM's initial "gold rush" period, many nonadditional projects were registered because project developers could claim additionality using an ill-defined "barrier test." As a reaction, regulators replaced the barrier test by an investment test, which immediately resulted in the share of nonadditional projects falling substantially (Michaelowa and Butzengeiger 2017).

Response and Contribution of the Bank Group in Addressing the Challenges

While the decline in the CDM was particularly painful for African countries and other LDCs, the important role for public finance institutions in this period was to fill in the demand gap for carbon credits to ensure the continuation of existing and take off of planned projects. In this light, the World Bank continued to honor the agreements in the ERPAs and paid fixed prices for CERs and ERUs, which was part of the approach to indicate continued commitment to carbon markets. New initiatives were also launched with the intention to create demand and reduce the negative impacts of the market crisis.

First, the World Bank continued its efforts to support for carbon markets through the Carbon Initiative for Development (Ci-Dev) which concluded emission reduction purchase agreements with CDM projects and programs in Africa (World Bank 2015). Ci-Dev focuses on underrepresented sectors, as well as innovative and transformational projects, including rural electrification, improved energy efficiency,

and waste management (Michaelowa et al. 2016). Ci-Dev thus provided a lifeline to activities that otherwise would have been stalled given the market conditions.

Second, the Pilot Auction Facility launched in 2014 – a results-based payment mechanism which sets a floor price for future carbon credits in the form of a tradable put option, competitively allocated via auctions – targeted the non-bank-supported CDM methane projects which were at the risk of discontinuation. The Pilot Auction Facility also demonstrated that subsidies offering a guaranteed price for future emission reductions through auctions help maximize climate impact per public dollar while incentivizing private investment in low-carbon technologies (Bodnar et al. 2017).

Finally, the Partnership for Market Readiness (PMR) is currently the only international initiative explicitly aiming at fostering the development of domestic market mechanisms, which could fill in the void created by the CDM decline supporting the design and implementation of carbon pricing initiatives. The PMR targets 19 middle income countries, while low-income countries are currently excluded from the program (Dransfeld et al. 2015).

Besides providing financial support to projects in the times of the carbon market crisis, the World Bank actively engaged in the policy dialogue to support regulatory reforms, notably the CDM Policy Dialogue. For example, a World Bank's study suggested the extension of the scope of standardization to include monitoring and verification, standardization of project registration procedures and further standardization of the procedures for PoAs addressing micro-scale activities (Platonova-Oquab A. et al. 2012).

Summary of the Period

Table 3. Summary of the Period (2012–2015)

Time Period	Main Features of the Period	Key Challenges	Bank Group Responses
From 2012 until 2015: Fragmentation and decline of carbon markets due to carbon price collapse	• Uncertainty on the future climate regime and lack of mitigation ambition from Annex I countries affect negatively the carbon markets • After failure of the Doha Amendment in December 2012 on ratification of the second commitment period of Kyoto (CP2), prices drop quickly reaching all-time low. Investors have less confidence on market mechanisms • Regarding the JI and CDM, only PoAs still show signs of life, with submission for registrations and issuances, although with limited numbers	• Carbon credit supply hits the demand ceiling • Supply-demand disequilibrium leads to carbon price collapse • Carbon prices are too low to sustain projects • Risk of project discontinuation and capacity loss • CDM reforms	• Some carbon funds terminated while IFC closed its carbon business. • Pilot Auction Facility establishes a floor price for carbon for some methane projects. • UCF—T2, Ci-Dev, CPF sign ERPAs from selected projects to bridge demand gaps. • PMR supports capacity building for domestic market readiness and the development of carbon pricing schemes in targeted high emission countries. • FCPF strengthens capacity building in REDD+ readiness. • BioCF ISFL launched to provide support for enabling environment, investments, private sector engagement, and upscaled crediting for landscapes in selected countries. • Engage in the policy dialogue to support regulatory reforms.

5. Carbon Markets and Regulatory Frameworks Post-Paris

Main Features of the Period: Post-Paris Revival of Carbon Markets

Evolving International Climate Policy Regime

The 21st Conference of Parties (COP21) held in Paris in December 2015 marked an historical turning point regarding fighting climate change: the Paris Agreement (PA) established ambitious global mitigation targets, with the goal of limiting temperature increase well below 2°C, with efforts to contain the temperature increase within 1.5°C (Art. 2). Moreover, a balance of emissions by sources and removal by sinks is to be reached by the second half of the century (Art 4.1). A global stocktaking (Art. 14.1 and 2) will be undertaken every five years, starting in 2023.

Unlike the KP that only covered developed countries the PA adopted in 2015 involves global participation, which comes, however, at the cost of increasing complexity. Instead of a uniform formula, the PA allows Parties to voluntarily define their Nationally Determined Contributions (NDCs) indicating the mitigation and adaptation targets for each Party under the PA and can also identify the instruments and measures to achieve them. This new regime, however, resulted in a significant level of heterogeneity complicating mitigation accounting (Kreibich and Obergassel 2016). The international climate regime has thus changed its character from a top-down approach based on mandatory emissions commitments to a bottom-up system of voluntary government pledges. Generally, the transition toward a bottom-up regime risks a reduction of transparency and increases in the transaction costs of mitigation (Michaelowa 2015).

Market Mechanisms under the Paris Agreement

The fate of international carbon markets post-Kyoto remained uncertain for a number of years. The negotiations under the UNFCCC on the New Market Mechanisms (NMM) and the Framework for Various Approaches, which covers both market-based and non-market-based approaches, have been ongoing since COP13 in Bali in 2007. Limited progress has been achieved by 2012 and a number of important design elements remained outstanding in the negotiations concerning the NMM and its modalities and procedures (Kulovesi 2012). These negotiations advanced slowly toward COP21 and the inclusion of cooperative mechanisms into the PA was one of the last-minute surprises (Dransfeld et al. 2016).

To encourage international collaboration and improve the cost-effectiveness of the achievement of NDCs, the Article 6 of the PA provides an array of market and nonmarket mechanisms:

- **Article 6.2** defines Cooperative Approaches (CA) which can be used to transfer "internationally transferred mitigation outcomes" (ITMOs) to fulfil a country's NDC targets. CAs are generally understood to be a mean through which parties can trade ITMOs bilaterally or in groups for instance through GHG crediting mechanisms, linking of emission trading schemes or direct government-to-government transfers. The mechanism is subject to UNFCCC guidance, but not direct international supervision. It can therefore be compared with International Emissions Trading and the JI Track 1 under the Kyoto Protocol.

- **Article 6.4** establishes a new market mechanism for generation of emissions credits – often called "Sustainable Development Mechanism" (SDM) – which is centrally governed by a UNFCCC body and is also meant to contribute to sustainable development in host countries. From the governance standpoint, the SDM can thus be compared with the CDM and JI Track 2.

- **Article 6.8**, in contrast to the SDM and CAs, "recognizes" the importance of nonmarket approaches to (i) Promote mitigation and adaptation ambition; (ii) Enhance public and private sector participation; and (iii) Enable opportunities for coordination across instruments and relevant institutional arrangements. At this point in time it is unclear how such approaches will function at the end. Article 6.8 might for example become a framework for public climate finance flows.

Emerging National and Regional Carbon Pricing Initiatives

While the global carbon market under the KP declined, there has been an increasing number of carbon pricing initiatives around the world in the past several years. According to the World Bank, as of 2017, 42 national and 25 subnational jurisdictions have implemented carbon pricing (ETS or carbon tax) covering about 8 Gt CO_2e or about 15 percent of global GHG emissions. According to the World Bank's "State and Trends of Carbon Pricing" Carbon prices vary drastically from less than $1 to over $140 with the total global annual value of over $20 billion (Zechter et al. 2017). Moreover, 81 of the 155 Parties that have submitted their NDCs have indicated the intention to use carbon pricing as a tool to meet their commitments (Zechter et al. 2017). Further growth of carbon pricing initiatives including emissions trading schemes around the world can therefore be expected in the coming years. The combination of existing, emerging, and potential carbon market mechanisms can be regarded as an emerging pre-2020 fragmented global carbon market landscape based on differing bottom-up market-based approaches (Redmond and Convery 2015). While it is expected that carbon prices will be applied in an increasing number of jurisdictions, some suggested that carbon price levels will remain relatively low, and their mitigation benefits will be more than outweighed by the growth of infrastructure and consumption (Michaelowa 2015).

Key Market and Regulatory Challenges in This Period

Increasing the Mitigation Ambition

The purpose of international carbon markets has changed from increasing economic efficiency to raising mitigation ambition (Cames et al. 2016). For example, while the CDM could theoretically increase ambition and provide "net mitigation" when crediting periods are shorter than the project lifetime, additionality issues put this possibility into question (Erickson et al. 2014). Discounting carbon credits and using baselines below business-as-usual were put forward as potential solutions (Warnecke 2014).

One of the suggestions to boost ambition, was the creation of a Club of Carbon Markets that would establish common standards for market infrastructure, transparency and environmental integrity (Nathaniel et al. 2017). It was argued that such a club could foster increased participation in climate change mitigation in the same way as the General Agreement on Tariffs and Trade helped broaden trade in products and services.

Linking different national and regional ETS was suggested to improve their economic efficiency and potentially help raise ambition. At the same time, there are some important risks related to linking, such as loss of control over domestic carbon policies (Ranson and Stavins 2016). "Exchange rates" were suggested to be used for linked systems in a similar way as currency exchange rates function (Pillay and Vinuales 2016). Haites and Wang (2009) points out that linking different emission trading scheme does not in itself necessarily ensure higher environmental integrity of the linked systems. Moreover, actual difficulties should be considered, and policy development and institutional cooperation are necessary to link different schemes. In the past, (Tuerk et al. 2009) found that in 2009 only little advancement could be theoretically made to link different schemes, due to differences in policy priorities and needs for harmonization. Even if difficulties are present due to different domestic and international policies, it was argued that the EU and the United States would benefit from a linked carbon market (Sterk and Kruger 2009). The issue of linking the fragmented carbon pricing initiatives therefore remains one of the open questions in the post-Paris international climate regime.

Baselines and Additionality for Mechanisms under Article 6

While the Article 6 mechanisms may provide governments with access to less costly mitigation options they could also provide an important incentive to increase the ambition NDCs over time. However, in order for this potential to be realized additionality must be defined carefully in the context of the Paris Agreement, especially if applied to policy instruments (Michaelowa 2017).

Using the CDM experience, it was argued early on that new market mechanisms should be focused on ensuring a high level of environmental integrity (Newell 2012a) particularly through the determination of project additionality (Bento et al. 2015a; Michaelowa and Butzengeiger 2017) and the emissions baseline used to calculate crediting volumes (Michaelowa 2012; Bento et al. 2015b). Indeed, many NDCs have baselines that are above any credible business-as-usual path. It is thus highly likely that a significant number of NDCs would generate "hot air" if NDC baselines were to be used as a basis for crediting emission reductions or allocating emission allowances. The experience gained with JI leads to a clear recommendation for the Paris mechanisms – international oversight is crucial to prevent transfers of "hot air" (Michaelowa and Hoch 2017). The issue of additionality under the Article 6 of the PA is further complicated by three factors (Spalding-Fecher et al. 2017). First, the nature of the conditionality of the NDC pledges is not clear. Secondly, there is a number of technical issues with translating the NDC pledges into metrics that are suitable for baselines and additionality assessment. Thirdly, using NDC pledges for crediting baselines assumes that these pledges are below business-as-usual emissions, which is not the case in practice (Michaelowa and Hoch 2017). In the context of the Article 6 of the PA an additionality algorithm was suggested depending on whether a given activity is covered by an NDC, whether it is conditional or unconditional and whether an NDC is likely to generate "hot air" (Michaelowa and Butzengeiger 2017).

An important issue that was raised for renewable energy projects in developing countries was the fact that in the context of widespread energy shortage, the extra electricity produced by the CDM projects is more likely to be used to provide extra electricity supply rather than substitute the business-as-usual electricity supply (Zhu and Tang 2015). Appropriate baseline setting was found to be the best instrument for minimizing nonadditional offsets compared with trade ratios and quantitative limits (Bento et al. 2015b).

It will also be important to make sure that the flexibility mechanisms do not deter setting ambitious emissions reduction targets and/or policies. Indeed, some researchers argued that the CDM is not neutral on the global level of carbon emissions as it entices countries to raise their emission caps (Brechet et al. 2016). It was therefore suggested that for future market mechanisms, a coordinated approach is needed to address potential trade-offs between global and national incentives at the sectorwide level (Liu 2015).

Issues Related to Monitoring, Reporting and Verification (MRV)

Monitoring, Reporting and Verification (MRV) is paramount in ensuring the environmental integrity of carbon markets and will therefore have to be properly addressed in the rules for the implementation of the Article 6 of the Paris Agreement. MRV, however, comes at a cost that in the CDM ranged from a few cents to EUR 1.20 and above per tCO_2e depending on the project type. Generally, there is a trade-off

between the stringency and the cost of monitoring, which if not addressed properly may become a major barrier for the implementation of mitigation projects in some sectors, particularly in the context of currently low carbon prices (Shishlov and Bellassen 2016). For example, monitoring rules under the CDM are often more stringent than those under the EU ETS, which could potentially put an unreasonable burden on project developers (Warnecke 2014).

Double counting is another important carbon accounting issue that needs to be addressed under the PA. The key challenge is that double counting can occur in several different ways, such as double issuance and double claiming. While avoiding these problems is difficult it is technically possible through a coherent set of rules for accounting of units, design of mechanisms, and tracking and reporting of units (Schneider et al. 2015).

The Future Role of the CDM

The future role of the CDM remains uncertain and will depend on the evolution of countries' NDCs and the development of the "Paris Rulebook" particularly for Article 6 of the PA. While the CDM is part of the KP, it could theoretically continue beyond 2020, for example, if recycled into the Sustainable Development Mechanism (SDM) under Article 6.4 of the PA. In this respect, different scenarios for the CDM future – from expansion to phase-out – can be envisaged (Vivid Economics 2012).

With regards to pre-2020 action, several recommendations were suggested, most notably (Cames 2016):

- Limiting the purchase of CERs to either existing projects with discontinuation risk, such as landfill gas flaring, or to new projects that have a high likelihood of ensuring environmental integrity.
- Accompanying purchase of CERs with support for a transition of host countries to broader and more effective climate policies.
- Focusing international crediting mechanisms to address specific emission sources in countries that do not have the capacity to implement alternative climate policies.

In some instances, the CDM might be seen as a transition mechanism to other climate policies, once the abatement cost has been discovered by the market. This was the case, for example, with HFC emissions that were included in direct regulations under the Montreal Protocol after the initial experience under the CDM. In some countries – most notably China – the CDM is being transformed into a domestic offsetting mechanism under the newly piloted national carbon trading scheme with more than 2000 projects re-validated for this purpose (Lo and Cong 2017).

Sustainable Development Benefits and Avoiding Harmful Effects

As the Article 6.4 of the PA explicitly focuses on sustainable development benefits, the issue of alignment of climate and development agendas is gaining new momentum. Studies demonstrated that existing frameworks under the CDM, REDD+ and GCF do not sufficiently integrate the issue of sustainable development in their rules and processes, as host countries' governance entities maintain the decisive role in the approval process (Horstmann and Hein 2017).

While the CDM did not provide explicit incentives for boosting SD benefits, the voluntary carbon market might have partially achieved that objective. For example, (Parnphumeesup and Kerr 2015) found that 56.4 percent of the buyers were willing to pay a price premium (on average EUR 1.12/tCO_2e) for carbon credits certified under the Gold Standard. Charity groups and governments are more likely to place a price premium on certified credit than private sector buyers. Torabi and Bekessy (2015) demonstrated on the example of carbon sequestration projects in Australia that corporate social responsibility was the main driving force for business interest in the co-benefits of carbon projects.

One issue related to sustainable development is making sure that carbon market mechanisms do not produce harmful environmental or social impacts, which was raised as an important issue in several sectors. For example, Leonard (2015) argued that carbon finance projects in the waste sector in South Africa stimulated waste accumulation to secure methane for carbon credits rather than fostering broader recycling, which has negative social and local environmental impacts. Gender issues related to improved cookstove projects in Africa were also raised (Wang and Corson 2015).[9]

Sector-Specific Considerations

While energy efficiency improvements are deemed to be one of the most important options to mitigate GHG emissions, studies demonstrated that carbon pricing signals might not be sufficient to unlock large-scale investments. For example, a survey of 509 industrial and commercial firms in Ukraine showed that an array of economic, behavioral, and institutional barriers may impede the deployment of energy-efficient technologies. Complementary policies, such as information provision and energy audits, might therefore be necessary to achieve the required emissions reductions from such policy change alternatives (Hochman and Timilsina 2017).

It was demonstrated that for many projects related to urban infrastructure investments, such as in transportation, the value of co-benefits of low-carbon investments by far outweighs the value of the carbon emissions reduction (Rashidi et al. 2017). However, as the case study of the Delhi Metro CDM project demonstrates, the evaluation and attribution of reduced local pollution (N_2O and PM) might be challenging (Goel and Gupta 2017). Overall, it was suggested that carbon finance in

the form of the CDM might not be suitable for low-carbon infrastructure investments in African cities (Silver 2015).

Cities might therefore require a more holistic approach through low-carbon development strategic planning. The World Bank together with DNV KEMA Energy and Sustainability successfully supported the development of the Low Carbon City Development (LCCD) Programme for Rio de Janeiro (Rescalvo et al. 2013).

The objective of balancing GHG emissions and sinks under the PA puts an implicit emphasis on CCS technologies. CCS was officially included in the CDM in 2011 after several years of negotiations (Thorpe 2012; Dixon et al. 2013). However, there was no uptake due to very high abatement costs of this project type. For example, it was estimated that a carbon price of above USD 50/tCO_2e is required to make CCS CDM projects feasible in India (Eto et al. 2013). The overall suitability of CCS as a mitigation solution was questioned from a political and climate governance standpoint, since it raises the question about the potential continuation of the use of fossil fuels (Krüger 2017).

"Blue carbon" activities provide a large potential for carbon sequestration and several countries including Kenya, India, Vietnam, and Madagascar have been piloting these activities using carbon finance (Wylie et al. 2016). A case study of Philippines demonstrated that tapping into the "blue carbon" mitigation potential requires carbon prices of USD 5-12/tCO_2e (Thompson et al. 2014). The case study of Guinea-Bissau indicated the necessary carbon price in the range of USD 6.7-7.2/tCO_2e (Vasconcelos et al. 2015). The potential for inclusion of "blue carbon" activities under the mechanisms of the PA (articles 6.2 and 6.4) remain uncertain (Herr et al. 2017).

Response and Contribution of the Bank Group in Relaunching Markets

In 2015, the World Bank unveiled the Transformative Carbon Asset Facility (TCAF) that has the aim to develop pilot activities for scaled up crediting under the Paris Mechanisms. This facility is innovative, as it goes beyond project-scale crediting and allows for crediting of policy measures, such as clean energy targets and industrial efficiency standards.

The Carbon Pricing Leadership Coalition (CPLC) launched at COP21 aims at fostering the accelerated deployment of carbon pricing initiatives around the world. It is structured around four working groups: fostering government leadership, building and sharing evidence base, mobilizing business support and communicating. As of 2017 the CPLC brings together more than 25 national and subnational government partners, over 150 private sector partners and over 30 partners representing NGOs and academia.

The Networked Carbon Markets (NCM) initiative is working with governments, the private sector, academia and civil society to develop and pilot innovative tools, services and institutions that could support bottom-up, linked international climate markets.

Finally, the newly launched IFC Forest Bonds is an innovative fixed income financial instrument that aims to pay a coupon in the form of carbon credits to bondholders.

The World Bank has also continued capacity building activities from the previous phase, most notably the PMR and the FCPF.

With regards to new technology support, the Bank Group has continued its work through the Carbon Capture and Storage Trust Fund (CCS TF) established in 2009 to support CCS capacity and knowledge building in developing countries. The World Bank CCS TF donors include the governments of the United Kingdom and Norway, and the Global Carbon Capture and Storage Institute. Pilot activities of Phase 1 has already been launched in nine countries. For example, in Botswana, the CCS TF support included such activities as: identifying potential geological reservoirs; evaluating institutional and regulatory arrangements; and providing training, education and capacity building (Beck and Kulichenko-Lotz 2017a). Similar activities were undertaken in Mexico and it was demonstrated that they were an important step for building capacity and increasing the awareness of CCS among the various stakeholders (Mourits et al. 2017). In South Africa, after the initial studies on the regulatory framework for CCS, techno-economic review of CCS implementation and the development of a national and local public engagement plan, the implementation of the Pilot Carbon Storage Project (PCSP) is planned as the next milestone to be completed between 2017 and 2021 (Beck et al. 2017).

Summary of the Period

Table 4. Summary of the Period (2015–present)

Time Period	Main Features of the Period	Key Challenges	Bank Group Responses
Post-Paris of "relaunch" of market mechanisms	• Prices in the carbon markets are still very low. Limited activities in the international carbon markets • The PA brings positive developments regarding market instruments through Article 6. Detailed modalities and procedures for the new mechanisms (that is, the SDM and CAs) are still to be defined • An increasing number of developed and developing countries implements or plans to do so, carbon pricing initiatives, some of which allow the use of credits	• Need to increase mitigation ambition at global level • Transition of the CDM to the PA. Issues with baselines and additionality, and on MRV still discussed • Stronger emphasis on the importance of SD benefits and need to avoid negative impacts of market mechanisms • New "sectors" emerge: cities and urban development, "blue" carbon, continued discussion on Carbon Capture and Storage (CCS)	Launch of new activities with different specific focus: • TCAF, to identify pilot activities for upscaled crediting in the context of the PA • CPLC, NCM and the PMR, to support the design and development of carbon pricing initiatives at domestic level • IFC Forest Bonds to support REDD projects and pay the coupon in carbon credits • CCS Task Force for continued capacity building on CCS in developing countries

6. Synthesis of Findings

The international carbon markets experienced widely varying fortunes since the 1990s. This is due to political and economic drivers that affect the development of the carbon markets during the different phases. The global climate policy negotiations and events at different times therefore strongly shaped the emergence, evolution, development and expansion of the international carbon markets across countries and at the global level. The positive drivers include the interest to launch the concept of Joint Implementation (JI) an embryonic form of market mechanisms following the Earth Summit in 1992: the signing of the KP in 1997, the launching of the EU ETS and the entry into force of the KP in 2005; and the signing of the Paris Agreement in 2015. The headwinds included the opposition against JI by developing countries after the 1992 Rio Conference; the early reluctance of China and India to participate in the CDM; the global financial crisis of 2007/2008 that reduced industrial emissions and the salience of global climate policy; failure of the U.S. Cap and Trade Bill in 2010 that would have generated massive demand for international credits; the EU import restrictions for CDM credits after 2013; and the failure of the Doha Amendment signed in 2012 to prolong the Kyoto Protocol into its second Commitment Period (2013–2020) to enter into force as it until 2019 had not been ratified by a sufficient number of countries. The interplay of the current global climate policy negotiations, commitments and emerging regulatory framework under the Paris Agreement will determine the future directions for carbon markets.

However, there are some elements that are common over the entire period covered by this literature review. A large share of the literature examined covers the flexible mechanisms of the KP with a strong focus on the CDM. This is a consequence of the large success of the CDM in the carbon market, at least until 2011–2012, as well as the transparency of the mechanism. As different topics and issues related to the carbon market emerged, the Bank Group implemented different actions contributing to addressing them and generating experiences in developing countries for enhancing their participation. However, there is only limited literature covered in this review that assesses the Bank Group's strategies and operations.

Some specific topics that have been discussed during each period and examined in this review include the following:

- Efficiency of the flexibility mechanisms
- Environmental integrity
- Baseline and additionality for carbon crediting
- Forestry sector and the associated concerns on the negative impacts of market mechanisms in this sector on biodiversity and local and indigenous communities

- Contribution to SD in developing countries and for local communities
- Contribution to technology transfer

The Bank Group contributed to the establishment and development of the carbon market since the 1990s and it is still a key player for capacity building and for supporting mitigation activities that are at risk of being discontinued, as well as the implementation of carbon pricing initiatives at national levels. This review found that several positive impacts have been recognized and attributed to the Bank Group activities:

- Establishment of carbon funds, that were seen as groundbreaking models for accessing low cost GHG emission reduction, aggregating demand and through the Bank Group ability to manage them.
- Focus on specific sectors that, especially in the early periods, have been only marginally benefited from the carbon markets. This refers for instance to the CDCF, focusing on low-income countries and low-income communities and the Biocarbon Fund, targeting biodiversity protection.
- Also in terms of providing capacity building, Bank Group had been able to successfully deliver support to developing countries and to the market as a whole. Bank Group has supported countries and companies in developing expertise related to mitigation projects design, implementation and monitoring, including the support to CDM methodologies development and review.
- When the crisis of the carbon market erupted, Bank Group continued to support mitigation activities, through the Ci-Dev initiative and the Pilot Auction Facility, even though this support was not sufficient to stem the market decline. Also, capacity building remained one of the main pillars of the World Bank's strategy: substantial efforts are put in supporting the development of new carbon pricing mechanism through the PMR and the CPCL.

However, criticisms have also been raised regarding the Bank Group operations in the carbon markets. While initial participation of the Bank Group in the markets was seen as positive, questions have been raised on the Bank Group acting to a large extent as a commercial intermediary, rather than supporting market development and capacity building. Concerns have been raised also on the World Bank's actual contribution to poverty eradication, which is one of the key goals of the Bank Group, through its activity in the carbon markets. In other cases, NGOs and local communities target WBG–supported projects in the forestry sector: many views highlighted the risks associated with this type of projects regarding environmental

integrity, permanence of the carbon sinks, adverse impacts for indigenous people and leakage issues.

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[1] A *carbon credit* is a generic tradable certificate or permit for GHG emissions reduced or removed from the atmosphere (for example, tons of CO2e) from generating mitigation activity. It is hence an instrument that represents ownership of a standardized unit of GHG emission reductions that can be traded, sold, retired or transferred. Crediting here refers to the issuance of a carbon credit for an equivalent reduction of GHG emissions (for example, tCO2e). Offsetting refers to the use of carbon credits within different schemes, for example,, CERs could be used as offsets under ETS or domestic carbon pricing but can also be canceled and hence contribute to net mitigation.

[2] Annex B parties refers to developed countries listed in Annex B of the Kyoto Protocol signed in 1997 which are Annex I Parties (under the UNFCCC treaty signed in 1992) with first- or second-round Kyoto GHG emission targets. The first-round targets apply over the years 2008–2012. The second commitment period for 2013–2020 signed under 2012 Doha Agreement, an amendment to Annex B, has not entered into force.

[3] The connotation of the term JI changed from the earlier terminology used in the UNFCCC. While initially, JI indicated all activities tested during the initial introduction and test period of the market mechanisms, it later indicated only the activities that can be implemented in Annex I countries.

[4] The United States, even though supporting the introduction of the flexible mechanisms, did not ratify the Kyoto Protocol and hence never participated directly in use of the credits generated by these mechanisms.

[5] Carbon leakage occurs when economic activities that generate GHG emissions migrate from a jurisdiction with a strict policy on emissions to another jurisdiction with lax emission regulations. Inflated baselines and additionality issues are discussed in the following sections.

[6] “Hot air” indicates the large surplus of AAUs in some of the emerging economies following the reduction of GHG emissions due to the collapse of the socialist economies.

[7] The term “clean coal” indicates those technology that still use coal as a fuel but have a higher efficiency than conventional coal technologies. Examples are the supercritical and ultra-supercritical power plants, requiring less coal per unit of energy produced.

[8] Unilateral CDM are those project activities that are implemented by developing countries and the CERs generated by these activities are sold without any participation from Annex I countries.

[9] These authors highlight the role of women's labor in creating emissions reductions, which then become tradable virtual commodities with property rights to the verified emission reductions transferred from the improved cookstove users to an international nonprofit carbon credit developer. While introducing some improvements in cooking time and indoor pollution, the authors argue that transferred carbon credits ultimately constitute a gendered approach which can marginalize rural women by denying a potential future source of income. Carbon revenues can however be used by the nonprofits for expanding access and use of clean cookstoves to other women and households – potentially creating a win-win.

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Appendix A. Search Procedures and Results

Academic literature search was conducted using the HEC Paris Library[1] search engine that covers an array of databases, including among others (databases with more than 100 initial search results are listed here):

- Academic OneFile
- Academic Search Index
- BASE
- Business Insights: Essentials
- Business Source Complete
- Complementary Index
- Expanded Academic ASAP
- General OneFile
- General Reference Center Gold
- GreenFILE
- InfoTrac Newsstand
- Regional Business News
- ScienceDirect

The following search terms were applied:

("carbon price" OR CDM OR "market mechanism" OR "carbon finance" OR "carbon credit" OR "Carbon Fund" OR "Clean Development Mechanism" OR "Joint Implementation" OR "regulatory regime" OR "Article 6" OR "Kyoto Mechanism" OR "baseline methodology" OR "additionality" OR "compliance market" OR "voluntary market" OR "Paris Agreement") AND ("carbon")

The following additional criteria were applied:

- Year of publication: 1997–2018
- Source type: academic journals
- Publication type: peer-reviewed
- Language: English

The initial search yielded 5,353 results. After removing duplicates, we have removed publications that were deemed irrelevant to the topic of the review. Out of the remaining 1,148 papers we then excluded theoretical papers on emissions trading further narrowing the number of peer-reviewed papers to 792. Journals with more than five articles that were retained are listed in **Error! Reference source not found.**.

Since gray literature was excluded from the initial search, a number of key seminal papers and review articles were identified by recognized experts in the field after the general literature search. This was particularly important for literature on market mechanisms under the Paris Agreement due to the relatively recent emergence of the topic and lack of relevant academic literature that has passed the lengthy peer review process. The list of 19 seminal papers that were added using expert judgment is presented in **Error! Reference source not found.**. The total number of articles thus increased to 811.

The initial screening also revealed a lack of articles related to the World Bank's activities. It was therefore decided to add an additional search term: ("World Bank") AND ("carbon"). This additional search yielded 320 peer-reviewed articles, of which 157 articles were retained after excluding duplicates and irrelevant articles. The total number of publications included in the review is thus 968.

Appendix B. Journals with More Than Five Papers Retained

Journal	No. of Papers Retained
Energy Policy	67
Climate Policy (Earthscan)	39
Carbon and Climate Law Review	38
Ecological Economics	19
Climatic Change	17
Mitigation and Adaptation Strategies for Global Change	17
Mitigation and Adaptation Strategies for Global Change	15
Environmental Science and Policy	10
Journal of Cleaner Production	10
Global Environmental Change	10
Carbon Management	10
Journal of Environment and Development	10
Climate Policy	9
Energy Procedia	8
International Environmental Agreements: Politics, Law and Economics	8
Climate and Development	8
Renewable and Sustainable Energy Reviews	7
Energy and Environment	7
Waste Management	7
Global Environmental Politics	6
Journal of Sustainable Forestry	6
Energy for Sustainable Development	6
Total	334

Appendix C. List of Seminal Papers Added Using Expert Judgment

- Cames, Martin, et al. 2016. "How Additional Is the Clean Development Mechanism?" Berlin: Öko-Institut.
- Cames, Martin, Sean Healy, Dennis Taenzler, Lina Li, Julia Melnikova, Carsten Warnecke, and Marie Kurdziel. 2016. "International market mechanisms after Paris." Dessau: Deutsche Emissionshandelsstelle, Umweltbundesamt.
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- Dransfeld, Björn, Stephan Hoch, Matthias Honegger, Axel Michaelowa. 2015. "Analysis of Possible New Market Mechanisms Pilot Activities Beyond the PMR." *Perspectives Climate Change*, Zürich.
- Fay, John; and Umesh Kumar. 2017. "Market-Based Incentives in Developing Countries: Geographical Dispersion, Antecedents and Implications of the Clean Development Mechanism." *Climate and Development* 9: 164–77.
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- Schneider, Lambert; Derik Broekhoff, Martin Cames, Sean Healy, Jürg Füssler, and Stephanie La Hoz Theuer. 2016. "Market Mechanisms in the Paris Agreement – Differences and Commonalities with Kyoto Mechanisms." *Deutsche Emissionshandelsstelle*, Berlin.
- Shishlov, Igor, Valentin Bellassen. 2012. "10 lessons from 10 years of the CDM." *CDC Climat Research*, Paris.
- Spalding-Fecher, Randall, Amrita Achanta, Peter Erickson, Erik Haites, Michael Lazarus, Neha Pahuja, Nimisha Pandey, Stephen Seres, and Ritika Tewari. 2012. "Assessing the Impact of the Clean Development Mechanism." *CDM Policy Dialogue*, Bonn.
- Spalding-Fecher, Randall, Francois Sammut, Derik Broekhoff, Jürg Füssler. 2017. "Environmental Integrity And Additionality In The New Context Of The Paris Agreement Crediting Mechanisms." *Carbon Limits*, Oslo.
- Stavins, Robert, Robert Stowe. 2017. "Market Mechanisms and the Paris Agreement." *Harvard Project On Climate Agreements*, Cambridge, United States.
- Vivid Economics. 2012. "The Future Context of the CDM." *CDM Policy Dialogue*, Bonn.

Appendix D. Abbreviations Used in the Report

AAU	Assigned Amount Unit
BioCF	BioCarbon Fund
CCS	Carbon Capture and Storage
CCS TF	Carbon Capture and Storage Trust Fund
CDCF	Community Development Carbon Fund
CDG	Carbon Delivery Guarantee
CDM	Clean Development Mechanism
CDM EB	CDM Executive Board
CER	Certified Emission Reduction
CF	Carbon Finance
Ci-Dev	Carbon initiative for Development
CPF	Carbon Partnership Facility
CPLC	Carbon Partner Leadership Coalition
DFI	Development Financial Institution
DOE	Designated Operation Entity
EE	Energy Efficiency
EIT	Economies in Transition
ERPA	Emissions Reduction Purchase Agreement
ERU	Emissions Reduction Unit
EUA	European Union Allowance
EU ETS	European Union Emissions Trading System
FCPF	Forest Carbon Partnership Facility
GHG	Greenhouse Gas
HFC	Hydro-Fluor Carbon
HIC	High-Income Country
IEG	Independent Evaluation Group
IET	International Emissions Trading
IFC	International Financial Corporation
IETA	International Emission Trading Association
IPCC	Inter-Governmental Panel on Climate Change
ISFL	Initiative for Sustainable Forest Landscapes
JI	Joint Implementation
KP	Kyoto Protocol
LDC	Least Developed Country
LIC	Low-Income Country
NCM	Network Carbon Markets
P12CF	Post-2012 Carbon Facility
PA	Paris Agreement
PAF	Pilot Auction Facility
PCF	Prototype Carbon Fund
PCSP	Pilot Carbon Storage Project
PDD	Project Design Document
PMR	Partnership for Market Readiness
PoA	Program of Activities
SDM	Sustainable Development Mechanism

TCAF	Transformative Carbon Asset Facility
UCF	Umbrella Carbon Fund
UNFCCC	United Nations Framework Convention on Climate Change
Bank Group	World Bank Group

[1] http://www.hec.edu/Library/