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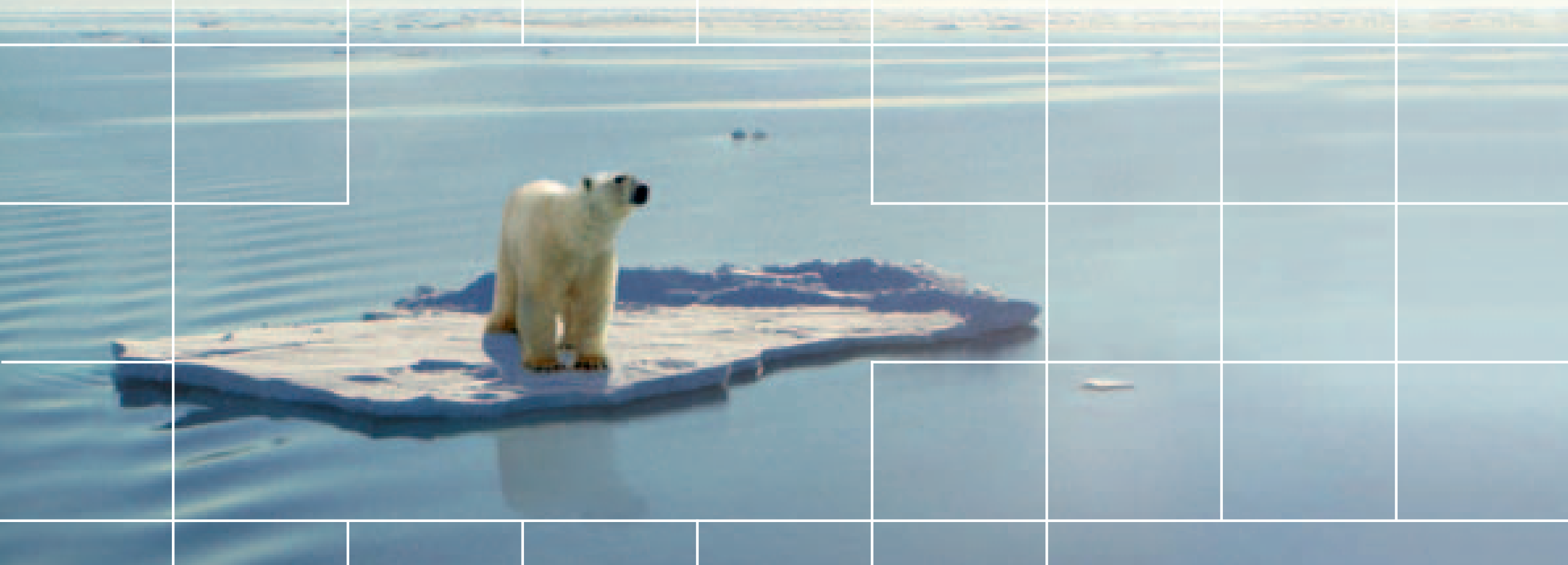
REPORT COMMISSIONED BY THE HIGH-LEVEL PANEL ON THE CDM POLICY DIALOGUE



FINAL REPORT
July 15, 2012

CDM Policy Dialogue

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Table of contents

Executive summary

The clean development mechanism (CDM) Policy Dialogue was established by the CDM Executive Board (EB) in late 2011, with the objective of providing recommendations on how best to position the CDM to respond to future challenges and opportunities so as to ensure the effectiveness of the mechanism in contributing to future global climate action. The CDM Policy Dialogue is implemented by a High-Level Panel, which is composed of distinguished individuals who possess a broad range of experience and expertise in fields of relevance to the operation and aims of the CDM. This report on assessing the impact of the CDM is one of three research reports commissioned by the High-Level Panel on the CDM Policy Dialogue, the other two covering the governance of the CDM and the future context of the CDM.

The objective of this report is to provide an independent assessment of the impact of the CDM across a broad range of metrics and possible effects. The impact of the CDM is assessed firstly in relation to its original purposes stated in Article 12 of the Kyoto Protocol, namely “to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments”. Beyond sustainable development and cost-effective emission reductions, there are other potential impacts of the CDM that have been highlighted by stakeholders in their submissions to the CDM Policy Dialogue and in the literature on the CDM. These include potential impacts on technology transfer, financing, net global greenhouse gas (GHG) emissions, energy security, clean energy investment and the regional distribution of projects, which are all also addressed in the report. The following summary highlights the key research findings as well as options for enhancing the positive impacts of the CDM.

Key findings on the impact of the CDM

Impact on the cost of compliance for Annex I countries

The analysis presented in this report suggests that the lower bound of savings for Annex I countries through the CDM is $3.6 billion. This is based on both government and private-sector savings. For the private sector, the CDM may have reduced compliance costs for firms in the European Union emissions trading scheme and Japan by at least $2.3 billion for the period from 2008 to 2012. These savings were estimated based on the extent to which certified emission reduction (CER) prices have been below European Union Allowance (EUA) prices. Since CERs have also had the effect of lowering the price of EUAs, the overall savings are likely to have been understated. For the public sector, the use of CERs by Annex I governments to meet their national emission limitation commitments will yield an additional $1.3 billion in savings.

Impact on sustainable development

At an operational level, designated national authorities (DNAs) articulate the concept of sustainable development to include at least three dimensions: the social, the economic and the environmental. The actual definition of sustainable development criteria and indicators, however, differs significantly across countries.

The majority of the studies on the impact of the CDM agree that the CDM has a positive impact on the various facets of sustainable development in the host countries. Employment generation was one of the most widely reported impacts in the literature. Studies note that the CDM is the only climate change mechanism that offers an innovative solution to the challenge of how to incorporate sustainable development considerations into emission mitigation activities. Even some of the studies that question the extent of its sustainable development impacts find that the CDM has contributed to the development of a global carbon market, allowing for temporal and spatial flexibility in achieving emission reduction targets.

A common view among stakeholder inputs to the CDM Policy Dialogue is that **capacity-building for low-carbon development within developing countries may be one of the most important sustainable development impacts of the CDM**. This capacity-building has not only engaged the local private sector in climate change mitigation and increased awareness of mitigation opportunities, but has also laid the foundation for domestic climate change policy, including emissions trading and other programmes, in many major developing countries.

In terms of project types, most studies conclude that industrial gas projects have fewer co-benefits than renewable energy and forestry projects, but a few studies challenge this finding, arguing that industrial projects can also have significant benefits. All studies agree that renewable energy projects can be particularly beneficial to developing countries. A study comparing project impacts in different countries suggests that Indian projects bring greater benefits for infrastructural development than either Chinese or Brazilian projects, but with the involvement of less technology transfer. On the other hand, Chinese projects contribute strongly to the protection of the local environment and natural resources. A comparative assessment of the performance of labelled projects (i.e. projects with additional certification from outside of the UNFCCC, such as Gold Standard and Community Development Carbon Fund projects) versus non-labelled ones concluded that, overall, labelled projects do not significantly surpass non-labelled ones in terms of sustainable development benefits. However, the influence of labelled projects on the social aspects of sustainable development tends to exceed that of comparable ordinary activities, while the opposite holds true for their contribution to economic development.

In addition to reviewing the literature, this study conducted an analysis of 202 registered project design documents (PDDs) to assess the reported contribution to sustainable development. **The results of the PDD analysis show that 99% of PDDs reported sustainable development benefits: 96% mentioned economic benefits, 86% mentioned social benefits and 74% mentioned environmental benefits.** Most of the PDDs mentioned more than one sustainable development benefit. Among sustainable development indicators, most of the PDDs mentioned benefits in terms of: improved local quality of life (82%), employment generation (80%) and contribution to national energy security (76%). In the sample of 79 small-scale and 123 large-scale projects, sustainable development benefits are mentioned more often in relation to small-scale projects than to large-scale projects. In the case of around 5% of the large-scale projects the PDDs did not mention any sustainable development benefit other than the transfer of technology.

Impact on Annex I Party ambition levels under the Kyoto Protocol

While in retrospect it is clear that the CDM has reduced the compliance costs for Annex I countries to meet their commitments under the Kyoto Protocol, the prospect of reduced costs due to the CDM does not appear to have been a factor in defining the ambition of the quantitative emission reduction commitments made by Parties in Kyoto in 1997. The complexity of the negotiations, the focus on other issues and the lack of information on the potential of the CDM meant that the negotiators did not make quantitative links between the availability of the CDM and the emission reduction targets in the final agreement. The current negotiations on the future of the climate change regime, however, are very much informed by the quantitative analysis of various flexibility mechanisms and that analysis will be very likely to influence any future emission reduction targets.

Impact on net GHG emissions

The CDM was intended as a zero-sum instrument, allowing increased emissions in developed countries in exchange for corresponding decreased emissions in developing countries, with no net impact on global GHG emissions. In practice, however, to the extent that some CDM projects may not have been additional, or may have been awarded more credits than the actual emission reductions achieved (e.g. due to overly high baselines, leakage or perverse incentives), the CDM could lead to a net *increase* in global GHG emissions. By contrast, if CDM projects have caused more emission reductions to occur than the number of credits issued and used (e.g. baselines are conservative and technologies outlast their crediting periods), then the CDM could lead to a net *decrease* in global GHG emissions.

This report finds that, to a large extent, the assessment of the net mitigation impact of the CDM hinges on judgements regarding the additionality of CDM projects in the power sector, especially wind and hydro, but also natural gas, coal, waste-gas capture and biomass energy power projects. These project types are projected to be the source of over half of the CERs issued by 2020. Researchers have expressed concerns that a substantial portion of these projects should be considered non-additional, leading to a significant net increase in global GHG emissions. Project developers, in contrast, have asserted that these concerns are “outdated” or “unfounded”. If these projects are indeed largely additional, they would represent a potentially large source of undercrediting, owing to the potential for these projects to operate well beyond their 10- or 21-year crediting periods. The difference in views on power sector project additionality translates to a wide divergence in the total net mitigation impact of the CDM.

Industrial gas (HFC and N_2O) destruction activities have been among the most controversial CDM projects and by far the most important sources of CERs to date (i.e. accounting for 75% of issued CERs). While evidence suggests that perverse incentives and leakage have thus far led to more credits being issued than the actual emission reductions achieved, methodological changes and the expected decrease in the share of CERs issued and used for these project types mean that these projects are relatively less important in terms of the net emissions impact of the CDM going forward.

Impact on energy security

While most CDM project types have the potential to increase security of energy supply by utilizing domestic resources or improving efficiency, it is difficult to see this impact at the national level. In terms of supply security, most of the major host countries are more dependent on imported energy than they were a decade ago. In addition, some of the proposed advanced fossil fuel CDM projects are located in coastal areas and will import their fuel, even though most of these projects use domestic resources. In terms of access, the CDM has had a limited impact on increasing access to energy services, but this is changing with the growth of programmes of activities (PoAs) focused on basic energy services and efficiency.

Impact on clean energy investment

Almost all countries have significant renewable energy resources, the development of which could increase national energy security. **Large-scale renewable power is the largest CDM project category and, within this, wind, hydropower and biomass are the largest contributors to new electricity capacity.** Registered CDM projects have accounted for more than 110,000 MW of renewable electricity capacity over the last 10 years, which is roughly the total power generation capacity of Africa. More than 90% of this renewable electricity capacity is in five countries: China, India, Brazil, Vietnam and Mexico. **The challenge is that the underlying economics of these large renewable-power projects, which are favourable in many markets, and the small contribution of carbon revenue to profitability make it very difficult to judge whether the projects are driven by the CDM or other widespread national incentives** for renewable power development. Stakeholder views and the literature suggest that the CDM may have had a major impact on smaller renewable energy markets and catalysed market development in the wind power sector in India, but that projects may have been driven primarily by national incentives rather than CDM benefits in some sectors in China. **Demonstrating additionality conclusively will always be challenging with these technologies, owing to the small financial impact of CERs.**

The CDM also includes substantial investments in natural gas (~27,000 MW) and high-efficiency coal (~16,000 MW), as well as in power generation using waste heat and waste gases (~6,000 MW). **While these fossil fuel projects are generally based on domestic energy resources, some also use imported fossil fuels** and there is no distinction made between these two types of projects, despite the associated implications for energy security. High-efficiency and lower-carbon fossil fuel projects have faced accusations of being common practice, both because almost all new projects (particularly in India and China) are applying for the CDM and because the financial impact of carbon revenue is small, as is the case for wind and hydropower. **Unlike the renewable power projects, however, the additional challenge for non-additional fossil fuel projects is that they lock in developing countries to relatively high-carbon growth trajectories.**

Energy efficiency has been almost entirely left out of the CDM, with few approved methodologies and projects, because the traditional barriers facing energy efficiency (e.g. split incentives, information asymmetries and transaction costs) have been amplified under the CDM. The success of the Indian compact fluorescent lamp programme notwithstanding, many experts argue that tapping energy efficiency potentials requires either a new, more focused, mechanism or significant changes in the CDM rules.

Impact on technology transfer

While technology transfer is not explicitly included as an objective of the CDM, other decisions of the Conference of the Parties (COP) have alluded to the importance of technology transfer under the UNFCCC. In summary, the literature cites a range of impacts on technology transfer: from the CDM contributing “significantly” to technology transfer, through technology transfer taking place in less than half of the CDM projects, to technology transfer being minimal. Importantly, the latter study uses a more stringent benchmark for establishing technology transfer than all of the other studies.

According to previous empirical studies, 27–39% of CDM projects report technology transfer as a component of the project design. However, because projects are not required to report technology transfer, a substantial portion of projects that do not explicitly claim this benefit may nevertheless involve some form of technology transfer. For example, a recent study based on a follow-up survey after an analysis of PDDs indicated that the actual proportion of projects involving technology transfer could be as high as 44%. Technology transfer is reported more often for large-scale projects. Most, but not all, studies find that unilateral and small-scale projects are less likely to involve technology transfer. Host-country policies can also have an impact on the rate of technology transfer. In addition, previous studies indicate that the frequency of technology transfer claims has remained stable as a share of the number of projects but has declined as a share of the estimated annual emission reductions.

According to **the PDD analysis carried out for this study, 27% of registered projects analysed reported some form of technology transfer.** Most of these projects reported both transfer of equipment and knowledge. Some sectors, such as coal mine methane and reforestation, did not report any technology transfer within this sample, while others, such as renewable energy and methane avoidance, reported higher than average levels of technology transfer. Higher levels of technology transfer are reported for small-scale projects than for large-scale projects, which is surprising given the findings of previous studies and may reflect the smaller sample size. The analysis found that the leading countries in terms of transferring technologies were Japan, Germany, the USA, Denmark, Italy and the United Kingdom.

Financing for CDM projects

The estimated capital investment for 4,832 registered or soon-to-be registered CDM projects is $215 billion. Annual investment peaked in 2008 at about $41 billion. A large number of projects are undergoing validation and they could lead to a new, much higher, peak for annual capital investment in 2012. Capital investment is dominated by wind and hydro projects and is concentrated in eastern Asia.

Most investment in CDM and Annex I renewable energy projects comes from domestic sources. The indications are that the share of projects with foreign investment has been rising, both for CDM and Annex I projects, as project size has increased and the industry has grown. The share of projects with foreign investment is higher for Annex I projects than for CDM projects, but the gap appears to be narrowing.

The pattern of foreign investment in CDM renewable energy projects is complex. About half of the projects with foreign investment receive funds from multiple countries. When the investment comes from a single country, it is a little more likely to come from an Annex I country than a non-Annex I country. The largest individual flow of investment is from Hong Kong in Chinese projects.

A comparison of CDM and Annex I renewable energy projects (e.g. geothermal, hydro, solar and wind) finds that CDM projects have a larger average capacity than similar projects in Annex I countries, often three or four times larger. CDM projects are 15% (solar photovoltaic) to 50% (geothermal and solar thermal power) less capital-intensive ($/MWe capacity) on average than similar Annex I projects. The average capital investment in both CDM and Annex I renewable energy projects has increased significantly over the past decade.

Many of the barriers to investment in CDM projects (e.g. poor investment climate and regulatory frameworks) are not specific to the CDM project cycle, but are generic challenges faced in relation to domestic and foreign investments in developing countries. In addition, barriers at the international level (e.g. CDM rule complexity) may affect all countries, while national and project-level barriers (e.g. access to finance and lack of migration potential) influence the distribution of CDM projects and CERs across countries. Important CDM-specific barriers at the national level are the CDM regulatory framework and institutional capacity, which goes beyond the DNA to include the lack of project consultants, auditors and financiers within the host country.

Regional distribution of CDM projects

As a market mechanism, **the distribution of CDM projects and CERs has generally matched the distribution of mitigation potential across countries**. This has meant that many countries with small economies and low emission levels have been left out of the CDM entirely, although the number of countries participating continues to grow. The emissions of many countries in Africa and the group of the least developed countries (LDCs), as well as some in Asia, constitute a very small share of non-Annex I emissions, so many do not yet host any CDM projects and those that do account for only for a small share of the CERs issued.

While the most important driver of project distribution is national mitigation potential, the general investment climate is also critical. Having a strong CDM institutional capacity and framework is necessary but not sufficient in itself to attract projects. At the project level, lack of access to early-stage seed funding for CDM costs and the high unit transaction costs are important barriers to CDM project development in many poorer countries, but it is often the lack of underlying project finance that prevents CDM projects from moving ahead in the underrepresented countries.

Because of their low emission levels and small national economies, **opening up CDM opportunities for underrepresented countries will require the simplification and streamlining of the CDM rules, innovative approaches to the development of national capacity and the mobilization of financing for both transaction costs and underlying project investments**.

Suppressed demand

One of the challenges of applying GHG emission accounting approaches in poor communities is that the current consumption of many household services (e.g. heating and cooking energy, lighting and potable water) may not reflect the real demand for those services. This could be a result of lack of infrastructure, lack of natural resources or poverty, particularly the high costs of these services relative to household incomes. The situation of 'suppressed demand' creates a problem for setting baselines and has negatively affected CDM project development in Africa, the LDCs and other underrepresented areas. Ironically, although new large-scale power plants do not have to show that they actually displace other plants (existing or new), many small-scale energy projects can only claim credit for displacing historical (very low level) emissions from households. **The new guidelines from the EB on accounting for suppressed demand are an important step forward; implementing them will require significant expert and stakeholder input to ensure that simplification is balanced with maintaining overall environmental integrity.**

Options for enhancing the impact of the CDM

The options below have been developed on the basis of reviews of the literature, stakeholder inputs to the CDM Policy Dialogue process, interviews with experts in the field and the analysis conducted by the research team. Given that the focus of this research was on the impacts of the CDM, the options for the future have not been subject to a feasibility analysis or an analysis of the politics surrounding their implementation. For more detailed institutional analysis and context, readers are referred to the two other research reports prepared for the CDM Policy Dialogue on the governance of the CDM and the future context of the CDM.

Not all of the options below can be implemented by the EB, as many would require the approval of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP) or may even be implemented by actors outside the UNFCCC. The actors involved in each option are illustrated in table ES1.

Sustainable development

For most stakeholders sustainable development is one of the most important impacts of the CDM and there is a desire to enhance this impact. In addition, almost all stakeholders would agree that any interventions should not infringe upon the host country's right to determine whether a given CDM project meets its sustainable development priorities. There is broad commonality across countries as to how they define sustainable development criteria at a high level, even if the detail of this application varies widely.

Depending on individual stakeholder priorities, there are three possible objectives of interventions related to sustainable development impacts: (a) increasing the overall sustainable development benefits originating from the CDM project pipeline; (b) measuring and reporting those benefits to the DNAs and other stakeholders; and (c) systematically preventing negative impacts. However, there may be differences amongst stakeholder groups in prioritizing interventions. For example, stakeholders that feel that CDM projects are generally delivering many positive benefits may want to focus on preventing negative impacts rather than increasing the monitoring of benefits. On the other hand, stakeholders that feel that negative impacts are best addressed at a national level may instead focus more on the measurement of impacts and enhancing benefits. The caveat to these choices is that it will be difficult to measure progress towards either greater positive impacts or fewer negative impacts without some form of monitoring and reporting system.

Providing a 'menu' of sustainable development indicators could enhance the documentation of the sustainable development benefits of the CDM. This menu could be compiled from current criteria or other international sources. Given that most DNAs already have criteria, they could also make these more accessible by reporting their own sustainable development criteria on the UNFCCC website, just as the national definitions of forest are currently reported.

Revising the PDD format to provide more guidelines on how project participants should declare their sustainable development contributions could assist DNAs in their decision-making process, whether or not the guidelines were linked to a list of specific indicators.

Improved voluntary reporting of sustainable development benefits could go a step further, providing for both initial and ongoing declarations. These declarations could rely on either DNA-specific guidelines or draw on international reporting options. Any monitoring would have to be designed in such a way as to minimize the transaction costs.

Mandatory monitoring of sustainable development benefits would provide a much more robust information base for the DNAs and other stakeholders than simple declarations in the PDD. There are many variations to monitoring, but none of these should infringe on the host country's sovereign right to determine whether a project meets its own sustainable development criteria. The DNA and project participants could choose which indicators were appropriate for the specific project, in the light of the host country's priorities. The monitoring could be supervised by the DNA, according to national criteria and procedures, or could be part of the UNFCCC project cycle. Verification could be conducted at validation and/or during verification (i.e. after project implementation). While this would add transaction costs, without some verification it is unclear how reliable any reporting would be.

Safeguards against negative impacts, such as human rights violations, corruption and labour exploitation, could also be strengthened in several ways. As a first step, the DNA could ensure that claims of negative impacts were taken up within the legal structure and processes of the host country. In addition, the PDD could be expanded to include a checklist of key safeguard issues. As with the reporting of benefits, the reporting of safeguards could happen at the start of the project only, or they could be reported periodically after implementation. The verification of compliance with safeguards could be undertaken by the DNA along with the verification of sustainable development benefits.

The consequences of inadequate performance could range from project developers being provided with information to assist them with compliance through to suspending the further issuance of CERs for a project. This could be based on the project not following through on sustainable development benefits and/or the project violating one of the safeguards. The DNA could decide on this, however, according to national criteria and procedures.

Preferences for specific project types or technologies could be established to differentiate eligibility and procedures across project types, scales or regions. This would require broad political agreements as well as a sound empirical evidence base upon which to prioritize.

Capacity-building for DNAs could strengthen the ability of DNAs, particularly those with the least resources, to apply their national criteria for sustainable development in the project approval process. It could include the sharing of experiences at a regional and subregional level and providing information on 'best practice' in project evaluation.

Although not discussed in detail in this report, an **enhanced stakeholder consultation and appeals process** could also strengthen positive sustainable development impacts. The options for this are discussed in the report on the governance of the CDM. DNAs could work towards strengthening the process of local stakeholder consultation. The relevant local authorities could be made more aware about sustainability issues and their role in the effective implementation of sustainable development benefits. Negative sustainable development impacts could be one of the possible grounds for a grievance. The governance reforms proposed under an enhanced stakeholder consultation and appeals process are also relevant to sustainable development impacts, particularly negative ones.

Regional distribution

Given the importance that the Parties have placed on the regional distribution issue, the following measures could increase access to the CDM in underrepresented countries and regions:

Capacity-building for the local financial sector to mobilize domestic finance – Given that CDM projects are mostly domestically financed, enhancing the awareness and capacity of the local financial sector in underrepresented countries could increase the flow of finance to CDM projects. Host countries in which availability of capital is a constraint could also take steps to encourage greater domestic investment in CDM projects and to facilitate foreign investment in CDM projects.

Including Africa in the 'LDC track' – Given that the guidance of the CMP on 'equitable regional distribution' always specifies Africa as well as the LDCs and countries with fewer than 10 projects, African countries could be included in all of the special provisions made for the LDCs in the CDM rules.

Focused DNA support – Focusing on the sharing of experiences and best practices, particularly within regions, to faciliate joint decision-making on regional PoAs.

Grants and/or loans for transaction costs – The CDM Loan Scheme should be critically reviewed after one year to determine its effectiveness at removing barriers related to transaction costs. In addition, a grant scheme could be considered for some portion or all of these transaction costs, for particular project types or areas where the loan scheme is not effective.

Standardization of parameters, including standardized baselines – The creation of a special standardized baseline track for household-level services (e.g. electrification, water purification and cooking). Guidance on specific standardized parameters (e.g. fraction of non-renewable biomass by country) should also be provided by the EB.

Standardization of procedures – A further simplified the project cycle could be applied to projects from underrepresented regions, including automatic registration (e.g. the elimination of validation procedures in favour of listing projects with the UNFCCC on the basis of clear templates and checking these requirements at initial verification). This could also be done on the basis of project scale, with micro-scale projects benefiting from expedited procedures.

Technology transfer

Several actions could improve the transparency of technology transfer benefits and enhance this impact of the CDM:

Improved database and data availability would involve the UNFCCC improving the way in which data on technology components and transfer are generated from the large number of projects in the pipeline and presented. A database could be created with more information on technological specifications and the name of the technology supplier or technical project developer. This may further facilitate technology transfer for new countries and potential project participants.

Improved reporting on technology transfer could address the issue of the limited information on technology transfer currently provided in PDDs, which is often inadequate and inconsistent. More comprehensive and clear information on technology transfer would enable better decision-making by DNAs. This would most probably require a revision to the PDD format and guidance.

Guidance from DNAs could assist by providing a clear and more operational definition of technology transfer in the project approval process. Host countries could also influence the extent and nature of technology transfer by including technology transfer within their sustainable development criteria, defining the criteria or indicators of technology transfer clearly and implementing these criteria stringently.

Net emissions impact

Shifting towards the sectors with the highest degree of confidence in the additionality of their projects would improve the overall integrity of the CDM, but it would not lead to a net decrease in emissions. To achieve that objective other approaches such as discounting or shorter crediting periods would be needed. There are several options available that could potentially improve or increase the net mitigation impact of the CDM. Each option carries with it a set of advantages and limitations (discussed in detail in the main text of this report) and, in many cases, may run the risk of missing opportunities for otherwise-additional projects to proceed. The findings of this research indicate that:

Discounting credits from particular project types may be a particularly effective option for increasing the net mitigation benefit of project types with relatively certain additionality and very low abatement costs (e.g. HFC destruction at HCFC-22 plants and N_2O destruction at adipic acid plants).

Shorter crediting periods may be a more effective option than discounting for increasing the net mitigation benefit of project types with higher capital costs (and lower recurrent costs) or where it is likely that projects are serving to accelerate the pace of technology adoption.

Creating 'negative lists' (i.e. excluding certain project types) would be the most straightforward approach for project types where additionality cannot be determined with a high degree of confidence, such as some large-scale power generation project types, as discussed below.

Other interventions, such as positive lists, standardized baselines and additionality, and transitioning to policy- or sector-based crediting, could all potentially lead to net mitigation benefits; however, the mitigation outcome would be highly dependent on how such interventions were implemented (e.g. baseline levels and crediting thresholds chosen).

Large-scale power generation: wind, hydropower, natural gas and coal

Determining additionality with a high degree of confidence is only possible for sectors or technologies for which the incentive provided by the CDM (i.e. carbon revenue) can be clearly demonstrated as the main cause of the project. This means that much more caution is needed in relation to projects in sectors where the incentive provided by the CDM is small relative to other decision-making factors and, as a result, the ratio of the 'signal' (CDM intervention) to 'noise' (other factors) is low. Research findings suggest that the likeliest incidence of a low 'signal-to-noise' ratio is in large-scale power generation, particularly wind, hydropower, natural gas and coal projects. Several options could address this concern:

The improvement of the current additionality approach could seek to increase consistency, transparency and objectivity of investment analysis and common practice analysis. This should be based on detailed research on project economics to clarify the 'signal-to-noise' ratio for these project types. This research would involve detailed analysis of not only the impact of carbon revenue on registered projects (i.e. including assessment of actual carbon prices in contracts), but also the magnitude of this impact relative to variability in other key parameters (e.g. electricity tariffs, capital costs and other public incentives and measures). While there has been substantial research on this topic already, as cited throughout this report, no one has taken a comprehensive look at the financial details for these CDM project types. Nevertheless, there could be scope to improve consistency (e.g. whether to use common discount rates across a country rather than those in the PDD) and transparency (e.g. verifying some of the assumptions in the PDD by referring to independent sources) for these projects so as to clarify the share of truly additional projects.

Alternative additionality determination approaches could also be used for technologies for which market-based investment analysis is not appropriate (e.g. where the main determinant of profitability and investment is public decision-making). Market penetration rates, default technology comparisons or other criteria could be used to test additionality rather than the current additionality tool. While the current standardized baseline development process of the EB does not include power generation yet, this could be expanded. The challenge of applying standardized baselines, however, would be that all renewables (except some large hydro and geothermal) are zero-emission sources, so they cannot be ranked by emissions, and the current standardized baseline guidelines still consider financial attractiveness as a key criterion.

Shifting some technologies to sectoral or policy-based (e.g. nationally appropriate mitigation action crediting) approaches, other new market mechanisms or non-credited climate finance instruments could reduce uncertainty within the CDM. Note, however, that similar challenges of identifying the impact of the carbon market signal on the development of the power sector must still be addressed under any market mechanism if it is to be used for offsetting (and even more so if it is to be used for net reductions).

The restriction of eligibility by geography, scale or subtype could directly address the strongest additionality concerns related to market maturity, public incentives and low 'signal-to-noise' ratio for specific technologies by limiting the CDM to the geographies, project scales or subtypes for which there is the highest likelihood of conclusive additionality testing with investment analysis.

The exclusion of entire categories or technology types would eliminate any uncertainty about additionality for those sectors, but this is obviously more politically difficult and also carries with it the risk of missed opportunities.

Suppressed demand

Building upon the current work of the EB on suppressed demand, options include: (a) limiting methodological changes to account for suppressed demand to methodologies relevant to household services; (b) developing a clear plan for approving 'minimum service levels' and baseline technology choices, including who will be involved and how, and the time frame within which the 'minimum service levels' should be achievable; (c) ensuring that the 'minimum service levels' are universal and not country specific; (d) using the methodology revision process to establish consistency across all sectors; and (e) providing guidance on how often the 'minimum service level' and/or baseline technology should be reviewed and, if necessary, updated.

Table ES1. Summary of options for enhancing the impact of the CDM and which actors would implement them

Option	EB	COP	DNAs	Others
Sustainable development				
Provision of menu of sustainable development indicators	✖		✖	
Revision of PDD format with regard to guidelines on reporting sustainable development contributions	✖			
Improved voluntary reporting of benefits	✖		✖	
Mandatory monitoring and reporting of benefits		✖	✖	
Safeguards against negative impacts	✖	✖	✖	
Consequences for inadequate performance		✖		
Preferences for project types		✖	✖	
Capacity-building for DNAs	✖		✖	✖
Enhanced stakeholder consultation and appeals	✖	✖		
Regional distribution				
Capacity-building for local financial sector				✖
Inclusion of Africa in ‘LDC track’	✖	✖		
Focused DNA support	✖			✖
Grants and/or loans for transaction costs	✖	✖		
Standardization of parameters and baselines	✖			
Standardization of procedures		✖		
Technology transfer				
Improved database and data availability	✖			
Improved reporting in PDDs	✖			
Guidance to project owners on DNA preferences			✖	
Net emissions impact				
Discounting		✖		
Shorter crediting periods		✖		
Negative listing		✖		
Large-scale power generation				
Improvement of current additionality approach	✖			
Alternative additionality approaches	✖	✖		
Shifting technologies to sectoral approaches		✖	✖	
Restriction of eligibility by geography, scale and subtype		✖		
Exclusion of entire categories or types		✖		
Suppressed demand				
Procedures, minimum service levels, technology choice and updates	✖			

Note: Others include the Nairobi Framework partners outside of the UNFCCC, such as the United Nations Environment Programme, the World Bank and the African Development Bank.

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Acronyms

AAU	Assigned amount unit
ACM	Approved consolidated large-scale methodology
AM	Approved methodology (large scale)
AMS	Approved small-scale methodology
BNEF	Bloomberg New Energy Finance
CDM	Clean development mechanism
CERs	Certified emission reductions
COP	Conference of the Parties
CME	Coordinating and managing entity
CMP	Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol
CPA	Component project activity
CPA-DD	Component project activity design document
DNA	Designated national authority
DOE	Designated operational entity
EB	Executive Board of the clean development mechanism
EE	Energy efficiency
ERU	Emission reduction unit
EUA	European Union Allowance
EU ETS	European Union emissions trading scheme
FDI	Foreign direct investment
GDP	Gross domestic product
GJ	Gigajoule
HCFCs	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbon
IRR	Internal rate of return
kWh	Kilowatt hour
LDC	Least developed country
MAC	Marginal abatement cost
MW	Megawatt
MWe	Megawatt equivalent
N_2O	Nitrous oxide
pCDM	Programmatic clean development mechanism
PDD	Project design document
PFC	Perfluorocarbon
PoA	Programme of activities
PV	Photovoltaic
SIDS	Small island developing States
tCO_2	Tonnes of carbon dioxide
tCO_2e	Tonnes of carbon dioxide equivalent
UNFCCC	United Nations Framework Convention on Climate Change

The symbol $ means US dollars in all cases.

List of figures

List of tables

1 Introduction

When adopting the Kyoto Protocol in 1997, Parties to the United Nations Framework Convention on Climate Change (UNFCCC) established the clean development mechanism (CDM) with the twin goals of contributing to the sustainable development of developing countries and assisting developed countries to meet their emission limitation targets. Over the last 14 years public and private entities have engaged in the rapid development and implementation of this mechanism, which is expected to result by 2012 in over 1 billion tonnes of carbon dioxide equivalent (tCO_2e) emission reductions from project activities and programmes in over 70 countries. International cooperation to address climate change now stands at a crossroads as we approach the conclusion of the Kyoto Protocol's first commitment period in 2012. Parties have thus intensified their efforts to expand existing agreements and develop new ones in a manner that reflects their respective needs and capacities.

The CDM Policy Dialogue was established by the CDM Executive Board (EB) in late 2011, with the objective of providing recommendations on how best to position the CDM to respond to future challenges and opportunities so as to ensure the effectiveness of the mechanism in contributing to future global climate action. The CDM Policy Dialogue is implemented by a High-Level Panel, which is composed of distinguished individuals who possess a broad range of experience and expertise in fields of relevance to the operation and aims of the CDM. This High-Level Panel conducts and oversees the CDM Policy Dialogue and will deliver, as its main output, an independent report setting out the Panel's recommendations for the future position of the CDM, its priorities and modes of operation. The High-Level Panel is implementing the CDM Policy Dialogue through targeted research and different types of stakeholder meetings, so as to independently form a basis for drawing conclusions and making recommendations about different aspects of the mechanism.

This research report on the impact of the CDM is one of three reports commissioned by the High-Level Panel, the other two covering the governance of the CDM and the future context of the CDM. The **objective** of this report is to provide an independent assessment of the impact of the CDM across a broad range of metrics and possible effects. The impact of the CDM is assessed firstly in relation to its original purposes stated in Article 12 of the Kyoto Protocol, namely "to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments". Beyond sustainable development and cost-effective emission reductions, there are other potential impacts of the CDM that have been highlighted by stakeholders in their submissions to the CDM Policy Dialogue and in the literature on the CDM. These include potential impacts on technology transfer, investment in low-carbon development, net global greenhouse gas (GHG) emissions, energy security, clean energy investment and accounting for suppressed demand.

The term "impact" in this report is interpreted quite broadly and is, for the most part, assessed separately from the question of additionality (i.e. the extent to which the value of expected CDM revenues caused CDM projects to take place). Nonetheless, it is important to recognize that these aspects are fundamentally inseparable. The CDM as a mechanism has an impact on sustainable development, technology transfer, energy security or other outcomes only to the extent that CDM projects are additional. To the extent that CDM projects are not additional, any associated sustainability or energy security benefits, for example, would have also occurred in the absence of the CDM and therefore the 'impact of the CDM' is zero. As a consequence, views on additionality are critical not only in terms of the net emissions impact, as assessed in chapter 4, but also in terms of the impacts discussed in other chapters, particularly the impact on energy markets, which is covered in chapter 5. Except where explicitly noted, discussions on impacts in other chapters implicitly assume full additionality.

In addition, the regional distribution of CDM projects is a key issue highlighted by all stakeholders and is addressed in this analysis. Where possible, the impacts of the CDM have been evaluated quantitatively, although this is not always possible if there are no data available (e.g. no verified sustainable development impact data). The quantitative analysis and review of the literature have been supplemented by inputs from a wide range of experts and stakeholders, both as part of the CDM Policy Dialogue stakeholder engagement process and through interviews by the research team.

The report is **structured** to include a chapter for each of the areas of impact evaluated: sustainable development, cost-effective emission reductions, net global GHG emissions, energy security, clean energy investment, technology transfer, financing, regional distribution of CDM projects and accounting for suppressed demand. The concluding chapter then summarizes the findings and recommendations resulting from the study. The sections of this report in which the questions posed in the terms of reference for this study are addressed are shown in annex A.[1]

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[1] This report does not contain an introductory explanation of the CDM project cycle and rules, but this can be found in the report commissioned by the CDM Policy Dialogue on the governance of the CDM (Classens, 2012).

2 Impact on Annex I Party ambition levels through cost-effective emission reductions

As discussed in the introduction to this report, one of the two main purposes of the CDM was to assist Annex I Parties in achieving compliance with their emission reduction targets. This purpose was to be achieved by providing them with lower-cost opportunities for emission reductions to supplement their domestic actions. This chapter addresses the questions of how cost-effective the CDM has been and to what extent it has reduced the marginal costs of emission reductions for Annex I countries. In addition, the last section of the chapter addresses the question of whether the availability of the CDM as part of the Kyoto Protocol increased the ambition of the commitments made by Annex I Parties at Kyoto in 1997.

2.1 Impact on minimizing the marginal costs of emission reductions achieved by Annex I countries

Annex I Parties to the Kyoto Protocol have national emission limitation commitments for the period 2008–2012. Each country's commitment is expressed as a cumulative total for the period relative to five times its base year (usually 1990) emission level. To meet its commitment, a country can implement policies and measures to reduce domestic emissions and/or purchase compliance units – assigned amount units (AAUs), emission reduction units (ERUs) and certified emission reductions (CERs) – from other countries.

A marginal abatement cost (MAC) curve is a tool that can be used by a country to help identify the lowest-cost options for meeting its national commitment. A MAC curve displays possible emission reduction measures in order of increasing marginal cost ($/t$CO_2$e reduced), starting with the most cost-effective measure. For each option, the curve shows the cost per metric tCO_2e reduced on the vertical axis and the potential emission reduction, in tCO_2e per year, on the horizontal axis. Each step on a curve represents an emission reduction option.[2] Figure 1 shows MAC curves for 2020 for 10 Annex I countries.

Countries whose curves lie closer to the vertical axis, such as Japan, Norway and Switzerland, have more limited emission reduction potential, so meeting a given percentage emission reduction from the 1990 level would be more costly. The emission reduction commitments of Annex I countries, expressed as a percentage of their 1990 emission level, differ, so each country's compliance cost depends both on its MAC curve and its commitment.[3]

In principle, each Annex I country could minimize the cost of meeting its emission reduction commitment domestically by starting with the lowest-cost option and implementing all of the emission reduction options needed to achieve sufficient reductions to meet its national commitment. The total compliance cost would be the area under the curve and the marginal cost would be the cost per tCO_2e reduced of the last option included. If the price of compliance units, such as CERs, is lower than the marginal cost of the last option, the total compliance cost can be reduced by purchasing such units and implementing fewer domestic reduction options. Any options which have a higher marginal cost than the price of compliance units are not implemented and units equal to the reductions expected to be achieved by those options are purchased.

In practice, the marginal abatement cost curve changes because the projected baseline emissions change (due to macroeconomic conditions, for example), the projected fuel prices change and the cost or performance of various options change (Wagner et al., 2012; Kesicki & Ekins, 2011).[4] Also, the policies implemented by a country may not cover all of the lower-cost options or may not achieve the full potential emission reduction for each option, so the policies needed to meet a national commitment are more costly than suggested by the MAC curve (Grubb et al., 2011; Kesicki & Ekins, 2011). In Europe, some of the policies are

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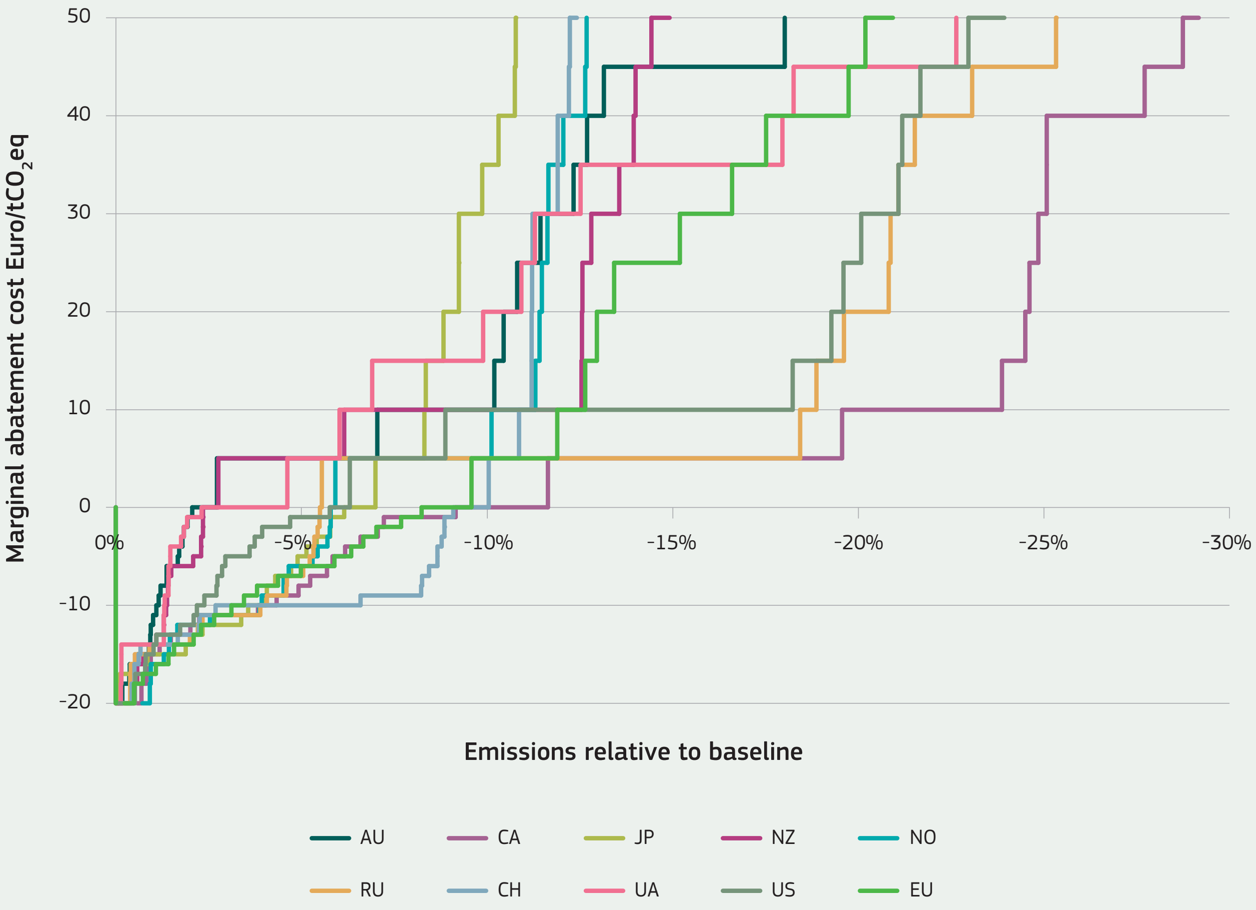
[2] The horizontal steps implicitly assume that all installations of each option have the same marginal cost. In reality the cost is likely to differ, so each horizontal line should be replaced by an upward sloping curve of the marginal costs of different installations. Then part of the potential reduction for an option may be more costly than some installations of the next most expensive option.

[3] The commitments of Japan, Norway and Switzerland are 94%, 101% and 92%, respectively, of their 1990 emission levels.

[4] Thus the precision suggested by the curve is misleading. But options can be grouped into cost ranges. And the groups of options that need to be implemented to achieve the emission reduction target can be identified.

Figure 1. MAC curves for 2020 for 10 Annex I countries



Source: Wagner et al. (2012), figure 8.

strictly domestic, while others are adopted by the European Union (EU), so it is less likely that the policies applied in each country will fully capture the low-cost options.

The CDM can help Annex I countries to reduce compliance costs in two ways. Firstly, the government can choose to purchase CERs (and other compliance units) instead of implementing policies to achieve more costly domestic reductions. Secondly, where permitted by the national government, entities subject to a domestic policy can use CERs (and other compliance units) to comply with that policy. The government then uses those CERs to offset the higher domestic emissions. For example, installations in the European Union emissions trading scheme (EU ETS) and Japanese firms with voluntary commitments can use CERs for compliance. Use of CERs by installations in the EU ETS for compliance has been the dominant use of CERs to date, accounting for almost half of the CERs issued up to March 31, 2012.

The cost savings already realized by installations in the EU ETS are estimated first. These are then extrapolated to cover CER use by Japanese firms. Finally, a crude estimate of the cost savings achieved by Annex I Parties thanks to the use of CERs by both firms and governments for the 2008–2012 commitment period is developed.

Each year, installations in the EU ETS must submit valid compliance units – European Union Allowances (EUAs), CERs or ERUs – equal to their actual emission level in the previous year. EUAs equal to the annual emissions cap are distributed each year, mostly through free allocation to participating installations. EUAs, like CERs, can be freely traded. CERs have a lower market price than EUAs but both are equivalent for compliance, so using CERs reduces compliance costs. Using CERs also reduces demand for EUAs and so may also lower their market price.

Thus, a lower bound estimate of the compliance cost saving to EU ETS installations resulting from the use of CERs

Table 1. Estimated savings as a result of the use of CERs for compliance by EU ETS installations[1]

Year	CERs used (million)	EUA–CER spread (€)*	Saving (€ million)
2008	82.5	1.90	156.8
2009	77.9	1.34	104.4
2010	116.9	3.19	372.9
2011	178.8	3.07	548.9
Total	**456.1**		**1,183.0**

Source: Authors' calculations.

Note: *Price spread on April 30 of the subsequent year.

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[1] Trotignon (2011) estimates the savings for 2008 and 2009 at €283 million (range €100 to €546 million) compared with the estimate of €261 million in this report. Trotignon uses the average of the daily spreads and the minimum and maximum daily spreads for the range. He also has a greater use of CERs for compliance – 170.4 million for the two years compared with 160.4 million in this report.

can be calculated from the difference in the market prices of CERs and EUAs and the quantity of CERs used for compliance. The quantity of CERs used for compliance each year is known. The EUA–CER spread changes daily and has varied widely over time from less than €1 to over €5.[5] The estimated cost savings, then, depend on the price spread used for the calculation. The relevant price spread is the one on the day that installations must decide which EUAs and CERs to submit for compliance, namely April 30 of the subsequent year. Since both EUAs and CERs can be banked for use in future years, the spread at the time the compliance decision is made best reflects the value of the savings to the installation.

The estimated compliance cost saving to EU ETS installations for the period 2008–2011 as a result of the use of CERs is calculated in table 1. The total saving over the four years is almost €1.2 billion ($1.5 billion). Both the number of CERs used for compliance and the EUA–CER price spread have generally increased over time. Greater use of CERs for compliance has been made possible by the growth in the number of CERs issued. For 2008 and 2009, use of CERs for compliance represented about 75% of the CERs issued prior to the compliance deadline. By 2011 cumulative use had fallen to about half of the CERs issued. In 2010 the EU announced that installations will no longer be able to use CERs from HFC and N_2O projects after 2012, so there is an incentive to use CERs from such projects during 2010, 2011 and 2012. This accounts for some of the growth in the use of CERs for compliance during 2010 and 2011.

The increased EUA–CER spread has been driven by reduced emissions and the cap on the use of CERs for compliance by EU ETS installations. The recession during 2009 and 2010 led to a reduction in EU ETS installations' emissions, thus reducing the demand for EUAs, CERs and other compliance units (ERUs).[6] Growth in the issuance of CERs (and ERUs) has increased the supply of compliance units. As a result, prices have fallen. The price of EUAs fell from €24.11 on April 30, 2008 to €6.94 on April 30, 2012.[7] The price of CERs has fallen more – the EUA–CER spread has increased – because use of CERs and ERUs for compliance is capped and the EU has announced that this cap will apply up to 2020.[8] Thus the demand for CERs for use for compliance by EU ETS installations is fixed, while the supply is increasing.

The availability of CERs should also lower the market price of EUAs. The price of EUAs fell by over €17 between April 30, 2008 and April 30, 2012. During that period, over 5 billion EUAs were used for compliance by EU ETS installations. An estimate of the savings resulting from the impact of CERs on the price of EUAs would require significant modelling work. As an illustrative calculation, if even €1 of the price decline has been due to the availability of CERs, then the CDM would have reduced compliance costs by a further €5 billion ($6.5 billion). Thus, the cost savings resulting from the impact of CERs on the price of EUAs could be

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[5] The price spread on a given day reflects expectations about the future supply of and demand for EUAs and CERs. Profits or losses due to sales of EUAs and CERs are due to trading activity and are not related to compliance.

[6] ERUs are emission reduction units issued for emission reductions in developed countries. They can be used for compliance by EU ETS installations.

[7] April 30 prices for 2008 to 2012 are as follows: €24.11, €12.92, €14.25, €16.27 and €6.94.

[8] The cap, about 1,450 million, covers the use of both CERs and ERUs, but the supply of CERs is much larger than the supply of ERUs – 919 million CERs and 143 million ERUs as of April 30, 2012.

much larger than the savings resulting from the use of CERs for compliance.

The use of CERs by Japanese firms to meet their voluntary commitments is estimated at 36 million CERs to date. There is no market price that can be used to estimate a price spread and hence cost savings resulting from the use of CERs for compliance by Japanese firms. Assuming that the cost saving is the same as for installations in the EU ETS, this yields an estimated compliance cost saving of €92 million ($120 million).[9]

For the 2008–2012 commitment period, there will be cost savings to Annex I Parties thanks to the use of CERs by both firms and governments. Installations in the EU ETS will probably use as many CERs for compliance in 2012 as for compliance in 2011, because CERs from HFC and N_2O projects will no longer be accepted after 2012. The EUA–CER price spread may also widen, since the quantity of CERs issued is rising while the use of CERs for compliance through to 2020 is capped.[10] Thus, the assumption that the compliance cost savings for 2012 are the same as those for 2011, at €548.9 million, is probably conservative. That would bring the total saving to €1.7 billion ($2.2 billion). Assuming that the savings to Japanese firms are equal to the annual average for 2008–2011 would bring the total savings for the commitment period to about €115 million ($150 million).

Government use of CERs, ERUs and purchased AAUs to help achieve compliance with their 2008–2102 emission limitation commitments by Japan and several European countries is projected at 500 to 600 million units (Kossoy & Guigon, 2012, table 5).[11] Most of this demand is likely to be met by CERs. To calculate the cost savings would require information on the costs of the domestic policies each country would have implemented in lieu of their CER purchases as well as information on the cost of the CERs purchased.

EU member States are expected to account for most of the government use of CERs to meet their 2008–2012 national commitments. Use of purchased CERs allows these countries to avoid implementing more costly domestic mitigation options. It is likely that the cost of the avoided options would exceed the price of EUAs, which reflects the cost of the domestic options being implemented. Thus, the EUA–CER spread, at €2.56 per CER, is probably a conservative estimate of the cost saving resulting from government use of purchased CERs. Assuming that Annex I governments use about 400 million CERs for compliance, the estimated savings are about €1 billion ($1.3 billion).[12]

In summary, the CDM has reduced compliance costs for firms in the EU ETS and Japan by at least $3.6 billion for the period from 2008 to 2011. The savings could be much larger, depending on the impact of CER use on the price of EUAs. For the 2008–2012 commitment period, the compliance cost savings for these firms are estimated to be at least $2.3 billion. Annex I government use of CERs to meet their national emission limitation commitments will yield an additional $1.3 billion in savings.

2.2 Mitigation cost-effectiveness by project type

Most project design documents (PDDs) that include an investment analysis provide sufficient information to calculate the projected cost per tCO_2e emissions reduced. The estimated mitigation costs differ substantially by project type. Estimated costs by project type for 2,336 registered and soon-to-be registered projects as of June 2012 are shown in figure 2. The project mitigation cost is the present value of all capital and operating costs over the life of the project less the present value of any revenue from sources other than the sale of CERs (e.g. for electricity generated), divided by the anticipated emission reductions over the life of the project. Thus, the project mitigation cost is measured in cost per tCO_2e reduced.[13] The bar represents one standard deviation above and below the average cost, while the line illustrates the minimum and maximum values.[14]

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[9] The saving to EU ETS installations is €2.56 per CER (€1,166.9 million/456.1 million CERs from table 1), so the saving for 36 million CERs is €92 million.

[10] A proposed temporary reduction of the quantity of EUAs issued or the setting of a minimum price for EUAs would also tend to increase the EUA–CER price spread.

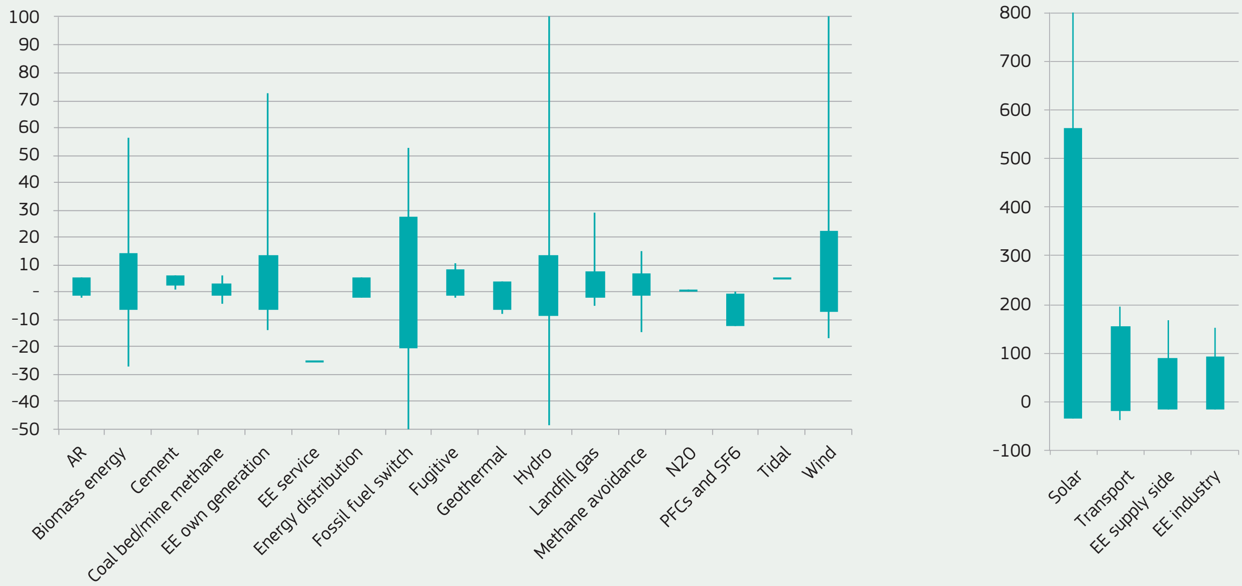
[11] Actual use of CERs will not be known until compliance with national emission limitation commitments for 2008–2012 is assessed, probably in 2014.

[12] CERs are expected to account for most of the 500 to 600 million units projected to be purchased and used for compliance by Annex I Parties.

[13] This metric is expressed in the same way as the capital investment by project type in figure 26, but the two are calculated and interpreted very differently. The project mitigation cost includes all operating costs and all revenue other than the sale of CERs over the life of the project, while the capital investment by project type does not.

[14] Where a line goes to the axis, the value has been truncated.

Figure 2. Estimated mitigation costs by project type ($/tCO$_2$e)



Source: Authors' calculations based on the estimated data provided in PDDs for 2,336 registered or soon-to-be registered projects as of June 2012.

Note: AR = afforestation/reforestation; EE = energy efficiency.

tCO$_2$e and have a negative cost component. As indicated in figure 2, solar,[15] transport, energy efficiency (EE) industry and EE supply-side projects have much higher mitigation costs. The project mitigation costs are sensitive to the discount rate used. The estimates shown use the discount rate proposed in the PDD.[16] The project mitigation costs are also sensitive to the project crediting period. The estimates shown assume the crediting period is the project life or the maximum crediting period including renewals, whichever is shorter. Most project participants choose a renewable crediting period. Project mitigation costs tend to be much lower with renewable crediting periods ($2.42/tCO$_2$e) when compared with fixed crediting periods ($23.80/tCO$_2$e).[17] The calculations do not include transaction costs, such as fees to designated operational entities (DOEs) for validation and verification, host-country levies or designated national authority (DNA) charges, the administrative cost levy of the EB, the share of proceeds for the Adaptation Fund and costs associated with the sale of CERs.

A mitigation cost below $10/tCO$_2$e is probably necessary for a project to be viable. The total cost, after including the transaction costs, needs to be lower than the price of CERs, which has been between $13 and $20 for most of the 2008–2011 period.[18]

The mitigation cost is a measure of a project's net costs, so a negative cost means the project is profitable without revenue from the sale of CERs. It is tempting, but incorrect, to interpret a negative project mitigation cost as indicating that a project is not additional. Firstly, a CDM project can be profitable without CER revenue, but it is still additional if the baseline scenario is more profitable. Although the number and types of projects for which this is the case has not been analysed, numerous PDDs claim that the project scenario would not be chosen despite its profitability because a more lucrative option is available.

Secondly, a CDM project can be profitable but still be additional if lack of access to capital or other barriers exist to restrict the implementation of the project. Many PDDs include detailed investment data but document the existence of such barriers. Thirdly, the transaction costs mentioned above are not included in the calculation.

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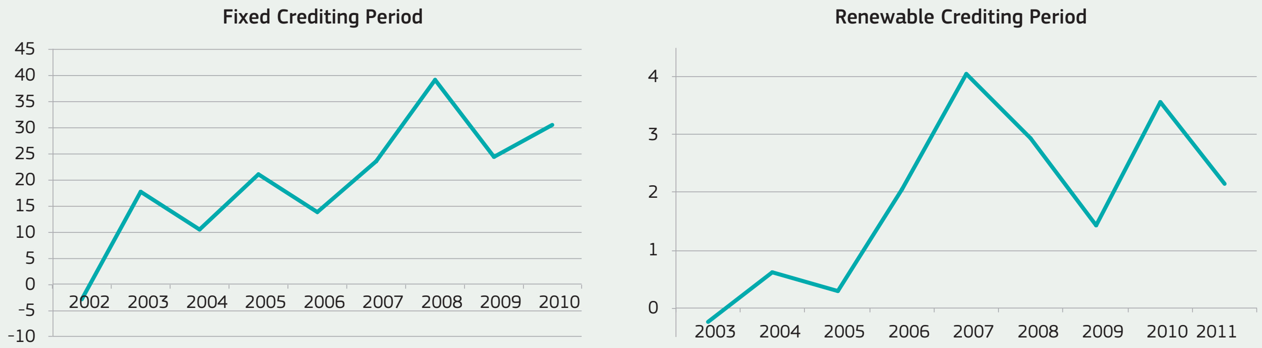
[15] The mitigation cost for solar projects is the average for several subtypes. Solar photovoltaic and solar thermal projects have a mitigation cost of $306/tCO$_2$e and $325/tCO$_2$e, but solar cooking and water heating have much lower costs at $3/tCO$_2$e and $4/tCO$_2$e.

[16] The mitigation cost was also calculated using the default values for expected return on equity as listed in the "Guidelines on the assessment of investment analysis" (report on the sixty-second meeting of the EB, annex 5), but no significant differences were detected.

[17] See annex D for mitigation costs for different crediting periods.

[18] Although the price of CERs was in the €20 range in mid-2008, it was between €10 and €15 before falling below €10 during the last half of 2011.

Figure 3. Estimated mitigation costs by year (\$/tCO_2e)



Source: Authors' analysis.

In addition, it is likely that the mitigation costs are somewhat understated. The average emission reduction performance of CDM projects is below the level anticipated in the PDD, thus the true mitigation cost is somewhat higher.[19] Finally, the calculations assume that crediting periods will be renewed with the same baseline and projected emission reductions. If that does not happen, the mitigation costs will be higher than these estimates.

The project mitigation costs are not directly comparable to the costs of similar emission reduction options in MAC curves. A MAC curve applies to a country, reflects a specific baseline scenario (fuel prices, etc.) and technology performance (lifetime, etc.) and typically uses a social discount rate. The project mitigation cost estimates are based on projects in different countries that probably have different baselines, have a limited crediting period and use private discount rates.

Furthermore, although the project mitigation cost is a relatively accurate measure of the project's costs over its lifetime, it may not represent the true abatement cost. If the baseline scenario includes costs, these should be subtracted from the project mitigation cost when calculating the marginal abatement cost. For example, most CDM renewable energy projects defer investment in fossil-fired generation, so the marginal abatement cost is the mitigation cost for the CDM project less the cost of the fossil-fired capacity avoided.

Figure 3 shows the trend in project mitigation costs based on the same set of projects. It suggests that the average mitigation cost has been increasing. This may reflect a change in the mix of project types, namely relatively more N_2O, PFC and SF_6 projects with low mitigation costs during the early years of the CDM. It may also reflect a more stringent assessment of additionality over time, leading to fewer projects that are economically viable without the revenue from the sale of CERs being registered.

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[19] The June 2012 CDM Pipeline Overview reports that for 1,580 projects with CERs issued, the quantity issued is 93.4% of the emission reductions anticipated in the PDD.

2.3 Impact on the ambition of commitments for the first commitment period of the Kyoto Protocol

Another potential impact of the CDM could be that the availability of flexibility in meeting their emission reduction targets encouraged Annex I countries to take on more ambitious targets than they would have without the CDM. In other words, even though the CDM was intended as an offset mechanism, did the availability of low-cost mitigation opportunities lead to more ambitious targets being taken on by Annex I countries?

Article 4, paragraph 2(a), of the Convention says that "Parties may implement such policies and measures jointly with other Parties and may assist other Parties in contributing to the achievement of the objective of the Convention". This concept of 'joint implementation' (JI) preceded the current JI mechanism under the Kyoto Protocol (Oberthür, 1993). This concept and the literature on gains from emissions trading in the USA led several researchers prior to 1997 to analyse the potential gains from emissions trading under the Convention and how this could reduce the costs of meeting particular global targets (e.g. Maddison, 1995; Weyant & Hill, 1999; Hammitt & Adams, 1996). The research utilized estimated MAC curves (see section 2.1) for both Annex I countries and non-Annex I countries to assess the gains from trading.

Many of the Parties to the Convention, however, strongly objected to any notion of emissions trading, particularly India, China and the EU (Grubb et al., 1999; Streck, 2004). The USA was the main force pushing for international emissions trading among Annex I countries throughout the negotiations leading up to the conference in Kyoto. After Sweden, the USA was also the most important player in the 'activities implemented jointly' pilot phase of testing of the concept of JI between Annex I and non-Annex I countries (Schwarze, 2000). Despite Sweden's involvement, and to a lesser extent Germany, France, Netherlands and Belgium, the EU was not supportive of the idea of project-based emissions trading with non-Annex I countries, nor was it in favour of international emissions trading in the early Kyoto Protocol negotiations (Grubb et al., 1999). Southern countries, such as India and China, also raised strong concerns about shifting the responsibility for emission reductions to developing countries and the 'cream-skimming' of cheap mitigation opportunities in poor countries (Chatterjee & Spalding-Fecher, 1997; Jepma, 1995; Parikh, 1995; Maya et al., 1996).

The CDM as we know it today emerged in the final month or two of the negotiations of the Kyoto Protocol. In June 1997, Brazil had put forward a proposal for a 'Clean Development Fund' that would use penalties paid by Annex I countries for non-compliance with their commitments to fund mitigation projects (and possibly adaptation) in developing countries. The fund proposal included ways of allocating the funding among developing countries, which was the origin of the concerns over regional distribution that emerged shortly after the Kyoto conference (see this discussion in section 8.1). Only in the final pre-Kyoto negotiating sessions in September 1997 did this idea shift to a mechanism that could allow companies or countries to invest in developing countries in exchange for offsets against their emission reduction targets (Grubb et al., 1999; Estrada Oyuela, 2012; Depledge, 2000). Even for the USA, then, there was very little time to assess how the CDM might affect the cost of meeting different targets. For the EU and Japan, even emissions trading among Annex I countries was not being considered when formulating their proposed commitments.

Interviews with negotiators from Annex I countries as part of this research process confirmed that the inclusion of the CDM in the Kyoto Protocol did not have a quantitative impact on the commitments Annex I countries made in the final hours of the negotiations. For the USA there was some value in having a mechanism that directly engaged developing countries in mitigation, because of pressure from the US Congress. For some other countries (e.g. the EU), even emissions trading had not been a priority, while for others (e.g. Norway) flexibility was important, but mainly among countries taking on commitments. Also, most Annex I countries were more concerned about the number of gases included in the commitments, the role of land use, land-use change and forestry and the differential commitments of Annex I countries than about offsetting in developing countries. The CDM did not, therefore, lead to more ambitious emission reduction commitments for Annex I countries, even though it was an important part of the overall package that was finally agreed in Kyoto.

3 Impact on sustainable development

Contributing to sustainable development in host countries is the first objective of the CDM mentioned in Article 12 of the Kyoto Protocol and is given the same level of importance as assisting Annex I Parties to meet their emission reduction targets. This chapter addresses the research questions as to what extent the CDM has, in fact, contributed to sustainable development and how these contributions can be enhanced. After a brief overview of UNFCCC requirements and procedures, the chapter then provides an overview of the criteria currently used by DNAs to assess the sustainable development contributions of CDM projects. This is followed by an extensive review of the literature on sustainable development and the CDM. We then present new analysis undertaken for this study on the reporting of sustainable development impacts in registered PDDs and the resulting trends in reported impacts by country/region and project type. This is followed by a discussion of negative impacts of CDM projects and how to evaluate the claims against some CDM projects of social and environmental harm caused by project implementation. Finally, we turn to a discussion of options for enhancing the sustainable development contribution of the CDM, including how to minimize negative impacts.

3.1 Current UNFCCC requirements and procedures[20]

Since the adoption of the Kyoto Protocol, there have been five decisions by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (CMP) that have provided consistent guidance on Article 12 as to how the sustainable development component of project activities is to be determined:

- Decisions 17/CP.7,[21] 1/CMP.2, 2/CMP.3 and 2/CMP.4 each have recitals that affirm or reaffirm "that it is the host Party's prerogative to confirm whether a clean development mechanism project activity assists it in achieving sustainable development".
- Decision 3/CMP.1, annex, paragraph 40, relates to the procedures for the registration of a CDM project activity and provides that: "The designated operational entity shall: (a) Prior to the submission of the validation report to the Executive Board have received from the project participants written approval of voluntary participation from the designated national authority of each Party involved, including confirmation by the host Party that the project activity assists it in achieving sustainable development".

No further guidance has been provided as to how the DNAs should assess the sustainable development impact of CDM projects. The PDD, which is used to register CDM projects, simply requires the project proponent to include in the description "the view of the project participants of the contribution of the project activity to sustainable development (max. one page)". It should be noted that the PDD for programmatic CDM projects (PoAs) does not even contain this requirement.

Over the years this set-up has been criticized by different CDM stakeholder groups, in particular by local non-governmental organizations (NGOs), claiming the following shortcomings:

- The lack of definition of sustainable development makes the requirement for CDM projects to contribute to sustainable development in the host country meaningless.
- In several cases registered projects are not contributing to sustainable development and in some cases are even detrimental to sustainable development.
- Since sustainable development is not included in the monitoring requirements of the CDM, the real impact of CDM projects is not known or reported.[22]
- Based on the above, there is a concern that, in some cases, the sustainable development impact of CDM projects is ignored.

Notwithstanding the recognition that the CDM gives the host country DNA a clear and exclusive right to assess and

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[20] This chapter is based on a more detailed assessment of technology transfer and the CDM commissioned by the CDM Policy Dialogue (TERI, 2012).

[21] The Conference of the Parties assumed the responsibilities of the CMP for this decision (see decision 17/CP.7).

[22] The UNFCCC secretariat's report entitled "Benefits of the Clean Development Mechanism 2011" (UNFCCC, 2011a) attempts to correlate claims of sustainable development benefits as stated in the PDDs with the responses received in a survey of project participants after project implementation, but finds that the reported impacts often differ significantly.

confirm the contribution to sustainable development of a CDM project, the CDM EB is currently engaged in discussions on to what extent the Board may provide guidance on this matter. In order to support this discussion, the Board launched at its sixty-first meeting a call for public inputs on sustainable development co-benefits and negative impacts of CDM project activities. The responses to the call were presented in a synthesis report by the EB at its sixty-fifth meeting. The Board noted that the "assessment of the contribution of project activities to sustainable development is under the authority of DNAs" and requested the secretariat to "undertake an analysis of the potential implications of the proposed measures and of what issues are within the remit of the Board to address".

At the seventh session of the CMP (decision 8/CMP.7), Parties requested the Board to "continue its work and develop appropriate voluntary measures to highlight the co-benefits brought about by clean development mechanism project activities and programmes of activities, while maintaining the prerogative of Parties to define their sustainable development criteria".

At EB 67, the Board considered a concept note on highlighting sustainable development co-benefits on a voluntary basis (EB 67 proposed agenda, annotations to the proposed agenda, annex 13). This note outlined the objective of enhancing reporting on co-benefits, the principles and constraints, and several options for implementation. Constraints include that any measure must be voluntary for project participants and that it must not undermine the role of the DNA in determining whether the CDM project contributed to sustainable development. Following discussion of this concept note, the Board requested the secretariat to develop a tool to include the following features:

- A checklist approach based on best practices and drawing on a wide selection of possible sources.
- Flexibility to include the voluntary tool in existing CDM documents and workflows.
- That a project participant or coordinating and managing entity (CME) may make an initial declaration using the voluntary tool.
- That a project participant or CME may choose to update, change or withdraw the initial declaration if circumstances change at any time prior to or after registration of the CDM project activity or PoA.

In the concept note for EB 67, the secretariat noted that such a checklist could be used in several ways in the CDM project cycle, namely:

- As an initial declaration at the start of project development.
- As an initial declaration that is updated during project implementation.
- As an initial and updated declaration that is subject to validation and verification.
- All of the above, plus possible adverse consequences for projects failing to perform.

3.2 An overview of sustainable development criteria set by DNAs

3.2.1 Introduction

Under the Kyoto Protocol, host countries have the responsibility of deciding what contributes to sustainable development (Marrakesh Accords, 2001). Each host country has to set up a DNA, which has the prime responsibility of determining whether CDM projects from its country will support sustainable development. As DNAs decide on sustainable development criteria on the basis of their national development priorities, there is wide variation in the way and detail in which these criteria are defined. The following section attempts to map this diversity and provide a summary of the sustainable development criteria used by DNAs and the common approaches employed to provide the letter of approval (LoA) to project proponents.

The present assessment is based on three main data sources: a compilation of questionnaire responses from DNAs, sustainability criteria as provided on DNA websites and relevant literature sources. The study was initiated with a sample of 51 countries. Of these, criteria for 20 countries could not be assessed owing to lack of information. Some DNAs do not have a website, others do not web-host their sustainable development criteria, while in some cases the information available on DNA websites was not accessible (e.g. language issues or website not working). Finland, being an Annex I country, was not included in the assessment. Hence, this confines the current assessment to an examination of the sustainable development criteria used by 30 countries.

3.2.2 Criteria set by DNAs to assess the sustainable development benefits of CDM projects

Most of the surveyed DNAs[23] mention that they have an operational definition of sustainable development in their country (six of the nine non-Annex I DNAs who responded to the survey). In Korea the operational definition is specified under the federal laws and in Mauritius under the national DNA regulations. Broadly, most countries define their sustainable development criteria under the social, economic and environmental dimensions. Technological benefits are usually either incorporated into the economic benefits or are a separate category. The degree of detail in which DNAs explain their sustainable development criteria differs. The approaches used by countries can be defined as per the following typology (see also table 2):

- *General listing of criteria/indicators under the three/four categories*: [24] For example, India, Morocco, Brazil, Korea, Kenya, Armenia, Uzbekistan, UAE, Peru, Senegal, El Salvador, Nicaragua, Bolivia and Mali give a list of indicators under social, economic and environmental categories.
- *Listing of criteria and a set of indicators under each category:* For example, Vietnam, Malaysia, Indonesia, South Africa, Rwanda, Zimbabwe, Mauritius, Panama and Serbia describe the criteria under each category and give a list of indicators suggesting what the criteria incorporate.
- *Listing of indicators under criteria, with scoring of each indicator:* For example, Thailand, Bhutan and Georgia provide elaborate scoring for sustainable development indicators under a set of criteria under each category.

Economic benefits: DNAs investigate project-specific, local and national benefits of CDM projects in order to assess the economic benefits. However, the major focus of DNAs while assessing the economic benefits of projects is on local and subnational (regional) benefits. The common project-specific criteria are the impact on cost-effectiveness of the project with respect to the baseline (Morocco and Georgia) and whether there is mutual consent between different stakeholders in the project (Indonesia and Korea).

Most DNAs expect CDM projects to contribute towards strengthening the local economy of the region by generating additional income for the local communities, by creating employment opportunities and by bringing in additional investment (Madagascar, Thailand, Serbia, Bolivia, Burundi, Vietnam, Zimbabwe, Uzbekistan, Brazil, Bolivia and Nicaragua).

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[23] A survey questionnaire was sent by the UNFCCC to all DNAs on April 29, 2012 with a deadline of May 25, 2012. Responses to the survey were received from 10 countries' DNAs: Bhutan, Burundi, Republic of Korea, Zimbabwe, Mexico, Finland, Mali, Madagascar, Mauritius and South Africa.

[24] While these countries only provide a listing of criteria/indicators, some of these are quite elaborate.

DNAs also assess the impact of the project activity on investment in the region and in the priority sectors of their country (Mauritius, Mexico, Thailand, Korea, India, South Africa, Armenia, El Salvador, Senegal, Bolivia and Serbia). Countries also give consideration to the impact of the project activity on the macroeconomic sustainability of the country through its impact on the balance of payments (Bhutan, Zimbabwe, Georgia, South Africa, Mauritius, Morocco, Rwanda, Serbia and Armenia).

Environmental benefits: The majority of DNAs rely on the environmental laws and regulations and the standards set by national, provincial and local governments in deciding whether the project is contributing positively to the local environment. DNAs provide an elaborate list of indicators to check the impact of projects on the environment. The environmental benefits of CDM projects expected by DNAs relate to GHG emission reductions, the impact of the project on the environment and resources and the project's contribution to the sustainability of resources. The impact of the project on the local environment and resources is the most frequently used criterion.

Many DNAs emphasize the impact of the project on the environment. Most of them further elaborate the impacts on air, water, marine and land environment and biodiversity. Several DNAs give a special mention to the sustainability of resource use through efficient resource usage, the local community's access to resources and the avoidance of resource degradation (Korea, India, Vietnam, Rwanda, Malaysia, Indonesia, Morocco, South Africa, Mauritius, Serbia, Georgia, Armenia, Uzbekistan and Thailand).

Social benefits: The impact that a CDM project has on the improvement of the quality of life of the local community is the most frequently used criterion. However, DNAs usually specify indicators that would justify the improvement of the life of local communities by the project. These include: assisting in poverty alleviation through employment generation; ensuring no adverse effects on health; engaging in developmental activities to support society; enhancing access to public services; and promoting local industry. Among these, impact on human health and engaging in developmental activities appear most frequently. Developmental activities highlighted by DNAs include infrastructure creation, provision of healthcare, educational facilities and civic amenities.

Most DNAs require effective community participation throughout the project cycle, ranging from consultations during project design and planning to providing local resources, services and labour during project implementation (Mauritius, Zimbabwe, Indonesia, Kenya, Thailand, Serbia, Georgia, Armenia, Bolivia, Peru, El Salvador and Rwanda). The Peruvian DNA requires a written agreement between the project proponent and local communities to issue the LoA. DNAs also emphasize the ability of the project to generate technical skills and knowledge in the local community. In addition, many DNAs account for the alignment of the project to provincial and national government objectives, local development priorities and specific sectoral objectives.

3.2.3 Procedures for issuing the LoA

The procedures for granting an LoA differ greatly from country to country and so does the institutional set-up of the DNAs. However, many DNAs have a requirement for the review of the project by technical and sectoral experts or relevant ministries. Almost all countries have representation from key ministries in the approval process. Their role is to review and evaluate the project and provide support to the DNA in its decision-making. In Kenya, for example, there is a National CDM Clearing House, with representation from the public and private sectors, institutions, civil society and academia.

Most DNAs decide on the compliance of the project with the sustainable development priorities of the country keeping the designated sustainable development indicators as a reference. Usually the project is not expected to fulfil all the criteria/indicators but to describe the ones to which it will contribute. However, some countries do specify this information. For instance, the DNA of Thailand, which has developed a method of scoring for each indicator under a defined set of criteria for all three dimensions of sustainable development (social, economic and environmental), mentions that a project needs to have a positive total score for all indicators mentioned and for each sector.

Some DNAs incorporate certain special checks to ensure that sustainable development requirements are fulfilled. For example, the South African, Brazilian and Malaysian DNAs expect the PDDs to be validated by a DOE before submission for host-country approval (although the validation does not include verifying the sustainable development benefits). The Rwandan DNA expects an updated sustainable development checklist demonstrating how the sustainable development criteria are being met once the project is operating each time a verification of the project is conducted.

The online assessment also reveals that there are many countries which do not have a DNA website. Previous studies (Arens, Burian et al., 2011) mention that the absence of a DNA website can function as a barrier to investors and can be a sign that these DNAs do not actively promote the CDM within the host country. However, the lack of financial

Table 2. Sustainable development criteria most frequently used by DNAs

To assess the economic benefits of CDM projects	
1.	Additional investment generated
2.	Employment generation
	2.1 Number of jobs created for the local community: within the project activity in the area
	2.2 Quality of jobs created
3.	Income generation
4.	Contribution to sustainability of balance of payments by its: impact on foreign exchange requirements impact on foreign direct investment contribution to macroeconomic sustainability impact on imports and exports
5.	Clean energy development: generation from renewable sources of energy access to clean energy cost of energy reduction in energy dependence and energy intensity
6.	Contribution towards improvement of technologies Use of technologies that are: cleaner, more efficient and environmentally friendly locally appropriate best available, modern and proven (not obsolete or substandard)
To assess the environmental benefits of CDM projects	
1.	GHG emission reduction
2.	Impact on environment
3.	Impact on air, water and land resources
4.	Impact on solid waste generation or disposal
5.	Impact on conservation/promotion of biodiversity (genetic, species and ecosystem) and ecosystems
6.	Contribution to resource sustainability: efficiency of resource usage access of local community to resources impact on resource degradation
To assess the social benefits of CDM projects	
1.	Quality of life of local communities
	1.1 Poverty reduction
	1.2 Impact on human health: health of the community in the project area occupational health and safety measures
	1.3 Inclusion of developmental activities to support the society
	1.4 Accessibility of local public services
	1.5 Promotion of local industries
2.	Effective public/community participation in project design, planning and implementation
3.	Capacity/skill/knowledge development
4.	Consistency with/contribution to national, provincial and local development and sectoral priorities

Source: Survey of DNAs.

resources and capacity issues of such DNAs also need to be considered.

3.2.4 Insights from literature on the sustainable development criteria of DNAs

There is a dearth of literature specifically targeting the sustainability criteria employed by DNAs. Olsen and Fenhann (2008), in their study on sustainable development benefits, conducted a review of the approval processes of the largest DNAs (India, China, Brazil, Morocco, Mexico, South Africa and Armenia) and concluded that most DNAs use a checklist approach for the establishment of sustainable development. Pointing to the weaknesses in the approval processes of these DNAs, the authors state that none of the countries require any monitoring of the sustainable development benefits to verify that the benefits are real and measurable. They criticize the current process of approval, stating that sustainable development is not included in the assessment of DOEs during verification and it is not a requirement at the international or national level that sustainable development benefits are actually realized. Boyd et al. (2009) raise questions as to whether the DNAs address the issue of accountability of project proponents in ensuring sustainable development benefits. Sterk et al. (2009) do a comparative analysis of conventional CDM projects with Gold Standard (GS) projects from six countries (i.e. India, Panama, Bolivia, El Salvador, Nicaragua and Brazil). The authors conclude that the procedures and criteria of Panama and Nicaragua are well developed with detailed stakeholder consultations and stress a safeguarding approach. India exemplifies both good and bad projects in terms of sustainable development benefits to communities. It was suggested that a stringent stakeholder consultation requirement by the DNA would improve this situation. Brazilian procedures are satisfactory but there is room for flexible interpretation. Bolivian indicators are "theoretically well-developed", while El Salvadoran indicators lack specific parameters. Overall, the study concludes that there is a need for further clarity in relation to the sustainable development criteria of DNAs and more detailed stakeholder consultation procedures. Arens et al. (2011) studied the potential of the CDM in 11 selected least developed countries (LDCs) in sub-Saharan Africa: Burkina Faso, Democratic Republic of the Congo, Ethiopia, Malawi, Mali, Mozambique, Rwanda, Senegal, Tanzania, Uganda and Zambia. They found that only three of the 11 countries studied have a DNA website, which can be a barrier to investors and a sign that these DNAs do not actively promote the CDM within their host countries.

3.2.5 Insights from stakeholder inputs

The issues of sustainable development criteria and the role of DNAs have been raised in some of the stakeholder consultations conducted by the CDM Policy Dialogue.[25] The key observations that emerged from stakeholder consultations conducted by the CDM Policy Dialogue are as follows:

- The current system, in which countries set their own sustainable development definitions and criteria for project approval, should remain, to ensure that country-specific indicators are aligned with local socio-economic conditions and respect national sovereignty. The EB or secretariat could, however, assist in developing some voluntary guidelines for countries needing assistance, especially in quantifying sustainable development impacts.
- DNAs need to have a more continuous role in the CDM process, with additional powers within the CDM project cycle to ensure sustainable development. Many participants thought that the role of the DNA should be expanded to include monitoring the activities of projects after approval and implementation.
- There is a need to further strengthen the capacity of DNAs (especially in Africa).

Some solutions were also suggested during various consultations (e.g. Tokyo Consultation, Africa Carbon Forum, Asia Consultation, Joint Coordination Workshop and meetings with negotiators during Bonn negotiation sessions). These are listed below:

- Providing DNAs with the power to withdraw the LoA.
- Embedding sustainable development criteria in the project verification stage.
- Enhancing the dialogue among DNAs to share ideas on best practices, sustainable development criteria and other key issues.
- The monitoring of sustainable development benefits by the host countries.

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[25] The consultation reports that include discussions on sustainable development criteria and the role of DNAs include those of the Tokyo Consultation (May 10–11, 2012), the Africa Carbon Forum (April 18–20, 2012) and consultations with African stakeholders (July 4, 2012), the Asia Consultation (June 7–8, 2012) ,the Joint Coordination Workshop (May 15–18, 2012), the meetings with negotiating blocks during Bonn negotiation sessions (May 2012) and the meeting with DNAs and NGOs during the DNA Forum (March 22–23, 2012).

- Improved communication between the secretariat and the DNAs.
- More stringent LoA issuance processes.

The need for the monitoring of sustainable development benefits was raised in most consultations. Many stakeholders felt that DNAs should become more involved in the CDM process to ensure greater accountability. Some stakeholders suggested that if the DNA is not satisfied that a project is meeting its sustainable development goals, the DNA should be able to exercise its authority, based on its own monitoring systems, or request the EB to designate a DOE to verify the sustainable development impacts. The DNA should then have the right to revoke the registration of the project on the basis of that evidence. However, while stakeholders mention that a monitoring system is important to measure the sustainable development benefits of a project, some stakeholders questioned the usefulness of such a system. They argued that while greater scrutiny of sustainable development is important, a more rigorous system might be counterproductive and have a negative impact on the market. Others feared that incorporating sustainable development criteria into the verification process would increase transaction costs, which are already one of the most important barriers to the CDM.

3.3 Literature review on sustainable development benefits

This section summarizes the review of scientific studies assessing the sustainable development performance of CDM projects. The last few years have seen a growing body of literature on the CDM and its contribution to sustainable development. Most of it is published by researchers and academics as peer-reviewed papers. In addition, the research papers and monographs from policy and think tank organizations are also significant. The studies acknowledged the difficulty of defining sustainable development, but generally accepted that sustainable development means the convergence of the three pillars of economic development, social equity and environmental protection. Each of these three dimensions of sustainable development has been further defined in terms of criteria and indicators by the researchers. According to Olsen and Fenhann (2008), “defining sustainable development once and for all is an impossible task”.

3.3.1 Methodologies used in key studies

In order to capture the multi-dimensionality of the concept of sustainable development, the majority of the studies on the subject assess the sustainability impacts of CDM projects using criteria and indicators (see table 3). However, the selection of specific criteria varies in different studies. Most of the studies have used the PDDs as the primary source of data/information. However, in order to validate the claims made in the PDDs, a few studies (UNFCCC, 2011a; Subbarao & Lloyd, 2011) have followed the textual analysis of PDDs with a survey of project owners or other relevant stakeholders, and site visits for selected projects, as part of their methodology.[26]

Most of the research studies have divided the criteria used for the analysis under three broad headings – environmental impacts, social impacts and economic impacts. A few, however, have focused on just the environmental dimension of sustainable development, in terms of GHG emission reductions, on the grounds that the primary objective of the CDM is to combat global warming (Huang & Barker, in press). Some studies have included quality of stakeholder consultation/participation and stakeholder comments as one of the indicators to assess CDM projects (Nussbaumer, 2009; Alexeew et al., 2010; Castro & Michaelowa, 2008; Sutter 2003; Subbarao & Lloyd, 2011). A few studies have also assessed projects with respect to distribution of CER revenues (Sutter & Parreño 2007; Nussbaumer 2009). More uncommon criteria/indicators used by studies include sustainability tax and corporate social responsibility (Olsen & Fenhann, 2008), training (Watson & Fankhauser, 2009) and migration (Subbarao & Lloyd, 2011).

One study focused on assessing the suitability of the GS for the CDM as a whole (Sterk et al., 2009) to enhance its sustainable development impacts, while another (Nussbaumer, 2009) attempted a comparison of GS-labelled projects with non-labelled projects of a similar type with respect to their impacts on socio-economic development and environmental conservation.

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[26] Two studies have used software for the textual analysis of PDDs: Olsen and Fenhann (2008) conducted an evaluation of 296 PDDs using a software program called Nvivo7 and Lee and Lazarus (2011) employed Atlas.ti Version 6.2 software for the same purpose.

Table 3. Summary of methodologies employed to assess the sustainability impacts of CDM projects and conclusions from reviewed studies

Title of the study; author(s) and year	Methodology	Case studies, sample number, countries, etc.	Conclusions
Sustainability check-up for CDM projects; Christoph Sutter, 2003	Multi-Attributive Assessment of CDM (MATA-CDM) of information received from stakeholder consultations/ surveys	Six case studies in South Africa, India and Uruguay	▸ Clear trade-off between the two objectives of the CDM ▸ Project developers can deliver sustainable development benefits with projects that go beyond the minimal requirements given by the host country. This only works if there is a market for premium CERs with a higher price
Does the current Clean Development Mechanism (CDM) deliver its sustainable development claim? An analysis of officially registered CDM projects; Christoph Sutter and Juan Carlos Parreño, 2007	MATA-CDM of information given in PDDs	16 projects registered as of August 30, 2005	▸ Trade-off between the two objectives of CDM ▸ Contributions to sustainable development are not well reflected in CER prices
The promotion of sustainable development in China through the optimization of a tax/ subsidy plan among HFC and power generation CDM projects; Martin Resnier, Can Wang, Pengfei Du and Jining Chen, 2007	The data extracted from PDDs were subjected to the CDM Tax/Subsidy Optimization Model (CDMTSO Model)[1]	All registered projects up to August 2006	▸ Internal rate of return of sustainable CDM projects would be close to 10%
Empirical Analysis of Performance of CDM Projects, Climate Strategies; Paula Castro and Axel Michaelowa, 2008	Empirical analysis of PDDs of CDM projects (including registered, in the pipeline, rejected and withdrawn projects) followed by interviews with international experts and project developers and literature review	275 registered CDM projects, 18 projects in validation, 20 rejected projects and 4 withdrawn ones (as of June 2007, United Nations Environment Programme Risoe Centre). For the case study assessments, four projects from China, India and Brazil were selected	▸ The performance of CDM projects in terms of their contribution towards sustainable development does not have any evident impact on their success in terms of CER issuance, lead times, validation or registration success ▸ Buyers do prefer good projects, with sustainability benefits, but they do not have a strong position since the demand for CERs is larger than the offer ▸ More detailed monitoring guidelines or measurable sustainability indicators may contribute to improving the sustainability performance of CDM projects

Title of the study; author(s) and year	Methodology	Case studies, sample number, countries, etc.	Conclusions
Sustainable development benefits of clean development mechanism projects: A new methodology for sustainability assessment based on text analysis of the project design documents submitted for validation; Karen Holm Olsen and Jørgen Fenhann, 2008	Text analysis of the PDDs using software program Nvivo7 (QSR International, 2006), developed for qualitative text analysis	Sampled 296 PDDs (out of 744 total as of May 2006)	▸ The trade-off between the two objectives of the CDM exists in favour of cost-efficient emission reductions and, left to the market forces, the CDM does not significantly contribute to sustainable development ▸ Employment generation is the most likely impact of an average CDM project ▸ The distribution of sustainable development benefits among the three dimensions is fairly even, with most benefits in the social dimension, followed by the economic and the environmental dimensions
On the contribution of labelled Certified Emission Reductions to sustainable development: A multi-criteria evaluation of CDM projects; Patrick Nussbaumer, 2008	Using information in PDDs, a MATA-CDM. GS and Community Development Carbon Fund (CDCF) CDM projects were compared with non- labelled projects of a similar type	39 registered CDM projects (as of April 1, 2008). All GS and CDCF CDM projects were selected	▸ The CDM's role in assisting host countries in their effort to promote sustainable development is minimal ▸ Labelled (GS and CDCF) projects do not drastically outperform non-labelled ones in terms of sustainable development benefits
Further Development of the Project-Based Mechanisms in a Post-2012 Regime; Wolfgang Sterk et al., November 2009	Based on information given in PDDs, analysis of the GS to assess its robustness and its applicability to the CDM as a whole	Five registered GS projects (as of March 2009); 10 conventional CDM projects, two each from India and China and one each from Bolivia, Brazil, El Salvador, Nicaragua, Columbia and Panama	▸ Project types such as transport or sustainable waste management which have a high sustainable development rating should also be included in GS, besides renewable energy and end-use energy-efficiency projects ▸ The existence of host-country sustainable development criteria does motivate project developers to think about sustainable development aspects ▸ Most DNAs' sustainable development criteria lack transparency and clarity ▸ Stakeholder consultation is often only rudimentary, completely unregulated and poorly documented
Reforming the CDM for sustainable development: lessons learned and policy futures; Emily Boyd et al., 2009	Evaluation of direct and indirect benefits on the basis of sustainable development criteria through PDD analysis	A random sample of 10 projects that capture specifically: (a) the diversity of CDM project types, including biomass, waste heat recovery, hydroelectricity, fuel switch, land fill, construction and biogas and (b) regions. The case studies were from India, Brazil, South Africa, and China	▸ The CDM in its current form has negligible sustainable development benefits ▸ Sustainable development benefits should be reflected in CER prices

Title of the study; author(s) and year	Methodology	Case studies, sample number, countries, etc.	Conclusions
The Clean Development Mechanism: too flexible to produce sustainable development benefits?; Charlene Watson and Samuel Fankhauser, June 2009	Textual/keyword analysis of information given in PDDs	The study samples 10% of the 4,064 projects (as of October 2008). All projects at all stages of validation except those rejected or withdrawn were considered	▸ Employment generation and training are the leading benefits of the CDM ▸ Indian projects contribute more to infrastructural development than either Chinese or Brazilian projects, but with less technology transfer ▸ Chinese projects contribute more to the conservation of natural capital in the form of reduced pollution ▸ Industrial gas projects have meagre co-benefits and renewable and forestry projects have a greater capacity to contribute to sustainable development
The Clean Development Mechanism and Sustainable Development: A Panel Data Analysis; Yongfu Huang and Terry Barker, 2009	Environmental Kuznets Curve framework[2]	34 CDM host countries over the period 1990–2007; however, CDM host countries which had their first CDM projects in the pipeline after 2006 were excluded	▸ CDM projects are correlated with a decline in CO_2 emissions in host countries
Analysis of the relationship between the additionality of CDM projects and their contribution to sustainable development; Johannes Alexeew, 2010	Literature review and multi-criteria (economic, social and environmental) assessment of PDDs	A sample of 40 (31 small- and nine large-scale projects –15 biomass, 12 wind, seven hydro, four energy efficiency and two HFC-23) registered projects, chosen from the pool of 379 CDM projects in India (as of January 2009). Only projects which applied the investment analysis method for proving additionality were considered	▸ Significant trade-off between the two goals of the CDM – projects with an above-average sustainability performance lack a high probability of being additional, and vice versa ▸ Wind, hydro and biomass projects are consistently observed to make a high relative contribution to sustainability, but are not as likely to be additional; whereas industrial energy-efficiency and HFC-23 projects are more likely to be additional, but do not contribute as much to sustainable development
Benefits of the Clean Development Mechanism 2011; UNFCCC, 2011	Multi-criteria assessment of PDD content and follow-up survey of project participants	All of the 2,250 projects registered as of July 2011	▸ All registered projects report multiple sustainable development benefits ▸ Sustainable development benefits are confirmed for almost all projects where survey was conducted, but the specific benefits reported in the PDD and in the survey are often not the same ▸ Employment creation and reduction in noise, odours, dust or pollution are the leading benefits of CDM projects

Title of the study; author(s) and year	Methodology	Case studies, sample number, countries, etc.	Conclusions
Can the Clean Development Mechanism deliver?; Srikanth Subbarao and Bob Lloyd, 2011	Desktop analysis of 500 PDDs. In addition, five case studies were investigated through site visits to verify the PDD documents	500 registered small-scale CDM projects (as of May 2008) were selected for desktop analysis, covering a wide range of sectors	▸ Renewable energy projects can be particularly appropriate for developing countries in terms of sustainable development benefits ▸ Small-scale, community-based rural renewable energy CDM projects can offer good prospects for poverty and livelihood benefits in developing countries ▸ Ground-truthing is critical to ensure that sustainable development claims in the PDD are actually delivered to the local communities
Bioenergy Projects and Sustainable Development: Which Project Types Offer the Greatest Benefits?; Carrie Lee and Michael Lazarus, 20111	Development dividend[3] framework and textual analysis of PDDs using the Atlas.ti Version 6.2 software (Atlas.ti GmbH 2010)	71 registered and five validation-stage biomass energy projects using plant-derived biomass (from a total of 291 registered biomass energy projects and 381 projects at the validation stage as of January 2010)	▸ The most common sustainable development benefits claimed in project documents were renewable energy production, stakeholder identification, waste reduction, employment generation and indirect income generation
Is the Clean Development Mechanism Promoting Sustainable Development?; Yongfu Huang, Jingjing He and Finn Tarp, May 2012	Long-differencing estimator models with Human Development Index as the dependent variable and CDM project development as the independent variable	All registered projects in 58 CDM host countries over the period 2005–2010	▸ Higher CDM credits per capita, higher ratios of CDM credits per unit of gross domestic product and per unit of emissions, and higher investment ratios are correlated with sustainable development ▸ The CDM plays a very positive role in encouraging developing countries to participate in the world's GHG abatement efforts

Source: Authors' analysis.

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[1] The CDM Tax/Subsidy Optimization Model (CDMTSO Model): a sustainable development assessment method evaluates the CDM projects' economic and environmental benefits and an optimization program returns tax/subsidy rates at which the greatest number of CDM technologies becomes viable and where 'better' CDM projects can be the most profitable.

[2] A Kuznets curve is the graphical representation of Simon Kuznet's hypothesis that as a country develops there is a natural cycle of economic inequality driven by market forces, which at first increases inequality and then decreases it after a certain average income is attained. The environmental Kuznets curve is a hypothesized relationship between environmental quality and economic development: various indicators of environmental degradation tend to get worse as modern economic growth occurs until average income reaches a certain point over the course of development.

[3] Development dividend can be defined as "benefits to developing countries beyond those strictly related to climate change, in the areas of economic growth through investment; technological evolution; poverty alleviation; environmental and human health improvements". In other words, the development dividend consists of those benefits that might arise from CDM projects *other than the reduction of GHG emissions* (source: Development Dividend, Phase II Report, IISD, 2006).

3.3.2 Conclusions from key studies on the CDM and sustainable development

The literature review shows the clear consensus on the three main dimensions of sustainable development: the social, the economic and the environmental (Nussbaumer, 2009; Boyd et al., 2009; Alexeew et al., 2010; UNFCCC, 2011a; Sutter, 2003; Subbarao & Lloyd, 2011; Sterk et al., 2009; Lee & Lazarus, 2011). Some of the common sustainable development criteria for each of the 'three pillars' used by different research studies include:

- Social criteria: health, welfare, learning, employment, poverty alleviation, equity, improved quality of life, and stakeholder participation.
- Economic criteria: financial returns to local entities, a positive balance of payments, and technology transfer.
- Environmental criteria: reduction of GHGs and the use of fossil fuels, conservation of local resources, improved local air and water quality, better waste management, etc.

The following paragraphs summarize the findings of the literature survey, predominantly covering themes such as the CDM and sustainable development, the potential trade-off between the two objectives of the CDM, the correlation between the sustainable development impacts and additionality of projects, the sustainable development benefits of small-scale and GS projects, and the ongoing debate on international guidelines for assessing the sustainability of CDM projects.

The majority of the studies agree that the CDM does have a positive impact on the various facets of sustainable development in the host countries (UNFCCC, 2011a; Huang et al., 2012b). According to Huang et al. (2012), despite its inadequacies and limitations, the CDM is the only climate change mechanism that offers an innovative solution to the challenge of how to incorporate sustainable development considerations into emission mitigation activities. Nussbaumer (2009) does question the CDM's role in promoting sustainable development in host countries. Nevertheless, the author finds the CDM to be very successful in contributing to the development of a global carbon market, allowing for temporal and spatial flexibility in achieving emission reduction targets.

Several studies have attempted to understand the impact of the CDM on sustainable development in the host countries. According to Olsen and Fenhann (2008), the distribution of sustainable development benefits among the three dimensions is fairly even, with most benefits in the social dimension, followed by the economic and the environmental dimensions. Of the various aspects of sustainable development, employment generation is the most predominant impact of CDM projects, followed by economic growth, improved air quality, and capacity-building of the local population (Olsen & Fenhann, 2008; Watson & Fankhauser, 2009; UNFCCC, 2011a). A study by Lee and Lazarus (2011) concludes that the most common sustainable development benefits claimed in project documents are renewable energy production, stakeholder identification, waste reduction, employment generation and indirect income generation through local sourcing of feedstock. However, it should be noted that differences in the dominant sustainable development impacts of projects as suggested by various studies could also be influenced by differences in the selection and definition of specific criteria and indicators for measurement, which tend to vary with the type of project assessed and depending on whether the assessment of impacts applies to the project/local, regional or national level.

In terms of project type, industrial gas projects have been found to have minimal co-benefits when compared with renewable and forestry projects (Watson & Fankhauser, 2009). According to Subbarao and Lloyd (2011), renewable energy projects can be particularly beneficial to developing countries. In rural areas and remote locations, the generation of renewable energy using local resources can address the issue of energy access. Under such conditions, renewable energy solutions for village power applications can be economical, practical and functional. The study further concludes that enhanced energy access and other related services can benefit the delivery of health and educational services in the rural communities by providing modern energy services such as lighting and refrigeration, information technology and communication. Renewable energy projects can, in addition, lead to the economic development of micro-enterprises, local economic growth and poverty alleviation. All this helps the local communities to reduce their reliance on government services, which in turn builds up the local capacity to manage community-based rural energy initiatives. Awareness in the community about 'environmentally benign development' is also enhanced in the process.

In terms of project scale, Olsen and Fenhann (2008) challenge the general perception that small-scale projects make a greater contribution to sustainable development than large-scale industry projects, as well as the view that HFC, N_2O, energy efficiency in industry, biomass and biogas projects have minimal sustainable development benefits. Subbarao and Lloyd (2011) find that small-scale CDM projects have often failed to deliver significant or substantial long-term sustainable development benefits to the community or region.

According to Watson and Fankhauser (2009), a comparison of projects from different countries shows that Indian projects have a far greater focus on infrastructural development than either Chinese or Brazilian projects, but with the involvement of less technology transfer. On the other hand, Chinese projects largely promote the protection of the local environment and natural resources, but it is not clear whether this can be attributed to China's preference for energy efficiency and renewable energy projects to achieve self-sufficiency and surplus generation of energy resources. Further, in relative terms, the levying of high taxes on CER revenues (2% for afforestation/reforestation (A/R) and electricity generation, 30% for N_2O and 65% for other industrial gas projects) has had no significant influence on sustainable development benefits delivered by project activities in other countries.

Numerous research studies have undertaken a comparative assessment of the performance of labelled projects (GS and CDCF) vis-à-vis non-labelled ones. Based on the findings of a comparative assessment of small-scale renewable energy and energy efficiency projects, Nussbaumer (2009) concludes that labelled projects do not significantly surpass the non-labelled ones in terms of sustainable development benefits. The author further states that the impact of labelled projects on social sustainable development tends to exceed that of comparable non-labelled projects, but the opposite holds true for the economic criteria of sustainable development.

A number of studies have focused on the potential trade-off between the two objectives of the CDM, namely emission reduction and the promotion of sustainable development (Sutter, 2003; Alexeew et al., 2010). According to Subbarao and Lloyd (2011), the CDM in its current state and design is facing several challenges that are hindering the mechanism in delivering and adhering to its dual objectives.

3.3.3 Recommendations from key studies for enhancing sustainable development impacts

Boyd et al. (2009) argue that the current make-up of the CDM is not allowing the mechanism to attain its full potential in terms of the promotion of sustainable development. The paper recommends favouring CERs from projects with high sustainable development ratings, rather than interfering with the market forces to incorporate the value of sustainable development into CER prices. Sutter and Parreño (2007) suggest, however, that market forces should recognize CDM projects not only for emission reductions but also for sustainable development benefits and, consequently, the latter should be reflected in the CER prices as well.

Sutter (2003) also recommends the creation of a market for premium CERs (with a high sustainable development quota) at a higher price. Buyers of premium CERs not only evade reputational risks associated with CERs generated by unsustainable projects but also have the opportunity to use these CERs for image-building and public relations activities. The Annex I countries could promote high-quality projects by enhancing eligibility requirements with respect to the sustainable development benefits of projects to be considered under domestic trading schemes. In order to address the trade-off between the two objectives, Alexeew (2010) suggests the introduction of a sectoral crediting mechanism and a CER discounting scheme.

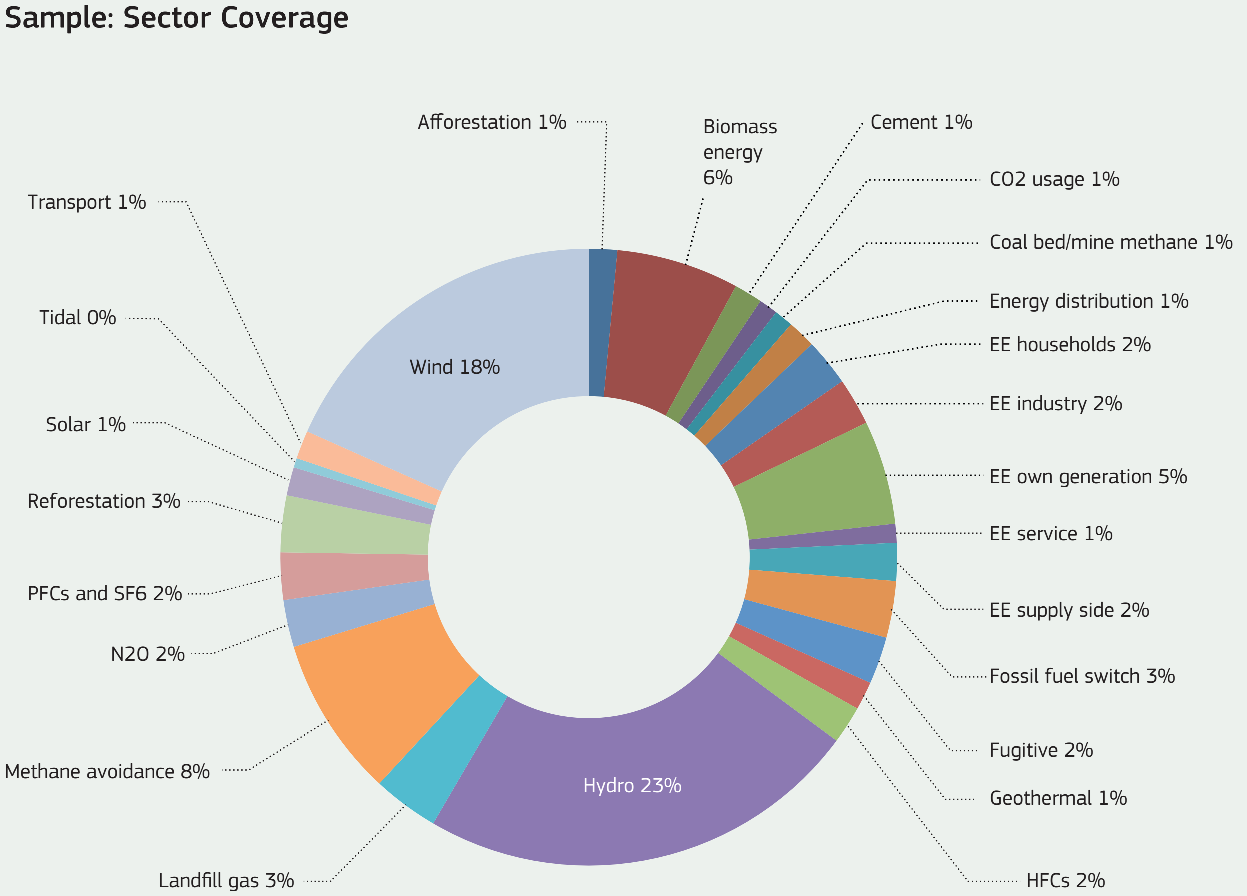
Alexeew et al. (2010) highlight the need for: clear rules for DOEs on how they should validate CDM projects, including sanctions in the case of poor performance; more objective criteria to assess additionality, such as ambitious emission benchmarks and quantitative thresholds for common practice; a strict exclusion of projects on which the CDM has little impact (i.e. small change in the internal rate of return (IRR)); and the creation of a verification protocol.

Currently, for most projects, the assessment of expected sustainable development benefits is done before the actual implementation of the activity, unlike emission reductions which are regularly monitored by the DOEs. Therefore, "efficient and robust guidelines" for the assessment of the sustainable development impacts of CDM projects are critical (Subbarao & Lloyd, 2011). In addition, Olsen and Fenhann (2008) argue for the need for an international standard for sustainability assessment, additional to national definitions.

In the context of the monitoring and verification of sustainable development benefits pledged in the PDDs, Subbarao and Lloyd (2011) feel that "on-the-ground examination" of the actual state of affairs with regard to benefits generated by CDM projects is indispensable. Defining criteria and indicators helps in the documentation of CDM projects but cannot ensure the delivery of those benefits to the local stakeholders.

Sterk et al. (2009) are of the view that discarding other project types except renewable energy and end-use energy efficiency in the CDM GS is "an arbitrary definition of sustainable development". Project types like transport or waste management have immense sustainable development

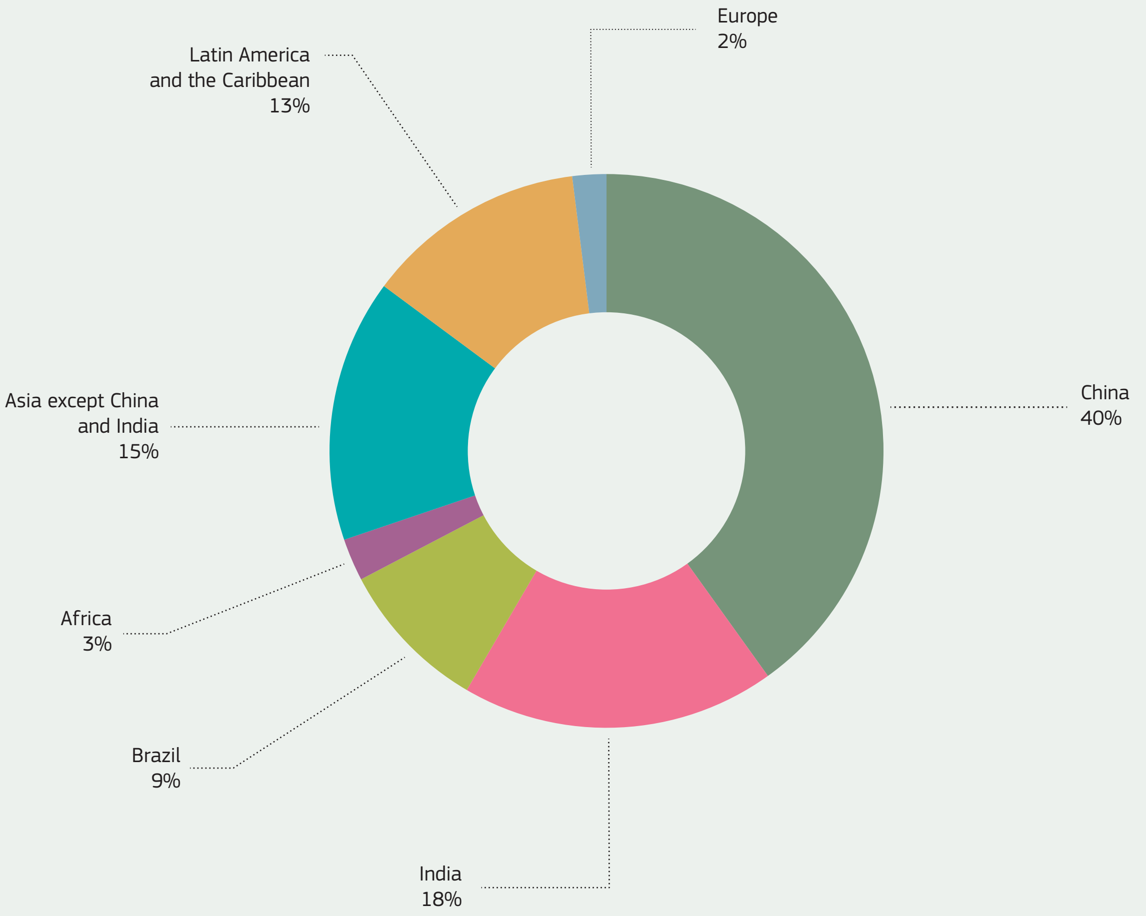
Figure 4. Composition of the study sample in terms of project types



Source: Authors' analysis.

benefits. According to the authors, the definition of sustainable development criteria at the host-country level does encourage project proponents to consider sustainable development elements while conceptualizing CDM projects. However, there is no ex-post verification of the benefits pledged in the PDD. Furthermore, most DNAs' sustainable development criteria lack transparency and clarity, which makes it easy for project developers to comply with the requirements. The process of stakeholder consultation is often "only rudimentary, completely unregulated and badly documented" (Sterk et al., 2009). The study recommends the introduction of an additional set of guidelines and procedures to ensure that sustainable development benefits result from CDM projects. The new guidelines could include criteria and indicators for assessing impacts, procedures for stakeholder engagement, the monitoring of sustainable development claims and the independent assessment of the process. The implementation of the new approaches could be pursued with different levels of ambition: an 'ambitious approach' (mandatory adoption), a 'do-no-harm approach' (mandatory evaluation of negative impacts) and a 'voluntary approach' (voluntary approach in line with the current negotiating text on promoting co-benefits).

Figure 5. Composition of the study sample in terms of regions



Source: Authors' analysis.

3.4 Analysis of sustainable development impacts reported in registered PDDs

This section describes the original PDD analysis conducted for this study, in which the sustainable development claims of a sample of registered PDDs were analysed.

3.4.1 Methodology for PDD analysis and sample selection

A random stratified sample of 202 projects was considered for this study, out of 2,963 projects registered as of May 1, 2012. 175 strata were identified representative of each region (i.e. the UN regions + India + China + Brazil) and particular project type (i.e. from 25 United Nations Environment Programme (UNEP) Risø Centre sectors). At least one project was selected from each stratum. Where the number of projects was more than one, a random selection was done. For every 25 projects, an additional project was chosen, such that a representative sample was obtained. A statistical analysis was conducted, which concluded that for a 95% confidence level the sample size should include at least 159 projects. Therefore, a sample of 202 was statistically significant. Figure 4 and figure 5 show the composition of the sample.

Each project in the sample was coded for sustainable development and technology transfer indicators, on the basis of which further analysis was conducted. The analysis of technology transfer impacts is presented in chapter 6.

3.4.2 Definition of sustainable development used in analysis

Based on the literature review discussed earlier, sustainable development criteria used for this study comprised social, economic and environmental co-benefits, which were further categorized into subcriteria and indicators. These are 'yes/no' criteria rather than quantitative indicators. A "yes" denotes the presence of the co-benefit and a "no" denotes the absence of the co-benefit (and no negative impacts). Table 4 presents a summary of the criteria and subcriteria adopted by the study to evaluate the sustainable development impacts of CDM projects.

The identification of criteria and indicators for the evaluation was an iterative process, alternating between reading, the conduct of textual analysis of the PDDs and developing and revising the taxonomy. Efforts were made to avoid overlaps between the criteria owing to the double counting of the same benefits (e.g. counting indoor smoke reduction both as a health benefit and an air-quality benefit).

3.4.3 Limitations of the study

There are several important limitations to this analysis:

- The source material for the analysis is the PDDs and therefore only positive contributions to sustainable development can be measured, since project developers are unlikely to write anything negative about their project.
- Furthermore, the descriptions of sustainable development contributions in the PDDs are only potential benefits and not the sustainable development benefits actually delivered.
- The absence of negative impacts of the project activity, such as no impact on water, air quality or land, is not counted as a benefit unless it describes an improvement to the status quo/baseline.
- General statements about the sustainability of a project activity such as "economic growth, social benefits and environmental improvement will be achieved" are only counted as benefits if they are documented with concrete examples.
- All sustainable development benefits claimed are considered to be caused by the project, even though it is possible that some of those benefits could have been realized without the CDM project activity.
- Some subjective judgement as to how to attribute the sustainable development criteria during the textual analysis of the PDDs cannot be ruled out. To address this issue to some extent, testing by a second analyst coding the same PDDs to check for inconsistent analytical results was undertaken on a portion of the sample.

3.4.4 Results of the PDD analysis

While all projects lead to benefits such as income generation through CERs[27] and GHG emission reductions,[28] 201 of 202 total PDDs in the stratified random sample mentioned other sustainable development benefits. 96% of the PDDs mentioned economic benefits through employment generation, contribution to national energy security, income generation, infrastructure creation, and transfer and promotion of cleaner, cost-effective technologies. 86% of PDDs mentioned social benefits such as improved access to clean energy, sustainable mobility, better shelter, food security, access to drinking water, improved sanitation, targeted support to local women and the strengthening of local capacity or institutions. 74% of PDDs mentioned environmental benefits such as improved local air quality, improved water quality, conservation of water, conservation of local natural resources, sustainable land-use, conservation of fossil fuel resources and better management of waste. Most of the PDDs mentioned more than one sustainable development benefit.

Amongst the indicators, PDDs mentioned benefits in the context of improved local quality of life (82%), employment generation (80%) and contribution to national energy security (76%) – all social and economic indicators. Amongst the indicators under the environmental dimension, PDDs mentioned benefits in terms of improved air quality (66%), followed by conservation of local natural resources (52%). Figure 6 shows the percentages of PDDs that mention various indicators of sustainable development, while Figure 7 shows the indicators by project technology type. Technology transfer was also considered as an important sustainable development indicator. 37% of the sample of PDDs mentioned technology transfer in varied ways. Further analysis of this indicator suggested that 43% of the PDDs mentioned "no tech transfer" and it was unclear from 18% of the PDDs whether there was technology transfer.

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[27] The contribution of CER generation to sustainable development is implicit in all cases, since a 2% levy contributes to the Adaptation Fund. A few DNAs, such as those of China and India, make an explicit mention of utilizing a certain percentage of CER revenues from all or from large-scale projects to contribute to the national or local sustainable development cause.

[28] GHG emission reduction is a global sustainable development benefit of all mitigation activities.

Table 4. Criteria to assess the sustainable development impacts of CDM projects

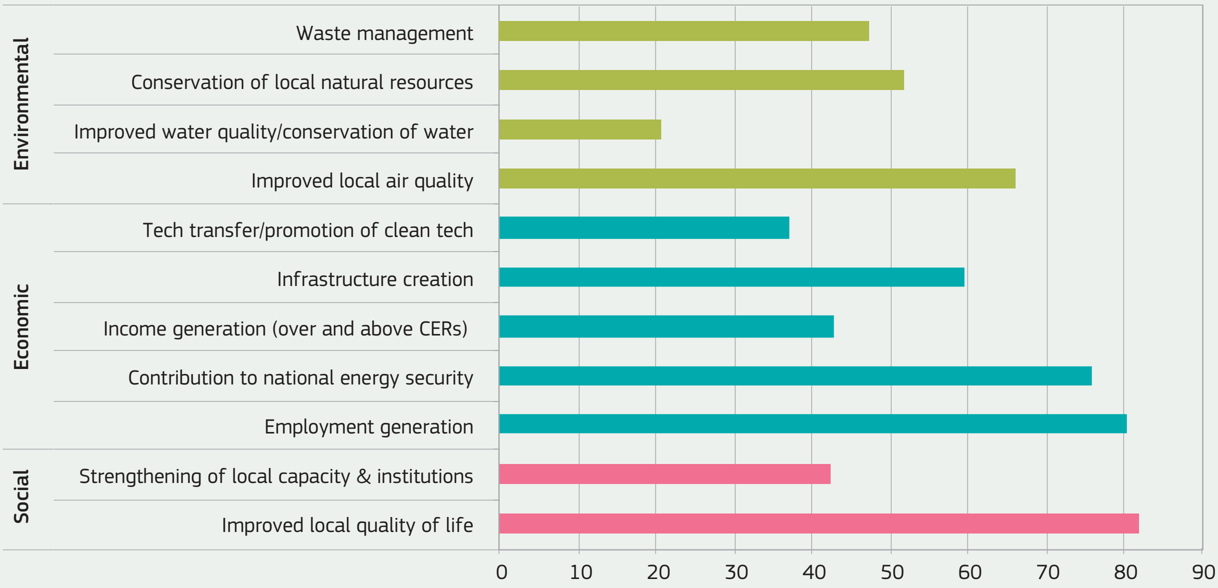
Criteria	Keywords used when searching PDD text
Social	
Improved local quality of life - access to clean energy - sustainable mobility - better shelter - food security - access to drinking water - improved sanitation - targeted support to women folk of the region	Off-grid renewable electricity, biogas, micro-hydro , public transport, housing, clean drinking water, sanitation, women, gender, potable water, etc.
Strengthening of local capacity and institutions	Training centre, local capacity, local bodies, women's group, skilled labour, technical education, schools, roads, primary health centre
Economic	
Employment generation	Jobs, employment, man months, man days,
Contribution to national energy security	Energy conservation, energy efficiency improvement, renewable energy generation, grid supply, replacing energy sourced from grid
CER (income) generation	
Infrastructure creation	Road, lighting, power transmission lines, gas pipes/lines, communication networks, water treatment plants
Transfer/introduction/promotion of cleaner and cost-effective technologies	Transfer of equipment, technology, know-how, soft skills
Environmental	
Improved local air quality	CO_2, CO, SO_x, NO_x, suspended particulates
Improved water quality, conservation of water	Clean water, water conservation, drinking water, potable water
Conservation of local natural resources - sustainable land-use - conservation of fossil fuel resources	Soil erosion, soil fertility, forest, sustainable biomass use, mines, minerals, biodiversity, conservation of fossil fuel resources
Waste management	Minimization of waste generation, recycling of waste, energy from waste

The sample included 79 small-scale projects and 123 large-scale projects across regions and project types. There were more sustainable development benefits stated for small-scale projects than for large-scale projects. For around 5% of the large-scale projects no other sustainable development benefit other than transfer of technology was mentioned. Most of these large-scale projects were N_2O abatement (50%) or HFC projects (33%). Interestingly, two of the PDDs mentioned a "no harm" indicator and that "no jobs will be lost" by the project activity.

For all the different regions, except China, the claims of benefits are more or less equally balanced across the social, economic and environmental dimensions (see figure 8). In contrast, for Chinese projects economic benefits are the most frequently claimed, followed by social and environmental benefits. Out of 81 Chinese PDDs analysed in the selected sample, 67 indicate social benefits, 80 indicate economic benefits and 49 claim environmental benefits. Whereas, out of the total 37 Indian PDDs in the sample, 36, 36 and 31 assure social, economic and environmental benefits, respectively. Similar trends were observed for the PDDs from Brazil.

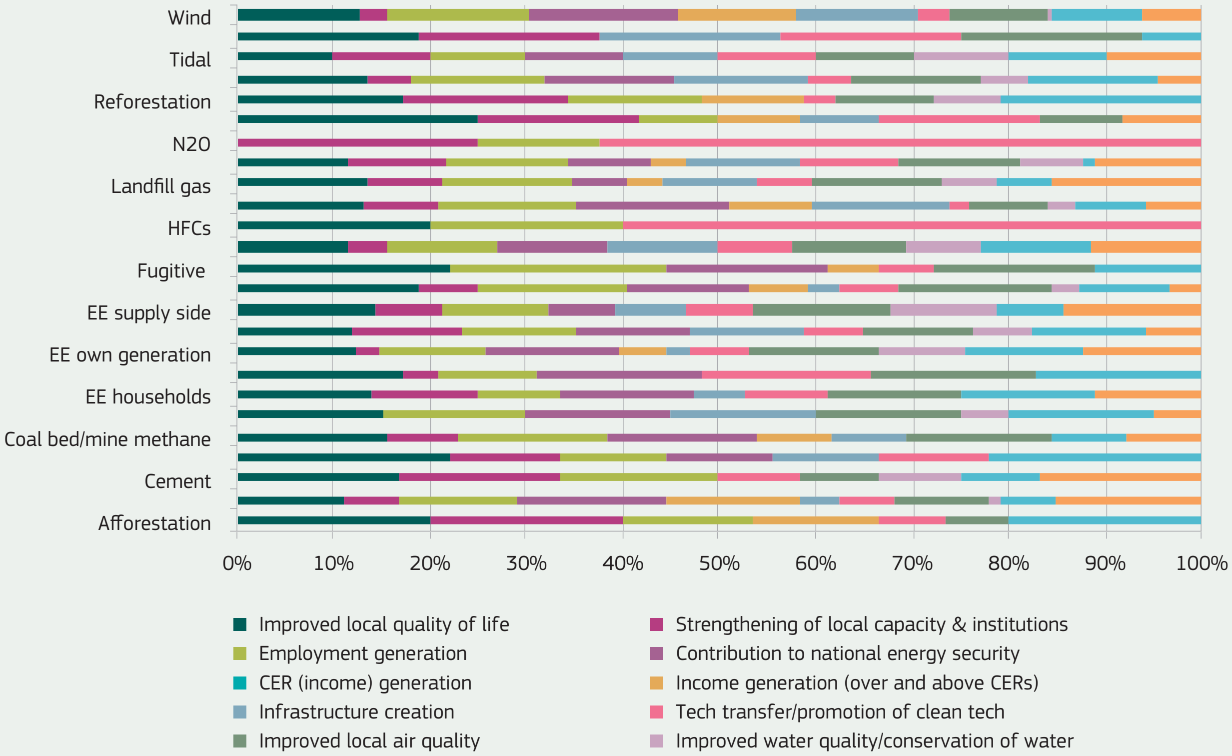
An analysis of trends of various indicators of sustainable development benefits across regions (figure 8) suggests that, amongst the key countries, there is the most frequent mention of improved local quality of life (includes sub-indicators such as access to clean energy, sustainable mobility, better shelter, food security, access to drinking water,

Figure 6. Percentages of PDDs mentioning various sustainable development indicators



Source: Authors' analysis.

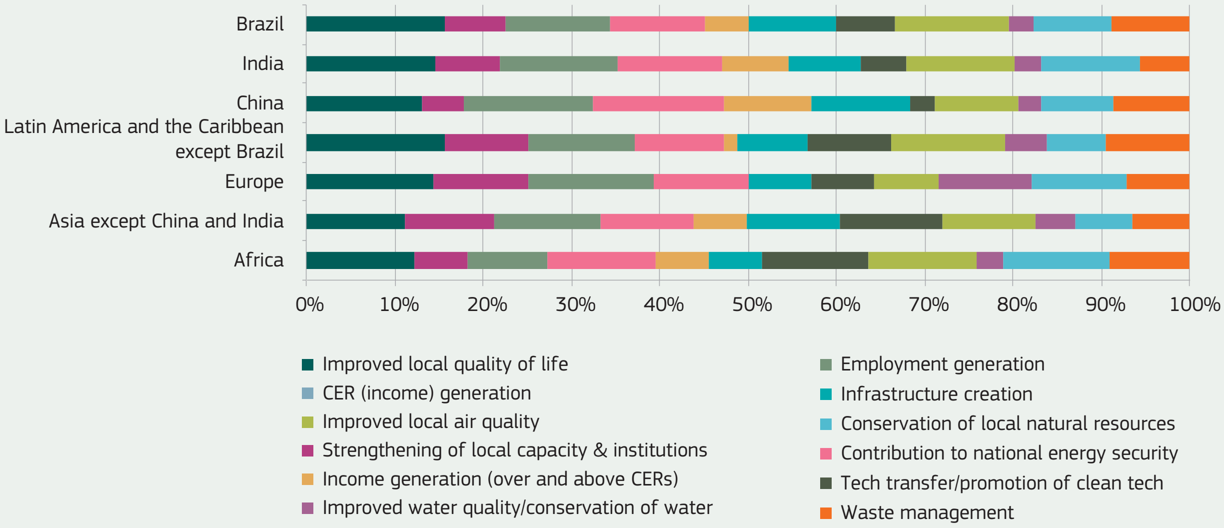
Figure 7. Sustainable development benefits cited by project type



Source: Authors' analysis.

improved sanitation and targeted support to the women folk of the region) in the PDDs from India and Brazil. PDDs from China mention contribution to national energy security the most. The rest of Asia (except for China and India) indicates employment generation as the key benefit. The rest of Latin America (except Brazil) indicates improved local quality of life as the key benefit. PDDs from Africa cite a variety of indicators, such as improved local quality of life, contribution to national energy security, technology transfer, improved local air quality and conservation of local natural resources.

Figure 8. Sustainable development benefits cited by region[1]



Source: Authors' analysis.

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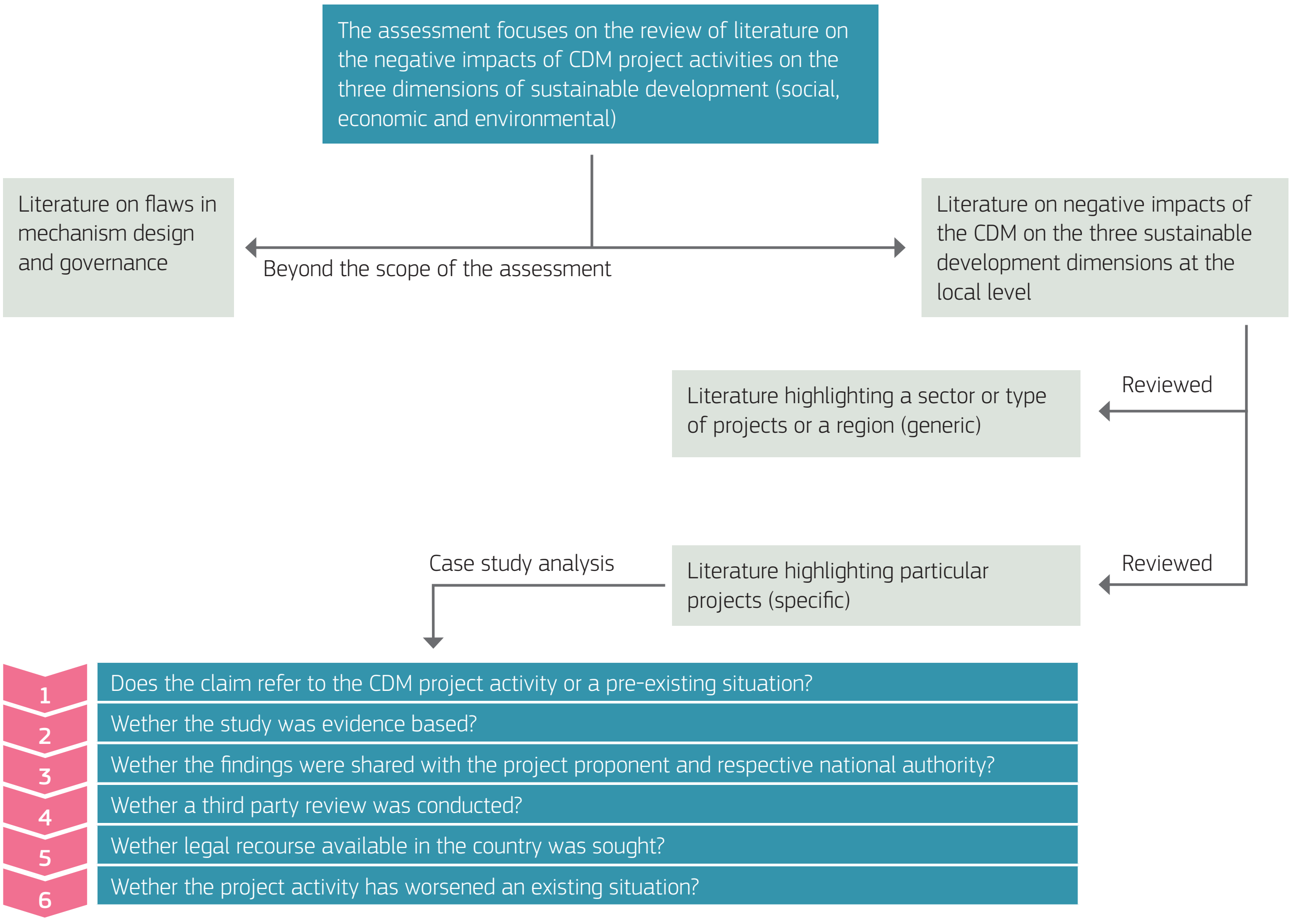
[1] Europe refers to Eastern Europe.

3.5 Assessing claims of negative impacts of CDM projects

This section focuses on assessing the claims of negative impacts on sustainable development. The approach included a literature review and case study analysis, based on an e-mail survey and follow-up interviews. The relevant literature was identified through a keyword search. The objective was to identify literature focusing on the negative impacts of CDM projects on sustainable development. Reviewing the claims, and the nature of such claims, in turn led to the identification of specific registered CDM projects where concerns had been raised. Each identified project was studied in greater detail on the basis of both its PDD and associated stakeholder comments (local and global). The authors of the negative claims were contacted, as were the project owners. The responses received were then screened and further reviewed as part of the assessment. In order to ensure the objectivity of the assessment, a uniform yardstick was used, which is illustrated in figure 9.

Figure 9. Approach to the assessment of claims of negative impacts of CDM projects



3.5.1 Findings regarding claims of negative impacts

While there is a significant amount of literature on the benefits of the CDM, which focuses on empirically evaluating the impact of the CDM on sustainable development and technology transfer, there is limited empirical work on the negative impacts of CDM projects. Such studies have primarily focused on the overall mechanism, identifying flaws in the design of the mechanism. Studies that examine the governance and design of the mechanism are addressed in the governance of the CDM report (Classens, 2012) commissioned by the CDM Policy Dialogue. The scope of this work is on the literature that examines the local negative impacts of specific projects.

The literature available on this issue is predominantly ‘grey literature’ (i.e. not peer-reviewed scientific literature). Amongst the grey literature, some papers highlight issues across an entire sector or category of projects. Examples include, for large hydropower projects, negative environmental impacts on aquatic life, negative social impacts through displacement of communities from the vicinity, and environmental impacts from leakage from the reservoir (Haya & Parekh, 2011). Similarly, for landfill projects, concerns are raised about the loss of livelihood for garbage pickers and the lack of consideration of alternatives to the project (GAIA, 2011). Furthermore, there is literature that has a strong regional focus (e.g. African Biodiversity Network et al., 2011, focusing on the projects that exist in Africa). The authors of that paper argue that the CDM presents serious challenges and negative impacts. They also criticize proposals to further broaden the range of projects that are eligible for the CDM, such as genetically modified crops and the addition of biochar to soils. A study by the University of KwaZulu Natal Centre for Civil Society (2012) discusses six case studies from African countries, including South Africa’s Bisasar Road landfill methane to electricity project and the Niger Delta gas flaring projects, amongst others, in the context of negative impacts. Some reports focus on specific problems, such as human rights abuse in Honduras. There are also policy papers (e.g. Zagema, 2011) highlighting the CDM as an international mechanism providing perverse

Table 5. Case studies of potential negative impacts of CDM projects

Case	Country	Issues under examination
Mtoni Landfill Gas Project	Tanzania	Livelihood of waste-pickers, environmental impacts (leachate), alternative project activities
The Pan Ocean Gas Utilisation Project	Nigeria	Promoting an activity which is illegal according to the domestic law of the host country
Bisasar Road landfill	South Africa	Environmental issues due to the landfill
Aguan biogas recovery from Palm Oil Mill Effluent (POME) ponds and biogas utilization	Honduras	Human rights issues
Barro Blanco Hydroelectric Power Plant Project	Panama	Human rights issues
Okhla-Timarpur project	India	Livelihood of waste-pickers
Improving Rural Livelihoods through Carbon Sequestration	India	Stakeholder process, livelihoods and natural resource management
Xiaoxi CDM Hydropower Projects (135 MW) from China	China	Displacement and inadequate compensation, environmental impacts

Source: Authors' analysis.

incentives to exacerbate already existing social, environmental and economic problems.

Eight cases were selected from the literature review for further analysis. Availability of information was critical in the choice of the cases. The cases, however, had a reasonable sectoral and regional coverage. In terms of the issues being examined, these projects have been discussed in literature in relation to various issues, including human rights violation, environmental impacts, loss of livelihoods and displacement of communities. The identified cases are shown in table 5.

Out of the above cases, for the Okhla-Timarpur project in India the reply to enquiries was insufficient to make an evaluation. Key findings from the other seven cases indicate that, in four of the seven cases, the issue raised regarding the CDM project related to a problem that existed before the CDM project was developed. For example, in the case of the Bisasar Road landfill in South Africa and Aguan biogas recovery from POME ponds and biogas utilization in Honduras, the problems cited by stakeholders existed prior to the CDM project activity. This means that the CDM projects themselves were not the causes of the problems, nor was there evidence presented that the CDM projects worsened these pre-existing situations.

In most of the cases, reports or responses do not provide evidence to support the claims of negative impacts of the CDM project activity. Only two cases indicated field visits and filed testimonies as the evidence for their claims (Xiaoxi CDM Hydropower Projects in China and Improving Rural Livelihoods through Carbon Sequestration in India). It is not clear (as most of the claimants did not respond to this question) whether the claims were presented to the project proponents. In one case (Xiaoxi CDM Hydropower Projects in China) the claims were presented to the funding partner, who in turn asked for a third-party verification of the claim. In another case, that of the Mtoni Landfill Gas Project in Tanzania, the project proponent responded to a newsletter article on negative impacts of the project.

In the case of Aguan biogas recovery from POME ponds and biogas utilization, a third-party review was conducted by the Inter-American Human Rights Commission on the human rights issue and the situation in Honduras. This review did not focus on the CDM project activity or implicate it as a cause of the problems. In the case of the Xiaoxi CDM Hydropower Projects, the funding partner sent a monitoring mission to the project site to verify the claims.

None of the respondents indicated that national legal recourse was availed for the problem. Only one respondent suggested that the report on the Improving Rural Livelihoods through Carbon Sequestration project in India was shared with the national authority on the CDM in the host country, but that there was no response from the DNA.

3.6 Options for enhancing the sustainable development contribution of the CDM

For most stakeholders sustainable development is one of the most important impacts of the CDM and there is a desire to enhance this impact. In addition, almost all stakeholders would agree that any interventions should not infringe upon the host country's right to determine whether a given CDM project meets its sustainable development priorities. There is broad commonality across countries as to how they define sustainable development criteria at a high level, even if the detail of this application varies widely.

Depending on individual stakeholder priorities, there are three possible objectives of interventions related to sustainable development impacts: (a) increasing the overall sustainable development benefits originating from the CDM project pipeline; (b) measuring and reporting those benefits to the DNAs and other stakeholders; and (c) systematically preventing negative impacts. However, there may be differences amongst stakeholder groups in prioritizing interventions. For example, stakeholders that feel that CDM projects are generally delivering many positive benefits may want to focus on preventing negative impacts rather than increasing the monitoring of benefits. On the other hand, stakeholders that feel that negative impacts are best addressed at a national level may instead focus more on the measurement of impacts and enhancing benefits. The caveat to these choices is that it will be difficult to measure progress towards either greater positive impacts or fewer negative impacts without some form of monitoring and reporting system.

The review of the literature, stakeholder inputs to the CDM Policy Dialogue process, interviews with experts in the field and the analysis conducted by the research team have highlighted a number of options for enhancing the sustainable development impact of the CDM. These are summarized below and explained in more detail in table 6.

Providing a 'menu' of sustainable development indicators could enhance the documentation of the sustainable development benefits of the CDM. This menu could be compiled from current criteria or other international sources. Given that most DNAs already have criteria, they could also make these more accessible by reporting their own sustainable development criteria on the UNFCCC website, just as the national definitions of forest are currently reported.

Revising the PDD format to provide more guidelines on how project participants should declare their sustainable development contributions could assist DNAs in their decision-making process, whether or not the guidelines were linked to a list of specific indicators.

Improved voluntary reporting of sustainable development benefits could go a step further, providing for both initial and ongoing declarations. These declarations could rely on either DNA-specific guidelines or draw on international reporting options. Any monitoring would have to be designed in such a way as to minimize the transaction costs.

Mandatory monitoring of sustainable development benefits would provide a much more robust information base for the DNAs and other stakeholders than simple declarations in the PDD. There are many variations to monitoring, but none of these should infringe on the host country's sovereign right to determine whether a project meets its own sustainable development criteria. The DNA and project participants could choose which indicators were appropriate for the specific project, in the light of the host country's priorities. The monitoring could be supervised by the DNA, according to national criteria and procedures, or could be part of the UNFCCC project cycle. Verification could be conducted at validation and/or during verification (i.e. after project implementation). While this would add transaction costs, without some verification it is unclear how reliable any reporting would be.

Safeguards against negative impacts, such as human rights violations, corruption and labour exploitation, could also be strengthened in several ways. As a first step, the DNA could ensure that claims of negative impacts were taken up within the legal structure and processes of the host country. In addition, the PDD could be expanded to include a checklist of key safeguard issues. As with the reporting of benefits, the reporting of safeguards could happen at the start of the project only or they could be reported periodically after implementation. The verification of compliance with safeguards could be undertaken by the DNA along with the verification of sustainable development benefits.

The consequences of inadequate performance could range from project developers being provided with information to assist them with compliance through to suspending the further issuance of CERs for a project. This could be based on the project not following through on sustainable development benefits and/or the project violating one of the safeguards. The DNA could decide on this, however, according to national criteria and procedures.

Preferences for specific project types or technologies could be established to differentiate eligibility and procedures across project types, scales or regions. This would require broad political agreements as well as a sound empirical evidence base upon which to prioritize.

Capacity-building for DNAs could strengthen the ability of DNAs, particularly those with the least resources, to apply their national criteria for sustainable development in the project approval process. This could include the sharing of experiences at a regional and subregional level and providing information on 'best practice' in project evaluation.

Although not discussed in detail in this report, an **enhanced stakeholder consultation and appeals process** could also strengthen positive sustainable development impacts. The options for this are discussed in the report on the governance of the CDM. DNAs could work towards strengthening the process of local stakeholder consultation. The relevant local authorities could be made more aware about sustainability issues and their role in the effective implementation of sustainable development benefits. Negative sustainable development impacts could be one of the possible grounds for a grievance. The governance reforms proposed under an enhanced stakeholder consultation and appeals process are also relevant to sustainable development impacts, particularly negative ones.

Table 6. Summary of options for enhancing sustainable development impacts

Broad concept	Option	Advantages	Disadvantages
Sustainable development criteria and/or indicators	Providing 'menu' of indicators drawn from DNA lists	Increased consistency and transparency of reporting on sustainable development	Political sensitivity around any definitions at the international level
	Providing 'menu' of indicators drawn from other international sources	Increased consistency and transparency of reporting on sustainable development Aligns the CDM with other relevant international conventions and standards related to sustainable development	Criteria may not fit specific DNA priorities and judgements with regard to sustainable development Sovereign concerns could reduce political willingness to implement changes Political sensitivity around any definitions at the international level
	Providing criteria and indicators specific to project types	Increased consistency and transparency of reporting on sustainable development Simpler, by focusing only on issues relevant to a technology Could focus attention on project types with a high level of sustainable development impacts	Multiple standards could add complexity to the overall CDM rule system Political sensitivity around any definitions at the international level
Revision of PDD format to enhance reporting	Providing guidelines for what impacts should be reported and how (e.g. qualitative versus quantitative)	Increased consistency and transparency of reporting on sustainable development Provides better quality information to DNAs without multiple forms	Requires time and effort of project participants and consultants to learn new format Potential increase in upfront transaction costs

Broad concept	Option	Advantages	Disadvantages
Declaration, monitoring and verification of sustainable development impacts	Voluntary declaration only	No change from current situation	No enhancement of positive impacts or reduction in negative impacts
	Voluntary declaration and monitoring	Could rely on DNA guidance rather than on a global standard, which could reduce the costs of monitoring Enhanced DNA ownership and engagement	Does not provide consistency and transparency of reporting on sustainable development, since only projects with the highest level of positive benefits will report and monitor them Some increase in transaction costs
	Mandatory declaration and monitoring	Increased consistency and transparency of reporting on sustainable development, including capturing the overall benefits of the CDM Provides unbiased basis for tracking effects of interventions to enhance sustainable development benefits	Could add complexity to the validation and verification process Increase in transaction costs for validation and verification Added burden on DOE capacity Political sensitivity around any definitions at the international level
Safeguards against negative impacts	'Do no harm' safeguards at the national level	No change from current situation	Not transparent and may not address some current concerns
	'Do no harm' safeguards at the international level	May reduce potential incidence of negative impacts Increased consistency of reporting of negative impacts	Difficult to attribute specific negative impacts to the CDM project activity, particularly if issues pre-date the CDM project
Project eligibility	Negative list based on sustainable development impacts, excluding projects with high chance of negative impacts	Could directly reduce negative impacts without any transaction costs or monitoring procedures	Choice of sectors to exclude would be highly politically sensitive and could also be subjective Ignores large differences in impacts across countries, even for the same project type
Consequence of non-performance in relation to sustainable development	Suspension of CER issuance upon DNA request	Could directly address negative impacts and ensure projects comply with safeguards and other reporting Gives DNAs the authority to enforce the sustainable development commitments made by project participants	Uncertainty for CER buyers could have a negative impact on CER prices and project flow Adds complexity as well as uncertainty to the CDM process Mistakes could lead to the penalization of projects that are actually performing
Capacity-building of DNAs	Capacity-building of DNAs by EB or Nairobi Framework agencies – sharing best practices on sustainable development	Enables countries with limited capacity to establish an effective sustainable development evaluation process Could increase project flow for some underrepresented countries and project types	Previous experience shows that DNA capacity is necessary but not sufficient in itself for CDM project development

Source: Authors' analysis.

4 Impact on net GHG emission reductions

The CDM has allowed industrialized countries to buy credits from developing countries for the purpose of meeting targets under the Kyoto Protocol. In principle, the CDM is designed to allow for flexibility in the location of emission reductions and thus decrease the overall cost of meeting emission targets, while providing sustainable development benefits in host countries. In principle, the overall level of global emissions (and emission reductions) should be unaffected by the use of the CDM. While CDM projects lead to emission reductions in host countries, the use of issued CERs from these projects allows buying countries to increase their own emissions (above target levels) by a corresponding amount. In theory, the CDM should function as a zero-sum instrument, with no net mitigation impact.[29]

In an explicit departure from the simple zero-sum calculus of the CDM, the Cancun Agreements reached at the sixteenth session of the Conference of the Parties (COP) in 2010 called for “one or more market-based mechanisms” capable of “ensuring a net decrease and/or avoidance of global greenhouse gas emissions”,[30] an intention that was reiterated at COP 17 in Durban in 2011.[31] This, in turn, has raised questions regarding the CDM and its future direction: what is the expected net emissions impact of the current CDM (i.e. with its current methodologies, procedures and project pipeline)? In other words, are the actual emission reductions that occur as a result of CDM projects more or less than the number of CERs issued and used to meet emission reduction obligations? And, secondly, what are the options for improving the net emissions impact of the CDM, were this to be an explicit aim of the CDM in the future?

This chapter addresses these questions in order. The first section of this chapter starts with a review of the CERs issued to date, expected in the future and already used by buyers in industrialized countries. It then explores research on the extent to which CERs represent additional GHG emission reductions and whether, in aggregate, issued CERs are matched by a corresponding level of actual GHG emission reductions. The second section considers options for improving the net emissions impact of the CDM.

4.1 Framework for analysis

To be registered under the CDM, projects are required to be *additional*: that is, they would not have occurred except for the incentive provided by the CDM (Gillenwater & Seres, 2011).[32] Projects are then issued credits relative to a *baseline* level of emissions, or the emissions that would have been expected had the CDM project activity not been implemented.

The CDM has instituted procedures to test for additionality and to develop a baseline scenario for GHG emissions. If it functions as intended, then the CDM has no net impact on global emissions, it merely shifts the location of emission reductions and, in principle, lowers the overall costs of mitigation. However, to the extent that CDM projects are not additional, or are awarded more credits than the actual emission reductions achieved (that is, they are ‘overcredited’), the CDM could lead to a net *increase* in global GHG emissions. By contrast, to the extent that CDM projects lead to more emission reductions than the number of credits issued (that is, they are ‘undercredited’), then the CDM could lead to a net *decrease* in global GHG emissions, a net benefit to the atmosphere.

This section summarizes and assesses the evidence regarding these and other potential outcomes of the CDM, including their prospective impact on the CDM’s net global emissions impact. Table 7 summarizes the potential outcomes of the CDM and where they are addressed in this section. All of the research presented is intended to help address the first key research question: *what is the expected net emissions impact of the CDM in its current form?*

The methodology for this assessment is largely a review of the literature, supplemented by an analysis of data compiled by the UNFCCC and the Institute for Global Environmental Strategies (IGES) on issued CERs, forecast CERs and the share of projects using investment analysis and barrier analysis in the course of demonstrating additionality.

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[29] The CDM’s influence on the ambition of past and future targets could also create a net mitigation impact, but this is not directly addressed in this chapter.

[30] See document FCCC/CP/2010/7/Add.1.

[31] The report of the COP “emphasizes that various approaches, including opportunities for using markets, to enhance the cost-effectiveness of, and to promote, mitigation actions […] must meet standards that […] achieve a net decrease and/or avoidance of greenhouse gas emissions“ (decision 2/CP.17, paragraph 79).

[32] See the report on the governance of the CDM (Classens, 2012) for a further discussion of definitions of additionality.

Table 7. Potential outcomes of the CDM and their implication for its net emissions impact

Outcome	**Conditions that could lead to outcome**	**Net emissions impact resulting from use of CERs (direct)**	**Where addressed in this report**
CERs issued from registered CDM projects that are *additional*	▸ CDM additionality procedures are effective; CDM functions as intended	No direct impact on global emissions	Analysis of claims of non-additionality (section 4.3)
CERs issued from registered CDM projects that are *non-additional*	▸ CDM additionality procedures are ineffective	Increase in global emissions	
More CERs issued than emission reductions occurred (or than business-as-usual emissions)	▸ Overly high crediting baselines ▸ Leakage ▸ (Perverse incentive to increase emitting activity)	Increase in global emissions	Analysis of over- and undercrediting (section 4.4)
Fewer CERs issued than emission reductions occurred	▸ Overly conservative (low) crediting baselines ▸ Positive spillover effects ▸ Projects continue after crediting period ends	Decrease in global emissions	
Additional projects not validated, rejected or do not seek CDM registration	▸ Erroneous review and rejection ▸ Barriers to CDM registration ▸ Stringent additionality test or baselines	No direct impact on global emissions (because CERs are not issued)	Noted where relevant

Source: Authors' analysis.

4.2 CER flows: historical and projected

4.2.1 Project registration and CER issuance to date

As of June 1, 2012, over 4,000 CDM projects had been registered. Credits have been issued for approximately 1,500 of these projects, totalling 943 million CERs. Table 8 provides further detail. Projects that reduce or avoid emissions of the so-called industrial gases HFC-23 and N_2O have, so far, been the dominant sources of CERs. Renewable energy projects (especially wind and hydropower) represent the greatest number of projects registered and receiving credits, and these project types are expected to be the source of a growing share of the CERs in future years. Because of the large number of credits issued, industrial gas and renewable energy projects have faced the greatest scrutiny from researchers investigating additionality and over- or undercrediting.

4.2.2 Use of CERs to date

To date, the vast majority of CERs have been used by buyers in the EU. As of the end of 2011, 456 million CERs had been retired by entities included in the EU ETS and 265 million CERs had been retired by EU 27 governments. Use of CERs has been increasing over time (table 9). In 2011 the EU ETS retired 179 million CERs, or 10% of the scheme's emissions, up from 6% in 2010 and 4% in prior years (European Commission, 2012).

Most of the CERs retired by EU ETS buyers – over 80% – have been from industrial gas projects that reduce or avoid HFC and N_2O emissions (Point Carbon, 2012b). The extensive use of CERs from industrial gas projects has important implications for the impact of the CDM. As discussed in the following sections, the additionality of these projects is relatively assured – one can say with relative

Table 8. Project registration and CER issuance as of June 1, 2012

	Projects registered	Projects issuing credits	Credits issued (million CERs)
Industrial gases	**115**	**67**	**620**
HFC-23	21	19	414
N_2O – adipic acid	5	4	167
N_2O – nitric acid	66	39	37
Other	23	5	2
Methane recovery	**745**	**245**	**47**
Landfill gas	198	87	24
Coal mine/bed	58	25	12
Manure/wastewater	399	121	10
Other	90	12	1
Renewable energy	**2,380**	**889**	**159**
Hydropower	1,226	489	88
Wind power	1,057	380	67
Other renewable energies	97	20	4
Other power supply	**608**	**379**	**90**
Iron and steel waste gas	101	53	34
Fuel switch (natural gas)	70	41	32
Biomass	385	162	21
Higher efficiency fossil	6	-	-
Supply-side efficiency (other)	23	8	2
Other	23	5	1
Other	**328**	**110**	**26**
TOTAL	**4,176**	**1,580**	**943**

Source: Authors' analysis based on IGES data (IGES, 2012c).

Table 9. Use of CERs by EU ETS and government buyers, 2008–2011 (million CERs)

	2008	2009	2010	2011	Data source
Annual CERs retired	**82**	**134**	**226**	**319**	
EU ETS	82	78	117	179	European Commission (2012)
EU 27 governments	-	20	109	137	IGES (2012d)
Other governments		36	0	3	IGES (2012d)
Annual CERs cancelled	**1**	**1**	**1**	**0**	
Voluntary market	1	1	1	0	IGES (2012d)
Annual CERs used (retired plus cancelled)	**83**	**135**	**227**	**319**	
Cumulative CERs used	**83**	**218**	**445**	**764**	
Cumulative CER supply (CERs issued to date)	240	364	496	816	IGES (2012b)

Table 10. Forecast cumulative issuance of CERs from projects in the CDM pipeline (million CERs) (after accounting for validation and issuance risks)

	2011[1]	2012	2020
Bloomberg New Energy Finance (2012)[2]	816	1,162	4,349
CDC Climat (Bellassen et al., 2012)	816	1,270	6,070
IGES (2012b)	816	1,170	5,885
Point Carbon (2012a)	816	1,110	3,900
UNEP Risoe Centre (2012)[3]	816	1,094	8,173

Source: Authors' analysis.

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[1] Issuance up to 2011 according to IGES (IGES, 2012b).

[2] 2020 figure excludes 214 Mt HFC/adipic CERs issued after the first quarter of 2013 due to limited demand. Furthermore, Bloomberg New Energy Finance estimates that 231 Mt CERs will be issued from projects that enter the pipeline post 2012. It is not clear whether these CERs are included in the total cited here or not.

[3] Does not include 2,087 million CERs that the UNEP Risoe Centre forecasts will be issued from projects that enter the pipeline post 2012.

confidence that HFC and N_2O destruction facilities would not have been installed in the absence of the CDM. However, other concerns – notably, perverse incentives to increase HFC output and shifts in adipic acid production leakage to CDM project locations (and hence increased N_2O emissions at these facilities) – have impaired the net mitigation impact and, as a consequence, the reputation of these projects. In turn, the EU has excluded these project types from eligibility in the third phase of the EU ETS. The recent increase in the use of CERs from these project types may be partly explained by that pending exclusion (Point Carbon, 2012b).

4.2.3 Forecasts of future CER flows

Project developers have continued to submit projects to the CDM at a high rate, despite uncertain demand arising from the lack of clarity on the future of the Kyoto Protocol and future international climate agreements. Drivers of continued (if uncertain) project inflow include:

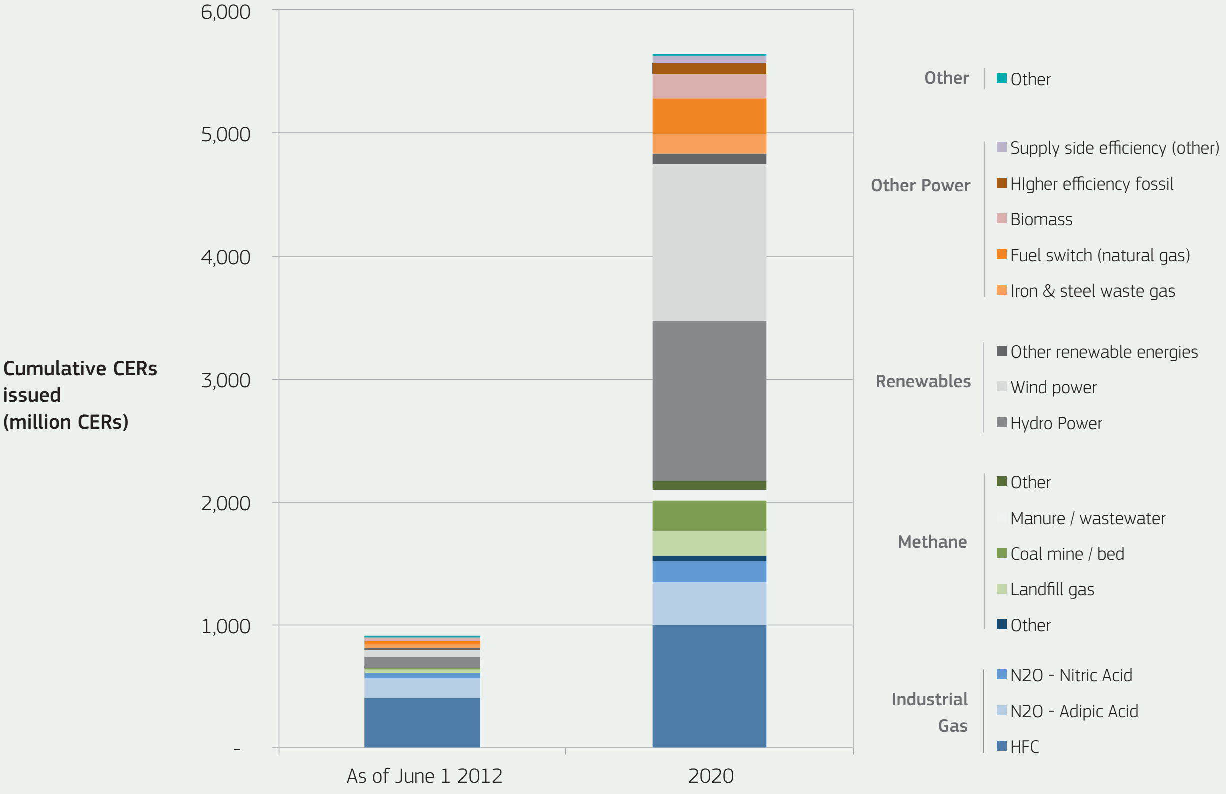
- **Continued perceived demand:** At COP 17/CMP 7 in Durban, Parties extended the Kyoto Protocol to a second commitment period, which allows the CDM to continue operation for at least another five to eight years and to continue to meet demands from the EU ETS, EU governments and other Parties that intend to sign up for a second commitment period. Furthermore, new domestic emissions trading systems in South Korea, China and Australia, among others, may provide additional sources of demand for CERs or otherwise reduce supply if they were to withdraw CERs from the global market in order to meet their own targets (Lütken, 2010).
- **The rush to beat EU ETS import restrictions:** To be used in the EU ETS, CERs from countries other than the LDCs must be registered before January 1, 2013. Recent improvements in the time required to process CDM registrations have given project developers greater confidence that they can meet this deadline.
- **Favourable economics:** For many projects most revenue comes from sources other than CER sales, meaning that CDM registration can be attractive simply if expected CER revenue exceeds transaction costs, which are generally less than $1 per tonne of credits (Buen, 2012; Antinori & Sathaye, 2007).

The World Bank estimates cumulative future demand up to 2020 for international credits (including both CDM and JI credits) at less than 2.7 billion tonnes (Kossoy & Guignon, 2012). By contrast, analysts expect the supply of CERs alone to be in the order of 4 to 8 billion tonnes up to 2020 (see table 10).

All of the estimates presented in table 10 and in the remainder of this section are risk-adjusted in order to account for the possibility that projects entering the pipeline may not end up being registered or being issued as many CERs as expected. These risks include delays or failures related to prolonged or halted validation, delays in registration, project underperformance and other factors (Koakutsu et al., 2011). Different treatment of these risks helps to explain the differences in these forecasts.

While industrial gas projects have accounted for the majority of the CERs issued to date, other project types – notably renewable energy projects – have represented a rapidly increasing share of project inflow and, by extension,

Figure 10. Forecast of cumulative issuance of CERs for projects in the CDM pipeline, by project type (million CERs)



Source: Authors' analysis based on IGES data (IGES, 2012b; IGES, 2012c).

expectations of future CERs issued (figure 10).[33] By contrast, the rate of issuance of CERs for industrial gas projects is expected to decline up to 2020 (Point Carbon, 2012a).

These trends in expected CER issuance suggest that hydropower, wind power, HFC, N_2O adipic acid and natural gas fuel switching projects will dominate the future pipeline. Together, these five largest project types represent over 70% of forecast cumulative CER issuance up to 2020 and therefore deserve extra scrutiny when assessing additionality and the potential for over- or undercrediting.

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[33] Figure 8 does not include forecasts of CDM programmes of activities (PoAs). CDM PoAs currently in the pipeline could yield up to 133 million CERs by 2020, with the majority (70%) from methane and energy efficiency projects (IGES, 2012). Because these projects represent less than 3% of the forecast cumulative CER supply up to 2020, they would not be expected to significantly affect the relative balance of project types in figure 8.

4.3 Additionality – assessing the evidence

Additionality is the cornerstone of project-based offsets. Broadly speaking, additionality occurs when a policy intervention (in this case, the CDM) causes an activity that would not have occurred in the absence of the intervention (Gillenwater & Seres, 2011). Assessing additionality, however, is inherently difficult and controversial. It requires establishing a causal connection between the policy intervention and the project activity, by assessing whether the project activity would have occurred in the absence of the policy intervention. Since a hypothetical future 'without a CDM world' cannot be directly observed, additionality can never be demonstrated with absolute certainty (L. Schneider, 2009b; Gillenwater & Seres, 2011). Furthermore, any given project activity may be 'caused' by a number of factors, including the prospect of CDM benefits, such as the financial value of the CERs it hopes to generate and/or the reputational or learning value of registering and operating a CDM project, and the non-CDM strategic, market or financial benefits of the project itself, as well as any policies and regulations that might encourage project implementation. Recognizing and balancing these inherent uncertainties and challenges, the CDM, like other offset programmes, has established procedures that enable an assessment of additionality. To date, the CDM has relied largely on the application of the CDM 'additionality tool' on a project-by-project basis, which requires a project's proponents to demonstrate that:

- *The project is either financially unattractive without the CDM (using an investment analysis) or has at least one barrier that is preventing the proposed project without the CDM (using barrier analysis).*

- *The project is not "common practice",* such that "no similar activities are observed" or there are "essential distinctions" between the proposed project and other similar activities (UNFCCC, 2011h). The common practice analysis must include an assessment of "the extent to which the proposed project type (e.g. technology or practice) has already diffused in the relevant sector and region". (Special consideration is given to an activity that is 'first of its kind'.)

- *The CDM was a factor in deciding to proceed with the project activity*. This 'prior consideration' test requires the CDM to have been "seriously considered in the decision to proceed with the project activity" and was especially important in the early years of the CDM to prevent the crediting of projects that were decided upon or even commissioned many months or years before submitting the project for CDM registration (Michaelowa, 2009). Until 2007, the 'prior consideration' test was part of the additionality tool as an initial 'step 0'. Now, for projects with a start date on or after August 2, 2008, the requirement is met by the publication of the PDD for global stakeholder consultation or the notification of the UNFCCC and host party DNA in writing of the intention to seek CDM status using the 'prior consideration' form (UNFCCC, 2011f).[34]

While the vast majority of registered, large-scale CDM projects[35] to date have used the standard 'additionality tool', there are some alternatives and variations in current use. A few project types can use a related 'Combined tool to identify the baseline scenario and demonstrate additionality', though its applicability is quite limited.[36] Some CDM project methodologies require the investment analysis to be used (i.e. barrier analysis on its own is not an option), often with guidance specific to the project type, including for the use of sensitivity analysis.

As noted elsewhere in this report, the EB is actively exploring alternatives to project-by-project assessment, such as the use of standardized performance standards and positive lists for determining additionality (Fussler, 2012; UNFCCC, 2010b; UNFCCC, 2011d).

Experience with using alternative methods for determining the additionality of CDM projects, however, remains limited at this time. Therefore, the impact of the CDM to date has been evaluated largely with respect to the performance and implementation of the CDM additionality tool.

4.3.1 Evaluations of CDM project additionality

For well over a decade researchers have been raising concerns about the ability of project-by-project assessment

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[34] For projects with a start date before August 2, 2008 (but no earlier than January 1, 2000), project applications must include evidence that the CDM was a 'decisive factor' in proceeding with the project. At this point in time, few, if any, new project submissions are expected to have such an early start date.

[35] Small-scale and micro-scale CDM projects follow simpler additionality guidelines.

[36] Both tools are available at: http://cdm.unfccc.int/Reference/tools/index.html. The 'tool for the demonstration of additionality' is the most broadly applicable and most commonly used (Michaelowa, 2009).

Table 11. Share of registered CDM projects using investment and barrier analyses to demonstrate additionality

	Share using investment analysis				**Share using barrier analysis**	**Share using both investment and barrier analysis**
	Total using investment analysis[1]	**Benchmark analysis**	**Investment comparison analysis**	**Simple cost analysis**		
Industrial gases	**70%**	**5%**	**6%**	**59%**	**43%**	**30%**
HFC-23[2]	0%	0%	0%	0%	19%	0%
N_2O – adipic acid	80%	60%	20%	0%	40%	40%
N_2O – nitric acid	97%	0%	2%	95%	35%	32%
Other	57%	13%	22%	22%	91%	48%
Methane recovery	**64%**	**44%**	**9%**	**13%**	**69%**	**34%**
Landfill gas	88%	57%	4%	31%	35%	27%
Coal mine/bed	100%	90%	9%	3%	14%	14%
Manure/wastewater	47%	27%	12%	8%	90%	38%
Other	66%	57%	3%	6%	80%	48%
Renewable energy	**91%**	**89%**	**1%**	**0%**	**45%**	**36%**
Hydropower	88%	87%	1%	<1%	53%	53%
Wind power	95%	94%	1%	<1%	32%	32%
Other renewable energies	63%	55%	4%	4%	67%	67%
Other power supply	**54%**	**41%**	**11%**	**2%**	**78%**	**32%**
Iron and steel waste gas	68%	55%	13%	0%	61%	30%
Fuel switch (natural gas)	79%	63%	14%	1%	37%	16%
Biomass	46%	36%	7%	3%	90%	36%
Higher efficiency fossil	100%	50%	83%	0%	0%	0%
Supply-side efficiency (other)	48%	26%	26%	0%	78%	26%
Other	43%	13%	30%	0%	96%	39%
Other	**54%**	**41%**	**7%**	**6%**	**75%**	**30%**
TOTAL	**77%**	**68%**	**5%**	**5%**	**56%**	**35%**

Source: Author analysis based on IGES (2012c).

[1] May be less than the sum of individual investment analysis approaches because some projects use multiple approaches.

[2] Approved methodology AM0001 deems HFC destruction projects additional if "the quantity of HFC-23 emitted to the atmosphere under the project activity is lower than the baseline quantity", and so these projects need not use the additionality tool.

methods, such as those embodied in the CDM additionality tool, to adequately assess additionality (Grubb et al., 1999). Many have argued that that the fundamental flaws in these tests – or the inadequate verification and review of them – have limited the ability of the CDM to adequately exclude non-additional projects.

Concerns that have been raised have focused both on the inherent structural challenges in assessing additionality and on specific critiques of the tests embedded in the CDM's additionality tool. Broadly speaking, structural critiques have included:

- **Asymmetric information.** Project developers have much more information on the costs, financing, barriers and local project conditions than the EB that must rule on the additionality of the project does. Project developers can therefore provide biased or inaccurate information that would increase the chance of their project being judged additional (Gillenwater, 2011).

- **Misaligned incentives.** Offset buyers (e.g. entities covered by an emissions cap) also have relatively little incentive to protect against non-additionality, since increased CER volume helps drive down their costs and, in most cases to date, once issued by the CDM, each CER credit counts for the same as any other for compliance purposes (Gillenwater & Seres, 2011).[37]

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[37] The exception to this rule is when the administrator of an emissions trading scheme specifically excludes certain types (or sources) of projects, such as will occur in the third phase of the EU ETS.

- **DOE conflict of interest.** DOEs are tasked with validating project proposals. However, they are hired by the project developers, raising the potential for conflict of interest since both parties would gain from the project being deemed additional.

- **Poor 'signal-to-noise' ratio.** Often there is so much variability in the key parameters for a financial evaluation of a project that the impact of the carbon revenue is relatively small and indistinguishable from other sensitivities. This makes it especially difficult for a DOE to assess the importance of CDM benefits in the investment decision of the project developers.

Critiques of the additionality tool's major tests are broadly summarized below. These tests include investment analysis, barrier analysis, common practice analysis and prior consideration.

Following the discussion of these tests is an assessment of the extent to which these concerns may apply to specific project types, along with a review of the steps that the EB has taken or is considering to address the concerns.

4.3.2 Critiques of investment analysis

The CDM's additionality tool provides for three alternative approaches to the investment analysis: (1) for projects with no revenue other than carbon revenue, a simple cost analysis to demonstrate that at least one alternative scenario is less costly; (2) an investment comparison analysis that compares the project to alternatives using common financial indicators, such as net present value (NPV) or IRR; and (3) a benchmark analysis that compares the financial performance of a project to a relevant benchmark or investment 'hurdle rate', usually an IRR.

Most analysts consider the first type of projects (e.g. HFC-23 destruction) to have a high likelihood of being additional, unless the activity is mandated by a well-enforced government policy (Grubb et al., 2011). Instead, most critiques of additionality focus on projects that would generate revenue even in the absence of the CDM. These projects would assess additionality either through a comparison to possible alternative projects or to a relevant benchmark.

In either case, the premise of the investment analysis is that financial return is a good predictor of whether the project will go ahead. However, in cases where projects are pursued for many other reasons – whether because they have been broadly supported by government policy or because they bring many other, non-financial benefits – financial return may not be a good test for the viability of a project. Critics of investment analysis describe how investments in power generation technologies – whether renewables such as wind and solar, or less-emitting fossil technologies such as natural gas or supercritical coal – are made for a variety of political, economic and strategic reasons that extend far beyond financial analysis. In many of the major CDM host countries, decisions on renewable power are driven by political priorities, and the decisions of public institutions on whether to invest are not primarily driven by profitability or return on investment. This means there is a mismatch between applying a 'market' test in a 'non-market' environment (He & Morse, 2010). As another example, critics contend that hydroelectricity (especially large hydro) is already financially viable (in part due to the government support mentioned above) in many developing countries, that the incentive of the CDM does not bring enough value to credibly support claims that the project would not have happened otherwise, and that the calculations of financial viability can rely on an arbitrary choice of inputs that can have considerable impact on the calculations of whether or not the project meets the chosen financial benchmark (Bogner & L. Schneider, 2011; Haya & Parekh, 2011; Ecofys & Azure, 2008; Au Yong, 2009).

The critique that CER revenue has too small an impact on IRRs to be expected to be the cause of some project types – especially wind and hydropower, where the change in IRR is in the order of 2 to 3 percentage points – has been particularly prominent in the literature (Alexeew et al., 2010; Ecofys & Azure, 2008; Lütken, 2012; Au Yong, 2009; Tatrallyay & Stadelmann, 2012). An example of this analysis is the IGES investment analysis database, which includes the financial assumptions used for all registered projects opting for investment analysis. As shown in table 12, wind, hydropower and natural gas are three of the categories with the least incremental IRR from carbon revenue.[38] The carbon prices in this analysis are those reported in the PDDs, which are generally sourced from international sources and exchanges (e.g. Point Carbon, Bluenext, EEX and Reuters), and not the verified prices in the Emissions Reduction Purchase Agreement (ERPA) for the project. When the World Bank analysed its own portfolio of CDM projects in 2010 using ERPA prices, it showed an incremental IRR of 1.7 percentage points at $10/tCO_2$ across all renewable energy projects (Kossoy & Ambrosi, 2010).

Researchers have also found that the information and approaches used to generate the investment analyses reveal

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[38] The other renewable energy category is not significant both because of the small sample size and because only 10% (six of 63) of registered solar photovoltaic projects use investment analysis. This category also includes two geothermal projects (of 13 registered) and three solar water heating projects (of six registered).

Table 12. IRRs with and without carbon revenue, by project type

	Average change in IRR	Average IRR without CER revenue	Average IRR with CER revenue	Sample size
Methane recovery				
Landfill gas	21%	2%	22%	46
Coal mine/bed	25%	6%	31%	40
Manure/wastewater	20%	5%	25%	53
Other	10%	5%	16%	22
Other power supply				
Iron and steel waste gas	8%	8%	16%	33
Fuel switch (natural gas)	4%	6%	10%	28
Biomass	7%	5%	12%	81
Supply-side efficiency (other)	5%	4%	9%	4
Renewable energy				
Hydropower	3%	7%	10%	721
Wind power	3%	6%	9%	552
Other renewable energies	2%	5%	7%	8

Source: Author analysis based on IGES (2012a).

Note: Average change in IRR is equal to the difference between the average IRR with and without carbon revenue. The averages here are weighted averages, where the weighting factors are the forecast cumulative CER issuance up to 2020. Weighting was performed to avoid a disproportionate influence of smaller projects that will not contribute as substantially to CER supply.

significant weaknesses. Schneider (2009b) found that project developers regularly provided investment analyses that lacked transparency, relied on internal (proprietary) company information or were missing information. In some cases, project proponents have prepared investment analyses for CDM project documents that differ in key respects from those submitted to financial institutions (Haya, 2009). Considerable debate has also centred on the choice of appropriate IRR benchmarks (Michaelowa, 2009). In part to address these concerns, in 2008 the EB introduced the "Guidelines on the Assessment of Investment Analysis" as an appendix to the additionality tool, with a number of detailed approaches and default factors, including in 2011 an appendix with default return on equity parameters for calculating benchmark IRRs.[39]

4.3.3 Critiques of barrier analysis

When using the additionality tool's barrier analysis, project developers must demonstrate that barriers exist that would "prevent potential project proponents from carrying out the proposed project activity undertaken without being registered as a CDM project activity". Barriers may include lack of access to capital, lack of technologies or skilled labour, or technology or process risks, but may not include costs, which should instead be evaluated as part of the investment analysis.

Many project developers have not provided objective, third-party evidence for the existence of such barriers and have not explained why the barriers cited would prevent the project (L. Schneider, 2009b). Furthermore, in some cases the barriers cited have not been credible, such as barriers that refer to general financial or policy risks that are highly subjective and difficult to assess (L. Schneider, 2009b; Michaelowa, 2009). To help improve the application of the barrier test, and after a number of rejections of projects using the barrier test from 2007 onwards (Michaelowa, 2009), in 2009 the EB adopted new guidelines that, among other stipulations, require project developers to "demonstrate in an objective way how the CDM alleviates each of the identified barriers".[40] This guidance provides greater objectivity as to what constitutes a valid barrier and increases transparency, but it cannot overcome the fundamental information asymmetry between project developers and those entities (e.g. the DOEs and the EB) that are tasked with reviewing the validity of the claims.

4.3.4 Critiques of common practice analysis

All projects are subject to the common practice analysis, which is a credibility check designed to assess "the extent to which the proposed project type (e.g. technology

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[39] See http://cdm.unfccc.int/Reference/Guidclarif/index.html.

[40] As per the "Guidelines for Objective Demonstration and Assessment of Barriers", available at: http://cdm.unfccc.int/Reference/Guidclarif/index.html.

or practice) has already diffused in the relevant sector and region". Few methodologies, however, have specific guidelines for what constitutes common practice. Instead, project developers must discuss similar activities that are occurring (not including other CDM activities), how extensively these other activities have diffused in the sector and region and describe "essential distinctions" between the proposed activity and the others.

Critics of the common practice analysis have asserted that the key terms 'similar' and 'essentially distinct' are defined so vaguely that any project could be argued to be not common practice simply by defining 'similar' very narrowly or 'distinct' very broadly (L. Schneider, 2009b; Michaelowa, 2009).

An even more widespread critique, however, is that the common practice analysis fails to exclude technologies that are already heavily supported (or would otherwise be) by government policies and broader market trends. This critique has been particularly strong in relation to power sector projects (hydropower, wind, new natural gas and, relatively recently, ultra-supercritical coal plants) in China and India (the dominant sources of these project types). Researchers have described the extensive government support for these technologies (via policies, incentives and, in some cases, mandates) and argued that the combination of this support and the increasing adoption of the technologies undermines the claim that these technologies are not common practice (or, for that matter, that they are not financially viable without the CDM) (Haya & Parekh, 2011; Bogner & L. Schneider, 2011; Wara & Victor, 2008; Lazarus & Chandler, 2011; He & Morse, 2010). In response to these criticisms (and, more specifically, to the rejection of a set of Chinese wind projects by the EB in 2009), carbon-market actors have asserted that government policies (e.g. feed-in tariffs) that support low-carbon technologies (e.g. wind power) should not be considered in determinations of additionality (IETA, 2009). The EB, however, has not issued comprehensive guidance on how to treat policies such as feed-in tariffs in determinations of additionality, stating that the "possible impact of national and sectoral policies in the demonstration and assessment of additionality shall be assessed on a case-by-case basis".[41]

In theory, the common practice test could be based on objective, third-party information concerning rates of technology diffusion, independent of the motivations of the project developer (unlike in the investment analysis or barrier analysis), but this would be difficult (L. Schneider, 2009b; Kartha et al., 2005). Nonetheless, in response to calls for more definitive guidance on the common practice analysis, in 2011 the EB introduced "Guidelines on Common Practice",[42] which establish a benchmark of 20% market saturation (by output or capacity) above which projects in a sector are considered non-additional. However, it is too early to say whether this change will have a tangible effect on future project approvals.

At present, project developers can exclude both existing and prospective CDM projects (those "registered project activities and project activities which have been published on the UNFCCC website for global stakeholder consultation as part of the validation process") from the common practice analysis (UNFCCC, 2011h). Some researchers suggest that, while this exclusion makes sense for projects with decisive cost or technical barriers, it can be problematic in situations where such barriers are not present – as has been the case for ultra-supercritical coal power plants in China – since all projects would therefore pass the common practice test even if few or none were additional (Lazarus & Chandler, 2011).

4.3.5 Summary of critiques of the additionality tool

Table 13 summarizes the criticisms of the additionality approaches and criteria used in relation to the CDM. The following section will explore evidence for these claims in relation to major CDM project types.

4.3.6 Additionality critiques of major project types

Table 14 summarizes the additionality-related concerns in relation to the major CDM project types.

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[41] Paragraph 27 of the EB 55 report, available at: http://cdm.unfccc.int/EB/archives/meetings_10.html#55. Deeming prospective CDM projects to be non-additional because they are supported by government policy might create a perverse incentive for countries to avoid implementing such policies, so as not to forego CDM revenues. The EB had previously considered draft guidance at EB 52 (see http://cdm.unfccc.int/EB/052/eb52annagan3.pdf).

[42] See http://cdm.unfccc.int/Reference/Guidclarif/index.html.

Table 13. Summary of systemic concerns regarding the CDM's additionality tool

	Investment analysis	Barrier analysis	Common practice analysis	CDM considered prior to project commissioning
Assessment criteria	Project is "unlikely to be the most financially attractive" option or is "unlikely to be financially attractive"	Project has "at least one barrier preventing the implementation of the proposed project activity without the CDM" and alternative scenario is "not prevented by any of the identified barriers"	"No similar activities can be observed" or similar activities have "essential distinctions"	"CDM was seriously considered in the decision to proceed with the project activity"
Criticism of approach of criteria	▸ *Project's financial benchmark (i.e. hurdle rate) is highly uncertain and easily manipulated* ▸ *Projects can claim financial additionality even if hurdle rate is not met or if IRR is only minimally improved* ▸ Projects have multiple non-monetary benefits that are not easily quantified	▸ *Barriers are not credible, are not documented and/or no evidence is provided for how the CDM would help overcome the barriers* ▸ *Barrier cited has often been cost, which is excluded from the CDM additionality tool*	▸ 'Similar' and 'essentially distinct' are defined so vaguely that any project could be argued to be not common practice; no definition for what constitutes 'common practice' ▸ Technologies that are already heavily supported (or would otherwise be) by government policy (e.g. mandates or national energy plans) or incentives (e.g. tariffs) should not qualify as 'common practice' ▸ Exclusion of other, pre-existing CDM projects from the consideration of 'common practice' is only appropriate if additionality testing is perfect; result is that outdated technology becomes the reference	▸ In early years, criterion was subjective and easily manipulated (e.g. by backdating)

Source: Authors' analysis (for sources of individual critiques, see the main text of this report).

Note: Italics in table indicate criticisms of criterion application, not necessarily of the criterion itself.

Based on the summary in section 4.2.6 and table 14, the largest two expected sources of CERs up to 2020 – and three of the top five largest sources – present some concerns regarding additionality.

Critiques of hydropower projects

By 2020 hydropower could be the most significant source of CERs issued, representing approximately 22% of all CERs forecast to be issued by that date. As of June 1, 2012, over 2,100 hydropower projects were in the CDM pipeline, 61% of which are in China (representing a similar fraction of forecast CERs), followed by India and Vietnam, each accounting for about 10% (IGES, 2012c). While small-scale hydropower projects constitute about half of the number of hydropower projects in the CDM pipeline, large hydropower projects (over 15 MW) dominate current and projected CER flows (over 80%) (IGES, 2012c).

The most widespread critique of the additionality of hydropower projects concerns the extent to which hydropower is considered to be common practice. Researchers have

Table 14. Summary of additionality-related concerns in relation to the major CDM project types [1]

Project type	Predominant methodology	Issuance to date (million CERs)	Forecast up to 2020 (million CERs)	Investment analysis	Barrier analysis	Common practice analysis	Prior consideration of the CDM
Industrial gases		**620 (66%)**	**1,563 (27%)**				
HFC-23 [2]	AM0001	414 (44%)	1,005 (17%)				
N2O – Adipic acid	AM0021	167 (18%)	334 (6%)			○ [3]	
N2O – Nitric acid	AM0028 & AM0034	37 (4%)	176 (3%)				
Other		2 (0%)	48 (1%)				
Methane recovery		**47 (5%)**	**600 (10%)**				
Landfill gas	ACM0001	24 (3%)	205 (3%)				
Coal mine [4]/bed	ACM0008	12 (1%)	237 (4%)				
Manure/wastewater	AM0006 & ACM0010	10 (1%)	97 (2%)				
Other		1 (<1%)	62 (1%)				
Renewable energy		**159 (17%)**	**2,670 (45%)**				
Hydro	ACM0002	88 (9%)	1,313 (22%)	● [5]	● [6]	● [5]	○
Wind	ACM0002	67 (7%)	1,271 (22%)	● [7]	○ [8]	● [7]	●
Other renewable energies	ACM0002	4 (0%)	87 (1%)				
Other power supply		**90 (10%)**	**822 (14%)**				
Iron and steel waste gas	ACM0004 [9]	34 (4%)	154 (3%)	● [10]	○ [10]	○ [10]	○
Fuel switch (natural gas)	AM0029	32 (3%)	295 (5%)	○	○ [8]	● [11]	● [11]
Biomass	ACM0006 & AMS-I.D	21 (2%)	199 (3%)	● [12]	○ [8]	○ [13]	
Higher efficiency fossil	ACM0013	0 (0%)	94 (2%)	● [14]	○ [8]	● [14]	●
Supply-side efficiency (other)	ACM0007	2 (0%)	59 (1%)		○ [8]		
Other		1 (0%)	11 (0%)				
Other		26 (3%)	239 (4%)				
	Totals	**943**					

● = Concern documented in the literature

○ = Conditions for potential concern have been noted in the literature

Note: ACM = approved consolidated large-scale methodology; AM = approved methodology (large scale); AMS = approved small-scale methodology.

[1] Table includes project types that cumulatively represent 80% of either all CERs issued or those forecast for issuance up to 2020, plus any project subtype that represents at least 2% of either CERs issued or forecast, with the exception of hydropower project subtypes 'run of river' and 'new dam', which do not correlate with the methodologies and where we instead substitute 'large' (ACM002) and 'small' (for simplicity, AMS-I.D. and everything else).

[2] Production of HCFC-22 in developing countries for some uses will be phased out under the Montreal Protocol. We consider this in more depth as a baseline issue affecting the level of HFC-23 production (L. Schneider, 2011).

[3] A large percentage of producers in the developed world have voluntarily undertaken N_2O abatement (Wara, 2006; L. Schneider et al., 2010), suggesting that these practices could at some point also become common practice in developing countries.

[4] Existing regulations for recovery of coal mine methane in China have created confusion over the additionality of coal mine methane capture projects (IEA, 2009a). While regulations exist, in many cases they have not been enforced.

[5] Haya and Parekh (2011). Bogner and Schneider (2011) also raise concerns about investment analysis and common practice for hydropower, especially large hydropower. Au Yong (2009) raises concerns about investment analysis for hydropower. Wara and Victor (2008) raise concerns about the rationale that hydropower is not common practice. Michaelowa (2009) provides evidence that wind projects in India were already viable without the CDM.

[6] Bogner and Schneider (2011).

[7] Bogner and Schneider (2011) and He and Morse (2010). Wara and Victor (2008) raise concerns about the rationale that wind is not common practice. Au Yong (2009) raises concerns about investment analysis for wind.

[8] As documented in Schneider (2009a), the barrier analysis is subject to systematic flaws, including its application by most power projects. As shown in table 7, the majority of hydropower, iron and steel waste gas, and biomass projects use barrier analysis, as well as over 30% of most other power supply project types.

[9] ACM0004 was replaced by ACM0012 in 2007.

[10] Michaelowa (2009). Rong et al (2012) state that the rate of rejection of waste energy and gas projects in China is higher than for other common project types, based largely on financial additionality, suggesting that the conditions for concern exist, even if the authors do not raise questions about registered projects. The CDM EB has rejected at least one steel waste gas recovery project (2304) owing to failure to substantiate "the identified technological barriers due to prevailing practice".

[11] Bogner and Schneider (2011). Wara and Victor (2008) raise concerns regarding new natural gas plants being common practice.

[12] Haya (2009c) and Michaelowa and Purohit (2007).

[13] Amatayakul and Berndes (2012) find that the development of bagasse power projects is more related to government policy than to the CDM.

[14] Lazarus and Chandler (2011).

asserted that hydroelectricity (especially large hydro) is a mature technology that is well established in CDM host countries, and was so before the CDM, and thus that the technology should be considered common practice (Bogner & L. Schneider, 2011; Wara & Victor, 2008; Haya & Parekh, 2011). Some researchers have also described the extensive government support for hydropower development, especially for large hydropower, in China (Bogner & L. Schneider, 2011; Wara & Victor, 2008; Haya & Parekh, 2011b) and India (Haya & Parekh, 2011) and have argued that long-standing support and significant market penetration contradicts the claims used to justify the additionality of many hydropower projects (i.e. that they are not common practice, are not financially viable without the CDM and are subject to significant barriers). For these reasons, Bogner and Schneider (2011) state that, in the case of China, “most [hydropower] projects would have been implemented in any case, i.e. without the CDM”.

In contrast, project developers have noted that a large proportion of hydropower potential in developing countries has yet to be tapped, and that developing countries remain challenged by high capital costs, construction costs, completion uncertainties and a lack of investors. They have also noted that the existence of large hydropower projects outside the CDM does not speak for the additionality of CDM projects. According to the Project Developer Forum (PDF), “there is no concrete evidence that any non-additional [hydro] projects have ever been registered as CDM projects”.[43]

In addition, critiques have focused on the investment analysis for hydropower projects, especially on the use of the financial benchmark. For example, Haya and Parekh (2011) state that recent benchmarks used for hydropower projects in India varied from 11.0–15.8% using the same method but with different choices of inputs. The CDM may have an impact on the financial return (as measured by IRR) of hydropower projects of 2 to 3 percentage points (see table 12 and Au Yong (2009)[44]). Although this could be a 20–35% increase in IRR, it may be much less than the uncertainty range of other parameters such as power tariff, capital cost, discount rate and operating costs. While this in itself does not disprove the additionality of any given hydropower project, it has raised questions about whether it is possible to distinguish the impact of the CDM from variability due to other key financial parameters and therefore show that the CDM provides a significant motivation for investment.

The published critiques cited here do not disprove the additionality of specific individual projects, and individual project conditions (whether technical, financial or political) could render specific projects untenable without the CDM. For example, small hydropower projects have had more difficulty securing loans than larger projects (Bogner & L. Schneider, 2011; Ecofys & Azure, 2008), which could increase the likelihood that these projects pass a financial or barrier analysis test. Nonetheless, the concerns expressed in the literature suggest that doubts regarding the additionality of hydropower projects, particularly for larger hydropower projects in China and other countries with significant hydropower capacity and support, are likely to persist.

Critiques of wind power projects

Along with hydropower, wind power is expected to be one of the dominant sources of CERs up to 2020, representing 22% of all CERs forecast to be issued by that date (IGES, 2012b). As of June 1, 2012, over 2,200 wind projects were in the CDM pipeline, 56% of which were in China (representing 72% of forecast CERs) and 32% of which were in India (12% of CERs) (IGES, 2012c). Like hydropower projects, wind projects use methodology ACM0002, which relies on the CDM additionality tool.

Concerns about the additionality of wind projects have, as for hydropower, focused on the extent to which wind power development has been driven by government targets, requirements and incentives for wind power and is thus now common practice in China and India (Wara & Victor, 2008; Bogner & L. Schneider, 2011; He & Morse, 2010; Lema & Ruby, 2007).[45] Wind power is seen in China as bringing several other benefits, including a means of diversifying away from fossil-based power, enhancing energy security and promoting economic development in renewable technologies (Lema & Ruby, 2007; IEA, 2007). Two separate research studies documented that in China, until 2007, essentially all wind power capacity had applied for the CDM (Wara and Victor, 2008; Bogner and L. Schneider, 2011) and section 5.2 of this report presents findings that these trends have continued in recent years. As Wara and Victor (2008) note the implication is that without the CDM almost no wind power plants would have been constructed in China, a prospect that the authors suggest appears unlikely given the considerable policy support for wind power noted above.

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[43] Response to the CDM Policy Dialogue stakeholder consultations: questions to project participants, May 8, 2012, p.24.

[44] This statistic is for all 39 projects sampled by Au Yong. Other researchers have found similar values for wind projects (Kossoy & Ambrosi, 2010; Lütken, 2012). Looking only at the hydropower projects in India, Au Yong’s median IRR is 2.2%.

[45] The coordinated and complementary nature of these policies such as China’s 2006 Renewable Energy Law, 2007 Medium and Long Term Plan for Renewable Energy Development in China and five-year plans, together with the centralization of authority within the Federal Government (e.g. National Development and Reform Commission and Energy Bureau) has, according to researchers, had a “profound impact” (Lema & Ruby, 2007) and been “extremely successful” (He & Morse, 2010) at stimulating the development of wind power in China.

Several criticisms of the investment analysis for wind projects have also been made. For example, researchers have described how the power market in China is not market-oriented, wherein state-owned power companies will routinely operate at a loss to maintain or expand market share or due to political pressure (He & Morse, 2010; Lema & Ruby, 2007; Ecofys & Azure, 2008). In this context – as well as because of the strong policy support (including tariffs) noted above – financial return (e.g. IRR calculations used in the CDM's additionality tool), researchers have argued, is not a reliable predictor of the viability of a project and therefore is not a reliable test of additionality (Bogner & L. Schneider, 2011; He & Morse, 2010; Ecofys & Azure, 2008). Nevertheless, these projects have largely relied upon on investment analysis to demonstrate their additionality and all (or nearly all) projects in China compare their IRR to a benchmark value.[46]

Lastly, some researchers note that wind, like hydropower, projects receive a projected CER benefit equivalent to an increase in IRR of about 2 percentage points (a 25% increase in IRR), which is a relatively small increase in comparison with the variability caused by other key financial parameters,[47] and also small compared with the impact for project types for which additionality is generally not questioned (Alexeew et al., 2010; Ecofys & Azure, 2008; Kossoy & Ambrosi, 2010; Au Yong, 2009).[48]

Critiques of other project types

While wind and hydropower projects have received the most attention with respect to additionality – together they could account for over 40% of the CERs issued by 2020 (IGES, 2012b) – concerns regarding several other project types have been documented in the literature. As can be seen in table 14, each of the following project types, all linked to the power sector, could account for at least 5% of CER issuance by 2020.

- **Coal power plants (ACM0013):** Since the approval of ACM0013 in 2007, new coal power projects claiming to use a more efficient, less GHG-intensive technology have been eligible to generate CERs. These projects involve the construction of new large coal power plants, using supercritical or ultra-supercritical technology, in comparison with the less-efficient subcritical technology previously dominant. As of June 1, 2012, 42 coal projects had applied, or were planning to apply, for CDM registration, all but three of which are in India and China, with six registered. Based on the projections shown in table 14, they are forecast to generate 94 million CERs by 2020, though issuance could exceed 300 million if all projects in the pipeline were to be registered and issued CERs.[49] However, serious concerns have been raised regarding additionality and the potential over-crediting of these projects, and, as a result, the EB suspended the methodology in November 2011 pending potential revisions.[50] With respect to additionality, the concerns are similar to those articulated for wind and natural gas plants. In both India and China, a number of non CDM related reasons have encouraged a shift away from less-efficient, subcritical coal plant technology: pressures on domestic coal supplies, growing exposure to rising international coal prices, government policies mandating the use of more efficient technologies, and prioritized grid access for efficient plants (Lazarus & Chandler, 2011). At the same time, nearly all more-efficient, supercritical (India) and ultra-supercritical (China) coal power projects are seeking CDM approval. Furthermore, concerns have been raised that investment analyses tend to find small differences in the cost of electricity between the proposed projects and their less-efficient alternatives, that sensitivity analyses have not been robust and that the value of CERs is small (i.e. as little as 2% impact on IRR) compared with the variation in coal prices witnessed in recent years (Lazarus & Chandler, 2011).

- **Natural gas power plants (AM0029):** As of June 1, 2012, 32 million CERs had been issued from projects involving natural gas power plants, most of which were from the construction of new natural gas power plants; these projects could account for nearly 300 million CERs, or 5% of all CERs issued, by 2020 (table 14).

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[46] He and Morse (2010) found that all Chinese wind projects had used an IRR benchmark of 8%, developed by the former, near-monopoly (since dismantled) State Power Corporation in 2002. However, this benchmark may no longer be valid for the current power market in China, which has been greatly evolved since 2002.

[47] Schneider et al. (2010) show that the impact of variation in electricity tariff, load factor and discount rate has five to 10 times the impact on profitability (measured as NPV per dollar invested) than carbon revenue does for both wind and hydropower.

[48] The 2.2% figure here is from Au Yong (2009), who also finds (per the appendix) a median of 2.2% for China, as do Ecofys and Azure (2008). He and Morse (2010) found an average of 2.5% for China.

[49] Total estimated CERs for all projects in the pipeline (and before applying IGES risk factors) is 326 million CERs. It has been noted that the ex ante CER projections for projects using this methodology could be overstated given conservativeness in the methodology and updating provisions in the baseline (PDF, 2012).

[50] The suspension does not affect the six currently registered projects.

Researchers have critiqued the additionality of new natural gas CDM project on grounds similar to the critique of wind power projects: common practice. Focusing particularly on China, as the country where nearly half of the CERs are expected to accrue, Bogner and Schneider (2011) and Wara and Victor (2008) both found that a majority of natural gas plant additions in China had applied for the CDM, and that up to 2007 (last year of data analysed) the share of such projects applying for the CDM was steadily increasing. While such trends are not necessarily conclusive, as with wind, the notion that most natural gas plants would not have been built in the absence of the CDM may not be fully credible. Bogner and Schneider (2011) suggest that, instead, the growth in natural gas use for power generation in China has been driven by a combination of political pressure for cleaner power generation (than coal), the availability of natural gas, the introduction of peak versus off-peak power pricing (which benefits natural gas over coal) and the desire to overcome power shortages.

- **Waste gas capture in the iron and steel sector (ACM0004 and ACM0012):** As of June 1, 2012, 34 million CERs had been issued from projects that recover waste gases at iron and steel plants; by 2020, about 154 million CERs are projected to be issued, based on the forecast shown in table 14. These plants can often recover waste gases and generate electricity at lower costs than from alternative fuels (e.g. coal) and can, in some cases, make waste gas recovery strongly cost-negative and thus financially attractive (Michaelowa & Purohit, 2007; McKinsey & Company, 2009). Analysts have noted concerns regarding the use of investment and barrier analysis to claim additionality for these projects.[51] Several projects have been rejected due to the use of a financial benchmark that the EB deemed to be too high (Michaelowa, 2009). Further guidance on investment analysis and more careful validation procedures may be helping to address this concern with respect to new projects applying for registration. At the same time, the analysis of the IGES investment analysis database shows a greater impact of carbon revenue than for wind, hydropower, natural gas, biomass and energy efficiency (see table 12).

- **Biomass energy (ACM0006, AMS-I.D. and others):** As of June 1, 2012, 21 million CERs had been issued from projects involving biomass for power generation. Biomass energy projects are forecast to issue nearly 200 million CERs up to 2020 (table 14). These projects use biomass, especially agricultural residues (including bagasse), to generate power and (in some cases) heat. Critics have argued that biomass projects in India (the source of about half of the CERs issued for biomass projects to date) have failed to perform proper investment analyses (Michaelowa & Purohit, 2007) and that the analyses use biomass prices that are so variable that they dwarf the potential benefit of the CERs, raising questions about the extent to which the projects are actually dependent on CER revenues (L. Schneider, 2009b). As Grubb et al. (2011) note projects that use bagasse (sugar cane processing waste) to power higher-efficiency cogeneration plants were far more successful in the 2000s, with CDM support, than during the 1990s, despite the World Bank's efforts to encourage the technology. A statistical analysis by Amatayakul and Berndes (2012) suggests that other factors – namely power purchase agreements – have driven the development of bagasse energy projects in India, Brazil and Thailand much more than access to the CDM. On the other hand, biomass projects show a much greater impact of CER revenue on profitability, according to both the IGES investment analysis (see table 12) and the recent analysis by Schneider et al. (M. Schneider et al., 2010), suggesting that the 'signal-to-noise' ratio for this project type may be stronger than for other renewable power technologies.

4.3.7 Summary of findings on additionality

After years of development, experience and revisions, CDM additionality assessment methods remain controversial and contested. Researchers have investigated and documented significant perceived flaws in the CDM's project-based assessment approach; some have argued that a large proportion of certain types of CDM projects would have proceeded in the absence of the CDM, owing to financial attractiveness, other market factors or government policies.

In response, the CDM EB has implemented a series of improvements to assessments of additionality, including

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[51] For example, the additionality analysis for projects 325 and 350, which account for about one quarter of the CERs issued for this project type as of June 1, 2012, showed that waste gas capture and use to generate power was not financially attractive in the absence of the CDM and faced a barrier of "complex technical problems" (Michaelowa & Purohit, 2007; Michaelowa, 2009). However, the project looked financially unattractive in part because of an 'artificial transfer price', wherein the proponent ascribed a coal-equivalent price to the use of its own waste gas, and the technical problems were resolvable with a simple, proven technology (a storage tank).

increasing the oversight and review of the DOEs and instituting a separate registration team that assesses each project to highlight particular issues. These improvements have led to increased scrutiny and more objections to, or rejections of, CDM projects over time (Gillenwater & Seres, 2011). However, it is unclear to what extent such changes will have an impact on the overall additionality of issued CERs. Some CERs flow from projects registered prior to these improvements,[52] and three quarters of the CERs forecast to be issued by 2020 from the current pipeline are from already-registered projects (IGES, 2012b). Furthermore, some of the critiques are fundamental and intrinsic to the determination of additionality: what would have otherwise happened can never be known; the relative influence of one factor (CDM registration and CER revenues) among many in deciding whether to proceed with a project can be hard even for a developer to assess; and the interaction between the CDM and government policies presents dilemmas with no easy answers. Finally, as information about a given project will always be unevenly shared among project proponents, regulators and observers, perspectives regarding additionality will remain difficult to reconcile.

Nonetheless, there appears to be a widely shared view that for project types for which there are few major incentives or requirements other than CERs, additionality is highly likely. These project types include industrial gas destruction, methane capture and combustion activities and most other non-energy project types that lack significant revenue sources. These project types represent a majority (about three quarters of the 943 million) of the CERs issued to date (June 1, 2012) and an even larger proportion of the CERs used to meet obligations under the EU ETS, with at least 80% having come from industrial gas projects alone (Point Carbon, 2012b).

Concerns about additionality tend to be concentrated around a handful of project types that involve electricity generation and are expected to generate a large volume of future CERs, in particular hydropower, wind, natural gas power, biomass energy, coal power and waste gas capture in iron and steel, though project developers have asserted that concerns are “outdated or later found unfounded” (IETA et al., 2012). These six project types represent about one quarter of the CERs issued up to June 1, 2012. Looking ahead, these project types could constitute over half of the CERs issued by 2020.

Furthermore, if future demand for CERs lags behind supply, as analysts have regularly suggested may be the case (Bellassen et al., 2012; Carbon Trust, 2009), then downward pressure on CER prices could decrease the incentive for truly additional projects that depend strongly on expected CER revenue. Such an outcome could further increase the share of non-additional projects in the pipeline.

In summary, should the critiques be warranted, CDM procedures remain largely unchanged and CER projections hold, then the quantity of non-additional CERs could be substantial and lead to a significant net increase in emissions. However, as project developers are keen to point out, aggregate critiques may not hold when considering the individual circumstances that each project faces. In addition, there is more to the assessment of net emissions impact than the question of additionality. In the next section, we review other features of CDM methodologies, such as emission baselines and crediting periods, and other more indirect potential project outcomes, such as leakage, spillover benefits and perverse incentives, which could increase or decrease the CDM’s net emissions impact.

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[52] In principle, additionality is determined for the lifetime of the project and (unlike baselines) is not revisited upon renewal of the (seven-year) crediting period.

4.4 Potential for over- or undercrediting under the CDM

Under the CDM, emission reductions are estimated relative to an emission baseline, which seeks to represent as accurately as possible the level of emissions that would have occurred had the CDM project activity not been implemented. Since this 'without CDM' baseline can rarely be observed, it – like additionality – can never be determined with absolute certainty. To develop a baseline scenario against which CERs are quantified, the CDM has relied on a series of methodologies specific to project types for estimating baseline emissions. For example, the methodology for large-scale renewable energy and many other electricity-related projects specifies steps to calculate a baseline ('combined margin') emission factor for the grid electricity, on the basis of formulas that use data regarding the production, fuel use and emissions of power plants in a given region. Like other methodologies, it enables a 'best guess' of the emissions a project would avoid and, like most, it relies on available data that are often incomplete and may be subject to random or systematic error (uncertainty or bias). Because of this uncertainty and potential bias, CDM methodologies often use conservative assumptions or factors that tend towards reducing estimated baseline emissions, and CERs awarded, in order to reduce the chance of overestimating emission reductions.

Because the baseline can never be determined with certainty, the number of CERs issued for any given project could be more or less than the 'actual' emissions reduced or avoided. Since credits are awarded to the extent that the project reduces emissions below its baseline, if the baseline is set too high, the project is awarded too many credits (overcredited). If the baseline is set too low, the project is undercredited. A number of practices or outcomes could lead to biases in the baseline and hence to over- or undercrediting under the CDM and, by extension, net increases or decreases in global GHG emissions. However, just as baselines (and additionality) cannot be established with any certainty, neither can the absolute extent of over or undercrediting.

4.4.1 Practices and outcomes that could lead to overcrediting

The following practices or outcomes could lead to overcrediting of CERs:

- **Setting baseline emissions at a higher level than the most likely future scenario.** As described above, if the baseline emission level is set higher than what would have been expected had the CDM project activity not been implemented, overcrediting will result. Researchers have asserted that CDM project hosts have an incentive to select baseline scenarios or key data or assumptions that result in the calculation of an inflated baseline emission level in order to receive greater numbers of CERs (Strand & Rosendahl, 2010; L. Schneider, 2011; Michaelowa 2011). Because of these perverse incentives, the project baseline may not be an accurate assessment of the likely future emissions in the absence of the CDM project activity.

- **Leakage (activity shifting).** If revenue from the CDM is great enough to cause production to shift from a region with a cap on emissions or with less GHG intensive production (with or without an emissions cap) to the CDM project facility, then emission leakage would occur, global emissions would increase and more credits would be issued than the actual emission reductions. Researchers have found that this activity shifting, or emission leakage, is likely to have occurred with adipic acid facilities, with production shifting from capped regions and facilities that emit fewer N_2O emissions to CDM project facilities that gain CERs for reducing N_2O emissions (L. Schneider et al., 2010). On the other hand, research has also suggested that for other sectors, particularly the production of energy-intensive products, leakage is unlikely to have occurred at CER prices to date (Erickson et al., 2011).

- **Excluding non-additional CDM activities from baseline calculations.** Several key CDM methodologies exclude CDM activities in the calculation of the baseline emission level. Since the baseline is intended to reflect emissions in a world without the CDM, activities that only occur due to the CDM, in theory, should not be included in the baseline. However, if some CDM activities are not truly additional, excluding them from the baseline will have the effect of artificially raising the baseline, leading to overcrediting.[53]

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[53] For example, researchers have suggested that a significant proportion of hydropower projects are non-additional, as discussed previously in this chapter. The exclusion of these projects from the build margin calculation in ACM0002 would raise the grid emission factor above where it would have been had these non-additional hydropower projects not been awarded CERs and included in the baseline. The resulting effect is that other power projects could be overcredited.

- **Accelerated implementation of a project activity** that would have occurred anyway before the end of the crediting period. The CDM is designed to bring about activities that would not otherwise occur, or at least that would not otherwise occur in the near term. In sectors with rapid technological progress (regardless of the CDM), however, the activities might otherwise be expected to occur before the end of a project's crediting period. While these projects would still be additional at the time of implementation, failing to account for this technological progress in the baseline could lead to the continued issuance of CERs to a project beyond the time when it would have occurred in the baseline scenario. (In effect, the CDM in these cases would be speeding up the implementation of a low-emitting practice or technology, without necessarily affecting its long-term penetration.)

- **The existence of perverse incentives that artificially boost production.** In some circumstances, if the CER revenues were great enough, the CDM could lead firms to artificially boost production beyond normal levels, simply to gain extra CDM revenues. In such cases, more CERs would be awarded than the actual emission reductions relative to a scenario without the CDM. This has been shown to occur in the case of HCFC-22 production (L. Schneider, 2011).

Table 15 summarizes these potential sources of overcrediting under the CDM.

Table 15. Practices or outcomes that can lead to overcrediting under the CDM

Practice or outcome	How this leads to overcrediting
Setting baseline higher than expected emissions (i.e. baseline does not incorporate business-as-usual incidence of emission-reducing technology or practices)	The forecast emission baseline or emission intensity is too high, resulting in more credits being issued relative to a 'true' business-as-usual scenario
Activity shifting (leakage) [1]	If revenue from the CDM causes production activity to shift from a region with a cap or with less GHG intensive production
Exclusion of non-additional CDM activities from baseline calculations	Excluding CDM activities that are non-additional from the baseline would artificially raise the baseline (e.g. the grid emission factor in ACM0002)
Accelerated implementation of a project activity that would have happened anyway in a few years	Credits are issued for the duration of the crediting period(s), even though the activity would have been implemented anyway at some point during that time
Existence of perverse incentives that artificially boost production	If revenue from the CDM was so great that producers made more of the product than they otherwise would, simply to gain CDM revenues

Source: Authors' analysis.

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[1] In addition, another form of leakage could occur if the reduction in fossil fuel use caused by CDM activities puts downward pressure on global energy prices, leading to increased use elsewhere (Strand & Rosendahl, 2009).

4.4.2 Practices or outcomes that could lead to undercrediting

Potential sources of undercrediting of CERs include:

- **Setting the baseline emission level lower than expected.** Baselines could also be set lower than what would have been expected had the project activity not been implemented. For example, to address uncertainty, in some cases (such as the new version of AM0001 for HFC emissions) the CDM has purposefully set the baseline lower than expected through the use of discount factors or other conservativeness parameters, a practice that could be expected to lead to some undercrediting.

- **Discounting for measurement uncertainty.** Several CDM methodologies apply discounts intended to account for uncertainty in measured or modelled emissions. If the underlying factors are, in fact, accurate, then the uncertainty discount leads to undercrediting.

- **Discounting for non-permanence risk.** Projects that sequester or store carbon, such as afforestation or carbon capture and storage, can use discounts or buffers to mitigate the risk that the stored carbon may later be released. If the discount is overly conservative (greater, on average, than any future reversals), then fewer credits could be issued than the actual abatement achieved.

- **The continuation of emission-reduction activity beyond the crediting period.** The crediting of CDM projects is generally limited to the shorter of the project lifetime or the length of the crediting period (usually either seven years renewable twice or 10 years). If the project continued in operation beyond the crediting period, emission reductions could continue but not be issued CERs. Though projects with net costs (including the transaction costs associated with the verification of CERs) have little reason to continue beyond the end of crediting period, projects that invest in long-lived capital stock and with net revenues (e.g. renewable energy projects) could be more likely to yield emission reductions beyond the length of the crediting period.
- **Spillover benefits to other, non-CDM, activities in the sector.** If the CDM were to bring new technology and support services (know-how) to host countries (Wang, 2010) and they were to catalyse broader emission reductions beyond the CDM activities themselves, then greater emission reductions could occur than the credits issued. Spillover benefits are discussed further in chapter 5 on energy security and clean energy investment.

Table 16 summarizes the practices that could lead to undercrediting.

Table 16. Practices or outcomes that can lead to undercrediting under the CDM

Practice or outcome	How this leads to overcrediting
Setting the baseline lower than the expected emissions	The forecast emission baseline or emission intensity is too low, resulting in fewer credits being issued relative to a 'true' business-as-usual scenario
Discounting for measurement uncertainty	Designed to reduce the risk of overcrediting by setting values (e.g. emission factors) lower than the expected actual values
Discounting or buffers for non-permanence risk (in sequestration projects)	Could lead to undercrediting if reversals do not occur
Continuation of emission-reduction activity beyond crediting period	If the emission-reducing technology or practice continues beyond the crediting period (and is still better than business-as-usual practice), then undercrediting could result
Spillover benefits on other, non-CDM, activities in the sector	Credits are issued only for the project activity itself, but the CDM project activity could catalyse broader technology transfer, know-how or other spillover effects that reduce emissions beyond the project activity

Source: Authors' analysis.

4.4.3 Over- and undercrediting: assessing the evidence

Compared with the topic of additionality, researchers have devoted relatively little attention to assessing the potential for over- or undercrediting under the CDM. In part, this is due to the difficulty of assessing what the 'correct' baseline is. Practices such as uncertainty discounts may in theory lead to undercrediting, but since there is no way of knowing how much the 'true' value differs from the discounted value, quantitative estimates are difficult.[54]

Researchers have, however, found evidence of some systematic flaws in the design of methodologies for industrial gas projects for HFC reduction and N_2O decomposition that could lead to overcrediting.

In particular, Schneider (2011) found evidence of overcrediting in relation to HFC projects owing both to baseline manipulation and to perverse incentives to increase production levels. Schneider found that some HCFC-22 plants had altered their practices to increase their baseline HFC-23 emission estimates (and hence their potential for generating CERs). Schneider also found evidence that plants were creating more HCFC-22 than they otherwise would, in order to generate (and subsequently destroy) more HFC-23, a practice that led to further overcrediting.

In response to these findings (as well as other investigations by the Methodologies Panel), the EB revised the baseline method for HFC-23 destruction, reducing the maximum baseline level by a factor of three. This more-conservative

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[54] Bento et al (2012) developed a model to estimate the potential impact of conservative baselines on undercrediting under the CDM. They concluded that, in theory, conservative baselines could lead to significant undercrediting, but their assessment was not based on the consideration of actual CDM methodologies.

baseline could lead to undercrediting for some projects, upon renewal of their crediting periods (or for new projects, though few, if any, are expected, given the exclusion of these project types by the EU ETS beginning in 2013). The overall effect of this change in methodology is uncertain, as the pending exclusion of HFC projects by the EU ETS creates uncertainty regarding the future demand for HFC credits and, by extension, as to whether such projects will continue operating and generating CERs.[55] Therefore, while it is likely that overcrediting of HFC-23 projects has occurred, it is not clear to what extent updating these projects' baselines upon renewal of their crediting periods will lead to undercrediting in the future.

Attention has also focused on N_2O destruction projects, particularly on facilities that generate N_2O in the course of making adipic acid. Researchers have found that the production of adipic acid partially shifted from plants that had already installed N_2O abatement technology to CDM plants, resulting in emission leakage and the issuance of more CERs than the actual emission reductions (L. Schneider et al., 2010). Research into N_2O emissions from nitric acid plants found no evidence of systematic baseline manipulation for these projects, though the authors noted that baseline estimates may not be taking into account recent advancements and the adoption of lower-emission primary catalyst gauze technology (Kollmuss & Lazarus, 2010).

Project developers have asserted that many CDM projects are likely to outlast their crediting periods, leading to the continued reduction or avoidance of emissions. In such cases, these projects could lead to more emission reductions than the CERs issued. Many types of CDM projects install equipment with expected operational lifetimes exceeding the length of the crediting period. For example, the average lifetime of hydropower facilities under the CDM is nearly 30 years,[56] exceeding the maximum crediting period for these projects of 21 years. Establishing whether these projects will be reducing emissions during this post-crediting period (or beyond, if the facility continued beyond its stated operational lifetime) would depend on a new assessment of what the baseline emissions would otherwise have been in this period, an assessment that depends on the rate of technological progress and which is particularly uncertain decades into the future.

Another potential source of undercrediting is the use of conservative default values or assumptions. The CDM was founded on the principle of conservativeness, with baselines established "in a transparent and conservative manner regarding the choice of approaches, assumptions, methodologies, parameters, data sources, key factors and additionality, and taking into account uncertainty" (UNFCCC, 2002, para. 45). Many CDM methodologies employ conservative default values that can be used if direct monitoring or other plant- or country-specific data are not available. Accordingly, the use of the conservative values may involve a trade-off between the costs of more precise measurement and the simplicity of using the default values. Using the conservative default values and assumptions could, in principle, lead to undercrediting if these values resulted in a baseline emission estimate lower than the 'actual' value. Project developers have pointed to several CDM methodologies' use of the lower bounds of the 95% confidence intervals of the International Panel on Climate Change (IPCC) as a potential source of undercrediting (where the defaults are used instead of local data). The IPCC's lower-bound emission factors for coal and natural gas are 5% and 3% less, respectively, than their corresponding default values,[57] suggesting that undercrediting could be in this order for projects that avoid emissions from coal and natural gas and use the IPCC lower-bound factors rather than specific in-country data.[58]

As another example of potential undercrediting, project developers have also pointed to the use of default methane combustion efficiency values of 50% for the burning of methane using an open flare or 90% using a closed flare.[59] Projects that combust methane (e.g. landfills, wastewater treatment plants and manure digesters) have the option of using these default parameters instead of monitoring the combustion efficiency directly. The actual combustion efficiency of these flares in use in CDM projects is not known, though further analysis could explore monitoring and verification reports to estimate the average collection efficiencies of flares that are monitored.[60]

Lastly, undercrediting could also occur if the CDM were to lead to the broader diffusion of technologies or practices beyond those in CDM-registered projects. While literature

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[55] Plants would presumably continue operation if the price of CERs would continue to exceed their costs. The cost of HFC-23 destruction is in the order of $0.20 per tonne, including capital costs (TEAP, 2007), and so operating costs could be expected to be lower. Additional costs would be associated with CER verification.

[56] Source: Authors' analysis of UNFCCC data.

[57] Based on 'other bituminous coal' (IPCC, 2006, table 1.4).

[58] Project developers may also use national average default values or values provided by the fuel supplier. If these figures were higher than the IPCC default, then the IPCC lower bound could be even more than 5% less than the 'true' value. Project developers have asserted that this is the case in China.

[59] Based on author review of 25 PDDs for landfill, coal mine methane, manure and wastewater treatment projects, projects more commonly use closed flares or power generators than open flares.

[60] The first monitoring report for landfill gas project 3127 reports a monitored combustion efficiency of its closed flare of 95.5%, suggesting that the use of the conservative 90% default in this case would have led to undercrediting by about 5%.

has focused on technology transfer under the CDM (e.g. Wang, 2010), few studies define technology transfer in such a way as to allow one to isolate the unique, additional effect of the incentive provided by the CDM (and much less to attempt to quantify it).[61]

Table 17 summarizes the potential sources of over- and undercrediting, by project type.

Table 17. Summary of potential for over- and undercrediting for major CDM project types

	Potential for overcrediting	Potential for undercrediting
Industrial gases		
HFC reduction/avoidance	▸ **Perverse incentive to increase baseline:** Value of CDM credits has created perverse incentive to produce more HCFC-22 in order to destroy more HFC-23, as well as to operate in such a manner that baseline emissions are inflated (L. Schneider, 2011)	▸ **New, conservative baseline:** Version 6 of AM0001 adjusts the maximum waste generation rate ('w') from 3% down to 1% (CDM Methodologies Panel, 2011), a level that could lead to undercrediting
N_2O decomposition – adipic acid	▸ **Activity shifting (leakage):** Production of adipic acid partially shifted from plants that had already installed N2O abatement technology to CDM plants, resulting in emission leakage (L. Schneider et al., 2010)	▸ **Uncertainty discounts** of 5–10% on the quantity of N2O entering the destruction facilities
N_2O decomposition – nitric acid	▸ **Baseline may be set too high**, if improvements in primary catalyst gauze technology are not being reflected in the baseline (Kollmuss & Lazarus, 2010)	
Methane recovery		
Landfill gas	▸ **Baseline for solid waste disposal in a landfill** may be set too high, as actual methane oxidization may be higher in the baseline than the 10% default (Chanton et al., 2009)	▸ **Uncertainty discounts for solid waste disposal:** Uncertainty discount of 10% on methane emissions at solid waste disposal sites (L. Schneider, 2009b) ▸ **Default flare efficiencies:** Defaults of 90% (closed flare) and 50% (open flare), where used instead of monitoring data, could be lower than actual values
Coal mine/bed, manure, wastewater		▸ **Default flare efficiencies** (where used instead of monitoring data) could be lower than actual values, as above

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[61] One analysis used statistical techniques to correlate the level of CDM activity with a country's GHG emissions (Huang et al., 2012a). The analysis found that each CER issued correlated with a reduction in a country's CO_2 emissions of 0.012–0.014 tCO_2. Interpreting this finding is challenging, in large part because a significant number of CERs issued over the time period of the analysis (2005–2010) were for non-CO_2 gases, which would not be expected to reduce a country's CO_2 emissions, and so there is little reason to suggest a causality between the independent variable (CERs) and dependent variable (national CO_2 emissions). If the finding were to hold for GHG emissions *including* non-CO_2 gases, it would suggest that while the CDM has helped to reduce a country's emissions, the *net effect* of the CDM could be to increase global GHG emissions, since each CER is associated with much less than 1 tonne of emission reductions.

	Potential for overcrediting	Potential for undercrediting
Renewable energy		
Hydropower	▸ **Baseline may be set too high:** Systematic bias in application of ACM0002 has led to overestimation of emission reductions (Michaelowa 2011) ▸ **Baseline excludes CDM hydropower projects that may be non-additional**, possibly inflating the baseline [1]	▸ **Facilities may continue to operate beyond crediting period**. Project developers report an average project life of 28 years for hydropower, about twice as long as the average crediting period, and 21 years for wind, nearly 75% longer than the average crediting period [2] ▸ **Use of IPCC lower-bound default values for baseline fuel emission factors** could lead to undercrediting (of up to approximately 5%)
Wind power	▸ **Baseline may be set too high:** Systematic bias in application of ACM0002 has led to overestimation of emission reductions of 1.5% in India (Michaelowa 2011)	
Other renewable energies	▸ **Baseline may be set too high**, as for other renewable technologies above	
Other power supply	▸ **Baseline may be set too high**, as for renewable technologies above	▸ **Facilities may continue to operate beyond crediting period**, as for renewables above

Source: Authors' analysis.

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[1] Excluding non-additional CDM hydropower projects would also affect the crediting rates of other project types, and excluding other non-additional power projects would also affect the crediting rates for hydropower.

[2] Source: Authors' analysis of UNFCCC data (UNFCCC, 2012b).

As displayed in table 17, the possibility exists of both over- and undercrediting. Very few of these effects have been individually quantified, much less the balance of these two possible outcomes. Quantitative estimates of over- or undercrediting would also be highly dependent on assumptions regarding additionality. For example, while some project types may have conservative baselines or lifetimes likely to exceed their crediting periods, the associated emission benefits would accrue only to the extent that projects are additional. Accordingly, any assessment of the net emissions impact of the CDM would need to consider both additionality and over- and undercrediting simultaneously. For an illustrative calculation of the potential range of the net emissions impact of the CDM, considering only a handful of the largest potential sources of the net emissions impact, see box 1.

4.5 Options for improving the net mitigation impact of the CDM

The foregoing analysis suggests that some CDM practices and outcomes, such as crediting periods shorter than project lifetimes, could lead to a net decrease in global emissions, while others, such as non-additionality or leakage, may lead to a net increase in emissions. On balance, the overall net mitigation impact of the CDM remains difficult to assess with certainty. Nonetheless, looking forward, there are two rationales for seeking to improve the CDM's net mitigation impact. Firstly, if one ascribes to the more pessimistic view outlined above, the CDM may currently be leading to a significant net increase in global emissions; steps to improve its mitigation impact would thus be needed simply to achieve the CDM's original purpose as a pure offset mechanism with no net mitigation impact. Secondly, even if the CDM is generally achieving its original purpose, Parties may still wish to increase the CDM's mitigation impact in the future, in the light of the increasing attention paid to achieving "a net decrease and/or avoidance of greenhouse gas emissions" in market, as well as non-market, mechanisms going forward (UNFCCC, 2011c, para. 79). If one takes the optimistic view outlined above, then the CDM, in aggregate, is already on course to deliver a net decrease in emissions; nonetheless, even in this case, it may still be warranted to improve the mitigation impact of certain project types that are not yielding a (sufficient) net decrease in global emissions.

Box 1. Two scenarios of the potential net emissions impact of the CDM

This box describes a range of factors and outcomes that could cause the CDM to lead to a net increase or decrease in global GHG emissions. To provide an illustrative sense of the potential magnitude of their combined net impact, two alternative scenarios were developed: a 'pessimistic' scenario that reflects critical perspectives found in the literature discussed in chapter 4 of this report; and an 'optimistic' scenario that reflects more positive perspectives, often expressed by the project developer community.

Specifically, the pessimistic scenario assumes that: (a) only projects with an IRR of at least 20% are additional (Lütken, 2012); (b) no extra emission benefit should be claimed for operation beyond the crediting period; and (c) leakage has led to the overcrediting of N_2O reductions at adipic acid plants. Meanwhile, the optimistic scenario assumes that: (a) all projects are additional; (b) all power supply projects continue to reduce emissions beyond the end of their crediting periods, up until the end of their stated operational lifetimes (thus yielding 1.5 to 2 times as many emission reductions as CERs issued); (c) the change in the maximum 'w' factor for HFC projects from 3 to 1 leads to undercrediting by a factor of three for the future renewal of crediting periods; and (d) conservativeness parameters lead to undercrediting by 5% for power supply projects and by 10% for landfill gas projects.

Table 18. Net increase (+) or decrease (-) in global emissions, cumulative up to 2020 (MtCO$_2$e)

		Pessimistic	Optimistic
Industrial gases			
HFC reduction/avoidance	Non-additional CERs	91	-
	Over/undercrediting	-	(382)
	Subtotal	91	(382)
N_2O decomposition	Non-additional CERs	46	-
	Over/undercrediting	61	(18)
	Subtotal	107	(18)
Methane recovery	Non-additional CERs	291	0
	Over/undercrediting	-	(40)
	Subtotal	291	(40)
Renewable energy			
Hydropower	Non-additional CERs	1,313	-
	Over/undercrediting	-	(1,382)
	Subtotal	1,313	(1,382)
Wind power	Non-additional CERs	1,271	-
	Over/undercrediting	-	(1,016)
	Subtotal	1,271	(1,016)
Other power supply	Non-additional CERs	558	-
	Over/undercrediting	1	(526)
	Subtotal	559	(526)
Renewable energy	Non-additional CERs	3,571	-
	Over/undercrediting	62	(3,365)
	Total	**3,633**	**(3,232)**
	Total forecast CERs (IGES, 2012b)	5,885	5,885
	'Actual' abatement/CERs	**0.38**	**1.57**

Source: Author analysis

Both of these scenarios have significant limitations. For example, they assume hydropower and wind projects are either all additional (optimistic scenario) or all non-additional (pessimistic scenario) and make other, stylized assumptions (such as the change in the HFC w factor from 3 to 1, meaning an undercrediting by a factor of 3) that may not be completely accurate. Furthermore, some potential factors were not quantified, such as the overcrediting of HFCs as a result of perverse incentives or the potential for other projects (e.g. methane capture projects) to yield emission reductions beyond their crediting periods.

Lastly, the analysis assumes the use of all 5.9 billion CERs issued up to 2020 (i.e. that sufficient demand exists for the projects to operate as projected).

This example calculation is illustrative only and depends on many factors that cannot be determined with certainty (e.g. additionality) or will not play out for many years (e.g. the potential that projects will outlast their crediting periods, or the actual issuance of and demand for the CERs).

The high variability in the outcomes illustrated here results largely from two key factors:

- **The non-additionality of hydropower and wind projects is the largest potential cause of a net emission increase in the pessimistic scenario** (2,600 $MtCO_2e$ of 3,600 $MtCO_2e$ of estimated overcrediting). These projects represent a large and growing share of issued CERs and raise significant concerns regarding additionality. This finding also applies to other power supply projects, such as new coal, natural gas and biomass projects.

- **Emission benefits from project operation beyond the crediting period for these same project types, wind and hydropower, is the largest potential source of a net emission reduction in the optimistic scenario.** Of the approximately 3,200 $MtCO_2e$ estimated to be undercredited in the optimistic scenario, about 2,100 $MtCO_2e$ is due to the operation of wind and hydropower projects beyond the crediting period, and another 500 $MtCO_2e$ is due to the operation of other power supply projects beyond the crediting period. About 600 $MtCO_2e$ of undercrediting is due to conservativeness parameters (most of which are due to the assumed future undercrediting of HFC projects).

This example calculation illustrates the extent to which views on the net mitigation impact of the CDM hinge upon one's perspective of the additionality of power sector CDM projects, wind and hydropower projects in particular.[1]

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1 Note that considering the emission benefit of the extended life of renewable and power sector projects in the 'pessimistic' scenario would reduce the net emission increase of that scenario by less than 150 $MtCO_2e$, a relatively minor effect.

This section considers options for increasing the mitigation impact of the CDM. Some options, such as conservative baselines, are already established and available within the CDM. Other approaches, such as credit discounting, shorter crediting periods or negative lists, would retain much of the current form of the CDM, but require new agreements at the level of the COP. Alternatively, some of these options could be adopted by Parties in their use of CERs for compliance purposes. Finally, there are options, such as shifting from project-based to policy-based or sector-based crediting, that would involve significant changes in the form of the CDM, along the lines of the new market mechanisms under discussion within the UNFCCC.

Table 19 outlines many of these options, along with their potential advantages and disadvantages. Many of these concepts, such as standardized baselines, have been discussed since the inception of the CDM and considered within the UNFCCC process for several years.[62] Most of the options shown may lead to a greater incidence of missed opportunities, to the extent that they will reduce the number of registered CDM projects (e.g. negative lists) or incentives to project developers (e.g. discounting and conservative baselines). As noted above, missed opportunities (unlike non-additional projects) have no direct mitigation impact, but could have indirect impacts, for example on the ambition of future targets. At the same time, most of the options listed in table 19 will reduce the number of CERs issued, creating upward pressure on CER prices, thus leading to a further, indirect, mitigation benefit to the extent that higher CER prices correlate with a higher proportion of additional project activity.[63]

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[62] In particular, the Ad Hoc Working Group on Further Commitments for Annex I Parties under the Kyoto Protocol issued a technical paper in 2008 (FCCC/KP/AWG/2008/3) that analysed a number of options for improving the environmental integrity and effectiveness of the project-based mechanisms under the Kyoto Protocol (UNFCCC, 2008d).

[63] Higher CER prices might, conversely, lead to lower mitigation ambition in future targets.

Table 19. Options for improving the net mitigation impact of the CDM

Option	Potential advantages	Potential disadvantages
Conservative parameters	Procedure already in use under the CDM.	Typically achieves a limited net mitigation benefit.
Discounting	As with conservative baselines, can yield a net mitigation benefit for project types where additionality is well established and incremental costs are much lower than the expected value of the CERs. Can be implemented directly by Parties in their use of CERs.	For project types where additionality is unclear and incremental costs could approach or exceed the expected value of the CERs, could increase the proportion of non-additional activity. Would require changes to the CDM modalities and procedures (M&P) and agreement on the process for determining and reviewing discount factors, if implemented on the supply side.
Shorter crediting periods	Can provide greater financial incentive than a corresponding discount rate (same amount of CERs but received sooner).	Similar to discounting, but less effective for project types that require CERs to cover recurrent (e.g. operating) costs once the project is under way (e.g. fuel switch or gas destruction projects). Would require changes to CDM M&P.
Positive lists	Procedure already in use under the CDM. Benefits are indirect only – positive listing would need to increase the share of project activities that have a greater than average net mitigation impact.	Might lead to net negative mitigation impact if positive listing increases the amount of non-additional project activity.
Negative lists	Would reduce non-additional activity and improve net mitigation impact if project types or characteristics can be identified that have a high likelihood of a net negative mitigation impact (e.g. non-additionality, leakage or other concerns). Can be implemented directly by Parties in their use of CERs.	Could lead to significant lost opportunities. May be difficult to reach agreement on clear criteria for exclusion. Would require changes to CDM M&P and agreement on criteria or process for exclusion.
Standardized baselines and additionality	Procedure already in use and being promoted under the CDM.	Effect on net mitigation impact is uncertain, dependent on interaction of baselines with characteristics of a given sector or technology.
Transition to policy- or sector-based crediting	Can reduce transaction costs for individual projects, capture leakage impacts and explicitly account for E-policies. Impact depends on baseline and mechanism design.	Many elements require negotiation. May present significant additional data/ monitoring, reporting and verification requirements. Overlaps with project-based CDM need to be resolved. Other measures may be needed to provide incentives to individual facilities.

Source: Authors' analysis.

The first three options listed in table 19, conservative parameters, discounting and shorter crediting periods, all lead to a generally similar outcome – fewer CERs issued for a given project activity – but with important distinctions. Conservative parameters[64] are employed in CDM methodologies for the calculation of baseline, project or leakage emissions, often where there is significant uncertainty or the potential for bias. In many cases, for example, project proponents are offered the choice between taking on the costs of more precise measurement (and therefore gaining more CERs) and the option of using conservative default parameters (and gaining fewer CERs). For example, as noted above, project proponents can elect to forego the costs of the continuous monitoring of enclosed flares and instead accept the use of a conservative default factor that might yield approximately 5% fewer CERs. While conservative baselines and other parameters may lead to the issuance of fewer CERs for a given project, they are

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[64] The overall principle of conservativeness – the choice of approaches that reduce the chance of overestimation of reductions – is established in the CDM modalities and procedures (UNFCCC, 2002).

often directed towards reducing the issuance of the more uncertain potential CERs and often involve a clear choice by project developers.[65] As a result, they may not necessarily and systematically lead to a net mitigation benefit.

Discounting would involve the multiplication of estimated emission reductions, as calculated using CDM methodologies, by a factor of less than one (UNFCCC, 2008d; UNFCCC, 2008b; L. Schneider, 2009a; Michaelowa, 2008; Kollmuss & Lazarus, 2011; Butzengeiger-Geyer et al., 2010). In contrast to conservative parameters, which are embedded within CDM methodologies, discounting could be applied by either CDM administrators (supply-side discounting) or by Parties in their use of CERs (demand-side discounting) and could be a single value across all CERs or vary based on project type, region, data or project registration or CER issuance, or another parameter. The impact of discounting will differ significantly depending on the level of discount and the characteristics of individual project types. Discounting could be particularly effective in yielding net emission benefits for project types such as HFC destruction at HCFC-22 plants and N_2O destruction at adipic acid plants. Because the combined abatement and CDM transaction costs at these facilities can be less than €1 per CER (TEAP, 2007; L. Schneider, 2011), even with a significant discount projects can continue to operate profitably. For example, a 50% discount would still keep costs below €2 per CER, well below even recent lows in CER prices (€4 per CER). In contrast, for project types where there is greater potential for non-additionality and incremental costs are near the price of CERs, the net mitigation impact of discounting is less clear. To the extent that the level of discounting does not dissuade projects from operating, discounting should have the intended impact of a net decrease in emissions. However, discounting could also reduce the proportion of additional projects. The reduced financial incentive resulting from a discount would dissuade otherwise additional projects from operating, especially where incremental costs approach expected CER revenues, far more than it would dissuade non-additional projects, where the only incremental costs are CDM transaction costs.[66]

Another related option for increasing mitigation benefit is to reduce the length of crediting periods. CDM project participants currently have two options for the period over which their projects can earn CERs: a fixed crediting period of 10 years or a crediting period of seven years that can be renewed twice up to a maximum length of 21 years. Informal Party discussions and published literature have raised the idea of shortening these crediting periods, owing to concerns that additionality and baselines may not be valid for such long periods,[67] thus compromising environmental integrity. For example, for projects that accelerate the adoption of low-emission technology that would otherwise be expected to be taken up without the project, but more slowly, a 10- or 21-year crediting period may have the result of overstating emission reductions. Since crediting period lengths were established in the Marrakesh Accords, any changes to them would require agreement at the level of the COP.

Shorter crediting periods can also be viewed as a variant of discounting, and, similarly, crediting period length can vary based on project type or characteristics such as host country or pace of technological change. In comparison with discounting, which might reduce CER issuance throughout a project's life, the use of shorter crediting periods would leave CER issuance unaffected in the early years, but cause it to be eliminated in later years. Cutting the crediting period in half (e.g. from 10 to five years for fixed crediting periods) would be equivalent to roughly a 50% discount factor in terms of total CERs generated.[68] However, the shorter crediting period approach might be more attractive to investors with high private discount rates, who place much greater value on CER revenues in the early years of project operation. Meanwhile, for projects for which CER revenues are needed to cover recurrent (e.g. operating and maintenance) costs, a project might cease operation after the end of the shortened crediting period and the potential for an increased mitigation benefit would disappear.

While positive and negative lists have typically been considered as means to achieve other objectives, such as reduced transaction costs, improved regional distribution and added technology transfer and sustainable development benefits, they could also be employed to decrease net emissions (UNFCCC, 2008b). Positive lists could help to achieve a net mitigation benefit, if they steered investment towards project types for which the risk of non-additionality is low and for which the CDM methodologies or other options noted above lead to undercrediting. For positive listing to lead to a net mitigation benefit, it would also need to increase project flow by overcoming current barriers to CDM registration.

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[65] The choice to use conservative parameters (rather than more costly measurement) is also made in some cases by national authorities, as in the case of ACM0002, where the DNA may elect to use IPCC lower-bound emission factors rather than develop local estimates.

[66] This point is discussed further in the additionality chapter of the report on the governance of the CDM (Classens, 2012).

[67] While baselines can change at the renewal of crediting periods (for the seven-year renewable option), reflecting methodological revisions, additionality is, in principle, determined for the life of the project.

[68] A variant of this approach could be to only allow the use of a fixed crediting period (no renewals).

Negative listing, or the exclusion of project types with a significant likelihood of non-additionality and/or overcrediting, could indirectly increase the mitigation benefit of the CDM. However, agreement on such project types or circumstances might prove difficult to reach. Unlike positive listing, which the EB can and has implemented, negative listing within the CDM would require agreement at the level of the COP. For example, the Marrakesh Accords put nuclear energy and reduced emissions from deforestation and forest degradation projects on a negative list, and further exclusions would require changes to the CDM modalities and procedures. However, Parties can independently implement their own negative lists or exclusions, as the EU has done in the case of CERs from HFC and N_2O projects after 2012.

Standardized baselines and additionality tests have long been explored as alternatives to the more project-specific approaches used under the CDM (Lazarus et al., 1999) and, if appropriately designed, could offer net mitigation benefits for project types to which they are well suited. For several years, at the request of the COP, the EB has pursued increasing standardization, issuing guidelines for establishing the standards and commissioning research to help develop new standardized methodologies. However, many questions remain regarding their scope and effectiveness, as well as whether and how they will affect the mitigation impact of the CDM.[69]

Transitioning from project-based to policy-based or sector-based crediting is yet another option that could increase mitigation benefits, especially for sectors or project types where significant mitigation potential remains untapped and where such a transition might alleviate concerns over additionality, overcrediting or interactions with domestic policies. As noted above, these concerns have been widely articulated in relation to power sector CDM projects and, indeed, considerable research has been directed towards the exploration of sectoral and nationally appropriate mitigation action (NAMA) crediting approaches in this sector (L. Schneider & Cames, 2009; Ward et al., 2008; IEA, 2009b). As with standardized baselines and additionality, the mitigation outcome of these alternative crediting approaches will, however, be completely dependent on their design and the baselines and crediting thresholds used, which are subject to political as well as technical factors (Baron et al., 2008; Bosi & Ellis, 2005) Transitioning the CDM to alternative crediting approaches for certain groups of emission sources (e.g. sectors) and regions would be likely to require agreements at the level of the COP and coordination with negotiations currently under way under the Ad Hoc Working Group on Long-term Cooperative Action under the Convention to establish a new market mechanism along these lines.[70]

4.5.1 Conclusions on options for enhancing the net mitigation impact of the CDM

In summary, there are several options available to the EB, the COP and Parties that could potentially increase the net mitigation impact of the CDM. Each option carries with it advantages and limitations and may run the risk of missing opportunities for otherwise-additional projects to proceed. The findings of this research indicate the following:

- Discounting may be particularly effective for increasing the mitigation benefits of project types with relatively certain additionality and very low abatement costs (e.g. HFC destruction at HCFC-22 plants and N_2O destruction at adipic acid plants). The use of an explicit discount factor within the CDM would be likely to require approval by the COP, or alternatively can be employed by Parties in their use of CERs.

- The use of conservativeness parameters has the advantage of being a well-established procedure, in wide use by the EB and its panels. While there may be scope to improve upon the use of conservativeness parameters within methodologies, this option may be less suited to broad, explicit efforts to increase the emission benefits of the CDM.[71] Often highly-specific to technical elements of individual methodologies, conservativeness parameters already play an established role in addressing uncertainty in measurement and estimation and guarding against the overestimation of emission reductions.

- Shorter crediting periods may be a more effective option for increasing net mitigation benefits than discounting for project types with higher capital costs (and lower recurrent costs) or where projects are accelerating the pace of technology adoption. Examples could include energy efficiency and power sector projects. This option would require approval at the level of the COP. While it could conceivably be implemented directly by Parties in their use of CERs, it would be likely to be extremely cumbersome to do so.

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[69] This topic is addressed in more detail in the report on the governance of the CDM (Classens, 2012).

[70] See, for example, paragraphs 79–86 of decision 2/CP.17.

[71] In some cases the use of a conservativeness parameter, such as the 'w' parameter in the HFC methodology (AM0001) as discussed above, can function in a similar way to discounting.

- For project types where additionality is highly doubtful, a negative listing or exclusion would be the most straightforward approach; however, agreement at the level of the COP might be difficult to achieve.

- Positive lists, standardized baselines and additionality, and transitioning to policy- or sector-based crediting, could all potentially lead to net mitigation benefits; however, such an outcome would be difficult to predict and highly dependent on design choices (e.g. baseline levels) that have yet to be made.

It is important to note that while all of these options could be considered with regard to the CDM going forward, it would be much more difficult to apply these options to already registered projects. These projects represent 76% of the CERs projected to be issued by 2020 from projects in the current pipeline, as shown in the estimates above. Generally, offset programmes such as the CDM tend to avoid significant changes in crediting methodologies and procedures that apply to already approved projects, since doing so might threaten existing financial arrangements and could undermine the reliability of the mechanism in the eyes of prospective future investors. The renewal of the crediting period does offer an additional opportunity to address mitigation impact and indeed any conservativeness parameters introduced in methodological revisions since the project was registered would automatically apply.[72] Furthermore, Parties can elect to implement some of these options, as the EU has already done in its exclusion of certain types of CERs past 2012, in their use of CERs.

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72 However, introducing new procedures such as discounting might be difficult for the reasons just noted. If such procedures were introduced, to be fair, project proponents could be allowed to revisit the option of electing a 10-year fixed crediting period.

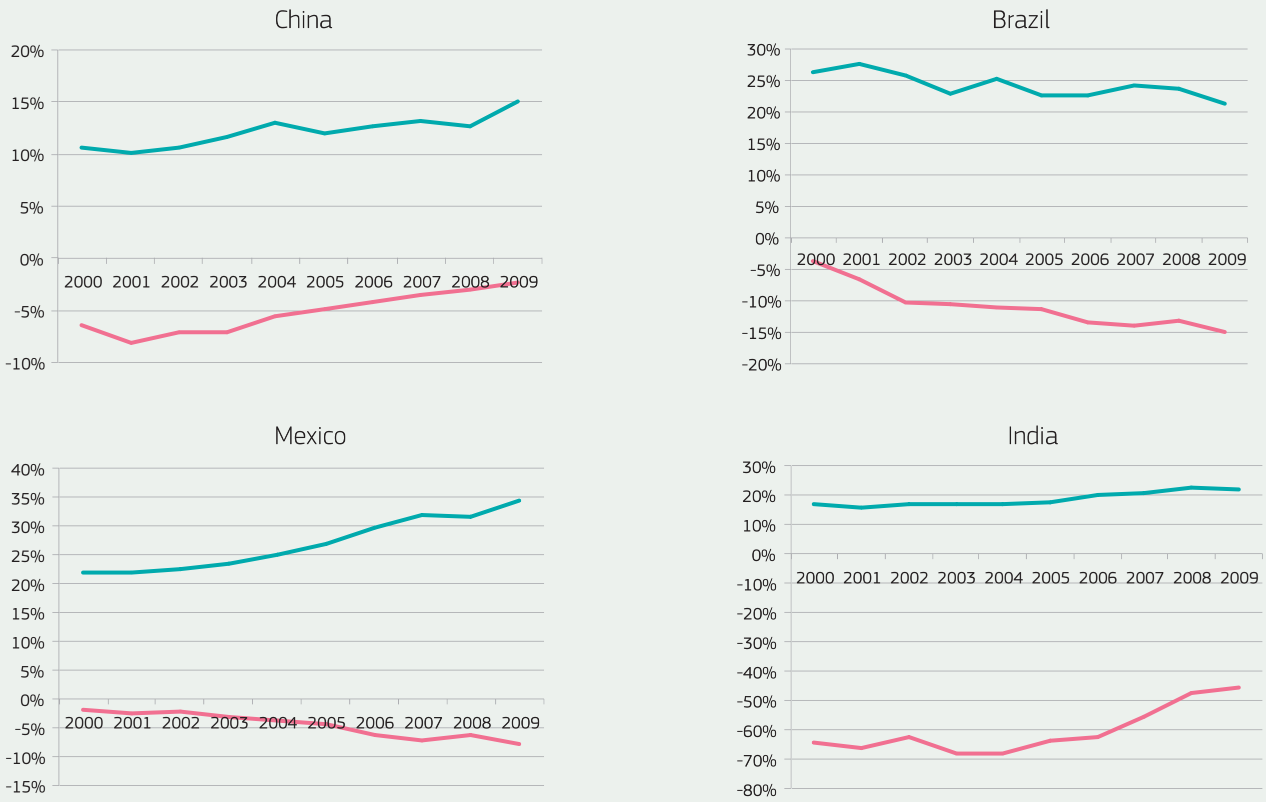
5 Impact on energy security and clean energy investment in developing countries

5.1 Impact on energy security

The concept of 'energy security' has a wide variety of meanings in the literature, but almost always includes issues of supply security. Bazilian et al. (2011) define it as "the uninterrupted physical availability of energy products on the market, at a price which is affordable for consumers". On the supply side, the dependence on imports is clearly an important energy security issue for many countries (Spalding-Fecher, 2003; Togola, 2010). The most important energy security issue in most developing countries, however, is the lack of access to modern energy services for the majority of the population (Bazilian, Sagar et al., 2010; Legros et al., 2009; IEA, 2010).

As one indication of supply security, figure 11 shows the overall dependency on imports of the four most active CDM host countries.[73] China, India and Mexico are all more dependent on imports than they were prior to the start of the CDM, while Brazil's dependence has declined as national oil and biofuel production have increased. In terms of increased access to energy services, there is only one registered grid-electrification project, a handful of small-scale off-grid electrification projects, 10 solar cooking projects and eight improved cooking stove projects – hardly enough to claim a large impact on access to energy services to date.

Figure 11. Imports and exports as a share of total primary energy supply for selected countries



Source: IEA (2011a).

Note: Blue line depicts imports and red line depicts exports.

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[73] While South Korea is actually the fourth most active CDM host country in terms of expected CER issuance up to 2012, it is not included here owing to the significant share of its CERs gained from non-energy projects.

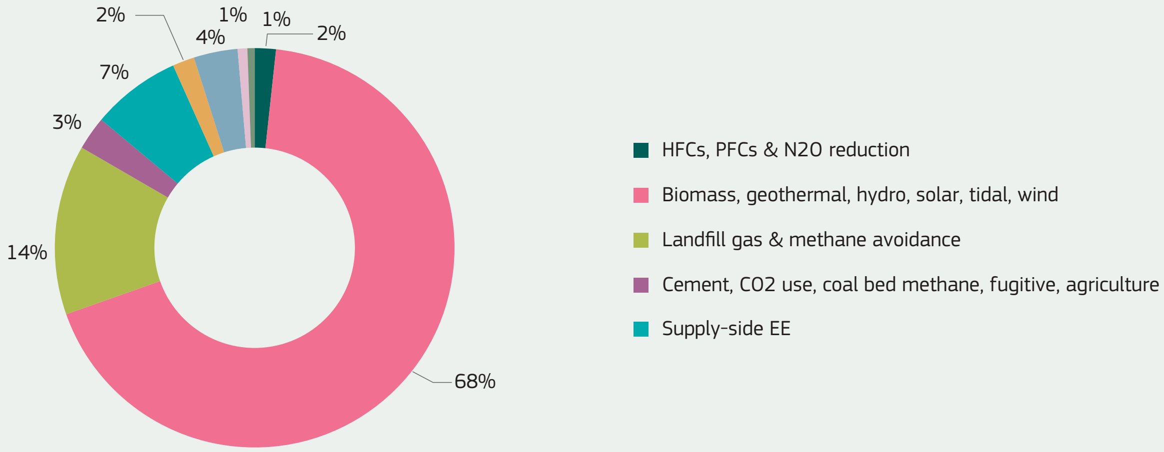
Measuring the impact of the CDM on energy security overall is difficult not only because of the lack of a clear definition of energy security but, more importantly, because of the many other factors that influence the energy sector and the energy trade balance. Natural resource discoveries, international fuel prices, national and global economic growth, and trade policies are all major drivers of energy security and are likely to have more influence than the CDM at an aggregate level. For specific technologies and subsectors, however, it may be possible to say more about the impact of the CDM. CDM projects that increase the use of indigenous resources (both renewable and fossil) or increase the efficiency with which resources are used should contribute to increased energy security, at least on the supply side. The following sections take a closer look at specific energy sector technologies that could have a positive influence on energy security.

5.2 Impact on renewable energy investments

One key way to increase the security of energy supply is to increase the use of domestic renewable energy sources. Renewable energy technologies[74] have been one of the most important CDM project categories, particularly now that many of the industrial gas mitigation opportunities (e.g. HFCs) have been largely utilized. At the same time, the renewable energy markets in many developing countries have grown dramatically since the start of the CDM (REN21, 2012; REN21, 2011). As many of these countries have policies and incentives in place to promote renewable energy, the relevant research question to be answered is: to what extent has the CDM driven the growth of renewable energy markets, as opposed to this growth being primarily driven by domestic incentives and policies? This section therefore presents data on the growth of renewable energy capacity under and outside of the CDM, an overview of the important relevant literature and the views of key stakeholders in this field. This analysis builds on some of the discussion in section 4.2 on additionality.

As figure 12 and figure 13 show, renewable energy projects represent 82% of the projects in the CDM pipeline and 56% of the expected CERs to be issued up to 2020.

Figure 12. Share of projects in the CDM pipeline



Source: UNEP Risø CDM Pipeline (Fenhann, 2012a), as at June 1, 2012.

Note: Includes all projects at validation and beyond; excludes projects withdrawn, rejected or whose validation was terminated.

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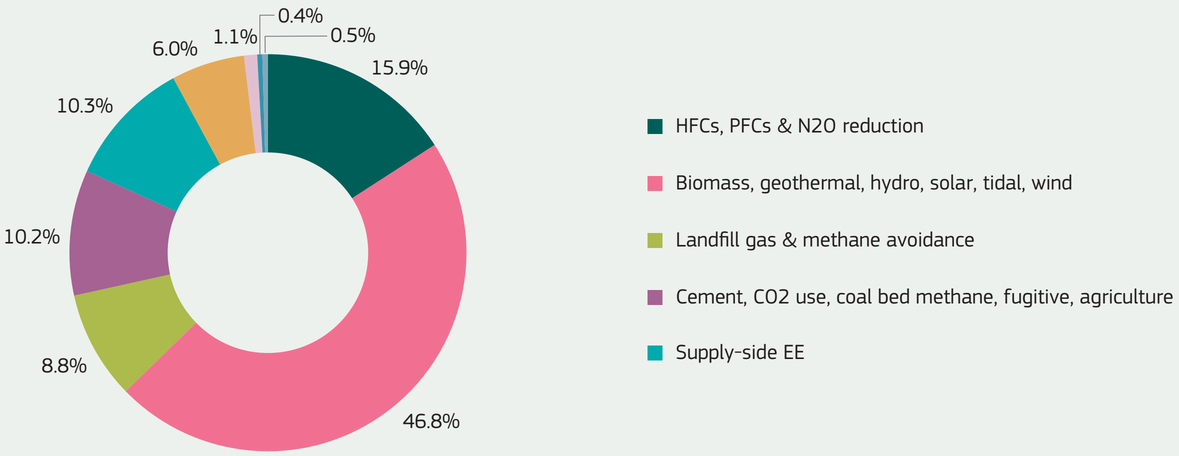
[74] Renewable energy includes the following UNEP Risø project types: biogas, biomass, landfill gas, geothermal, hydropower, landfill gas, methane avoidance, solar, tidal and wind. Landfill gas and methane avoidance are included because more than 90% of these projects report a 'MW electrical capacity' and so are generating electricity. Note that the project category 'transport' includes biodiesel, but there is only one registered biodiesel project to date.

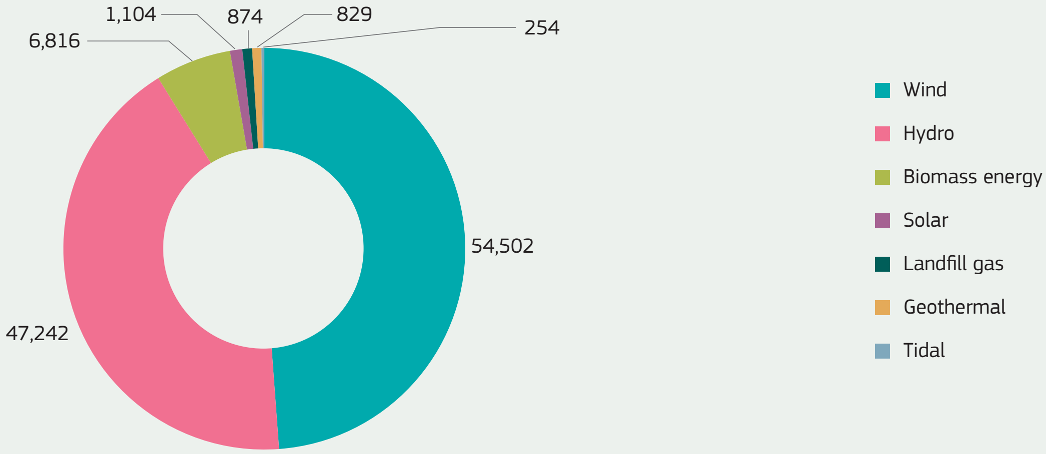
Figure 13. Share of expected CERs issued for projects in the CDM pipeline up to 2020



Source: UNEP Risø CDM Pipeline (Fenhann, 2012a), as at June 1, 2012.

Notes: Includes all projects at validation and beyond; excludes projects withdrawn, rejected or whose validation was terminated. The estimates up to 2020 do not include any risk adjustment.

Figure 14. Electrical generation capacity of registered renewable energy CDM projects (MW)



Source: UNEP Risø CDM Pipeline (Fenhann, 2012a), as at June 1, 2012.

Notes: Includes all projects at validation and beyond; excludes projects withdrawn, rejected or whose validation was terminated. The estimates up to 2020 do not include any risk adjustment.

While renewable energy projects are defined here as including technologies other than electricity generation (e.g. solar water heating, solar cooking and biomass burning for thermal applications), these categories constitute a very small portion of the projects and CERs, so the focus of this analysis is on power generation. Based on the power output reported in the PDDs of registered projects, wind, hydropower and biomass make up more than 95% of the estimated total capacity of registered CDM projects to date (figure 14).[75] The analysis in this report therefore focuses primarily on these three project types, although other project types are discussed briefly as well.

In terms of countries, table 20 shows that China, India, Brazil, Vietnam and Mexico are the countries with the most

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[75] Within these three project types, only seven projects in the registration pipeline do not report MW capacity.

Table 20. Capacity of wind, hydropower and biomass CDM projects in the CDM registration pipeline – top 10 countries

Country	Capacity (MW)
China	78,294
India	11,490
Brazil	4,249
Vietnam	2,944
Mexico	1,870
Chile	971
Peru	822
Georgia	466
Korea	462
Morocco	461

Source: UNFCCC Analytical Database (UNFCCC, 2012b), as at May 15, 2012, for projects with a start date up to May 2012.

Notes: "Registered projects" means projects in the registration pipeline, including request for registration, request for review, under review and registered, but excludes projects rejected, withdrawn or at validation. The three projects in these categories with no reported MW capacity are not included.

capacity in terms of wind, hydropower and biomass power projects installed under the CDM.

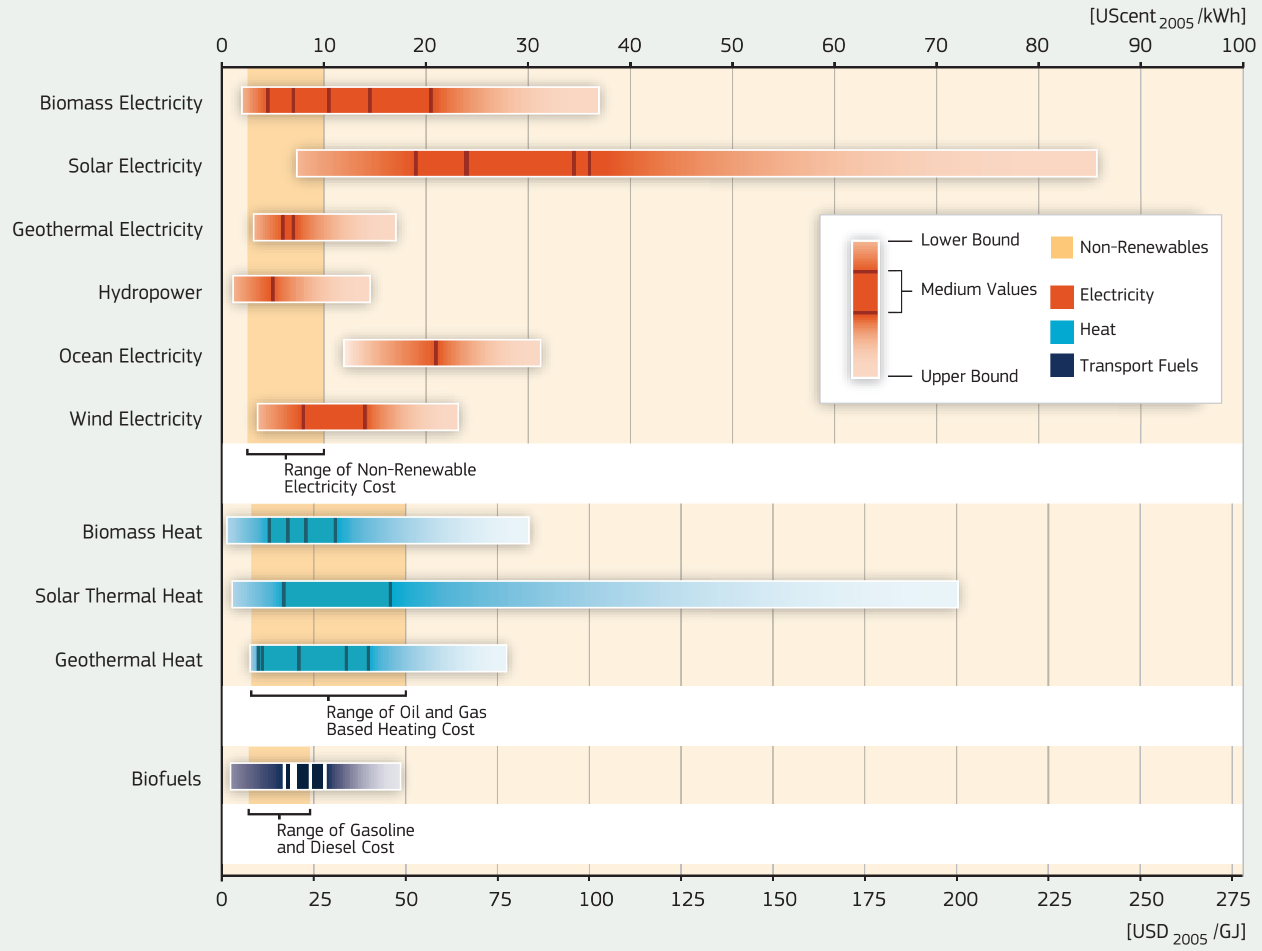
Before turning to the relationship between the CDM and the overall market for renewable power generation, we will look briefly at the underlying economics of large-scale, grid-connected renewable power generation. This builds on the analysis in chapter 4 but focuses more specifically on renewable energy in the context of the major CDM host countries. The questions of causality and additionality (i.e. to what extent the CDM has driven growth in renewable power markets) are related to the underlying economics of these technologies in several ways:

- If the technologies are close to conventional power technologies in terms of levelized costs, it will be more difficult to distinguish which projects are additional and therefore whether the CDM is driving market growth.
- If the impact of carbon revenue on the financial viability of the project is relatively small, then it will also be difficult to distinguish additional projects.
- Finally, if there are large variations in the underlying profitability of the project across and within countries (e.g. because of large variable cost inputs or resource availability), then we could see a share of the total market using the CDM, but would not expect to see the entire market using it, as long as the additionality testing was robust. Even here, however, there could be a problem with the 'signal-to-noise' ratio, if the variability in profitability caused by key cost and revenue inputs is so much greater than the impact of carbon revenue that distinguishing the carbon price 'signal' from the 'noise' of other variability could be difficult.

In terms of the first point, the IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (2011) shows that the average costs of electricity from biomass, geothermal, hydropower and wind are in line with the costs of non-renewable energy sources (see figure 15), while the costs of solar and ocean electricity are almost always much higher. The median cost values for hydropower are well within the cost range of non-renewable energy sources, as are those for onshore wind, biomass co-firing and biomass combined heat and power (see notes below figure 15). This provides some insight into the very low numbers of solar PV and ocean energy CDM projects, since the carbon revenue is insufficient to make up the wide gap in profitability compared with traditional alternatives (see also the impact of carbon revenue on solar PV in figure 17).

In terms of the second point, recent research by the UNEP Risoe Centre, based on actual registered projects, shows that the impact of carbon revenue relative to capital investment is quite small for wind, hydropower and biomass (agro and forest residues) projects, but becomes larger for landfill gas and wastewater capture (both of which are commonly used for power generation in the CDM project pipeline) (figure 16). This is supported by the World Bank (2010b) analysis showing that the typical impact of carbon revenue over 10 years on IRR for renewable energy projects is 1.7% at \$10/tCO_2, while for solid waste projects (including landfill gas to energy) it is 50–60%.

Figure 15. Range of renewable energy costs from IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation



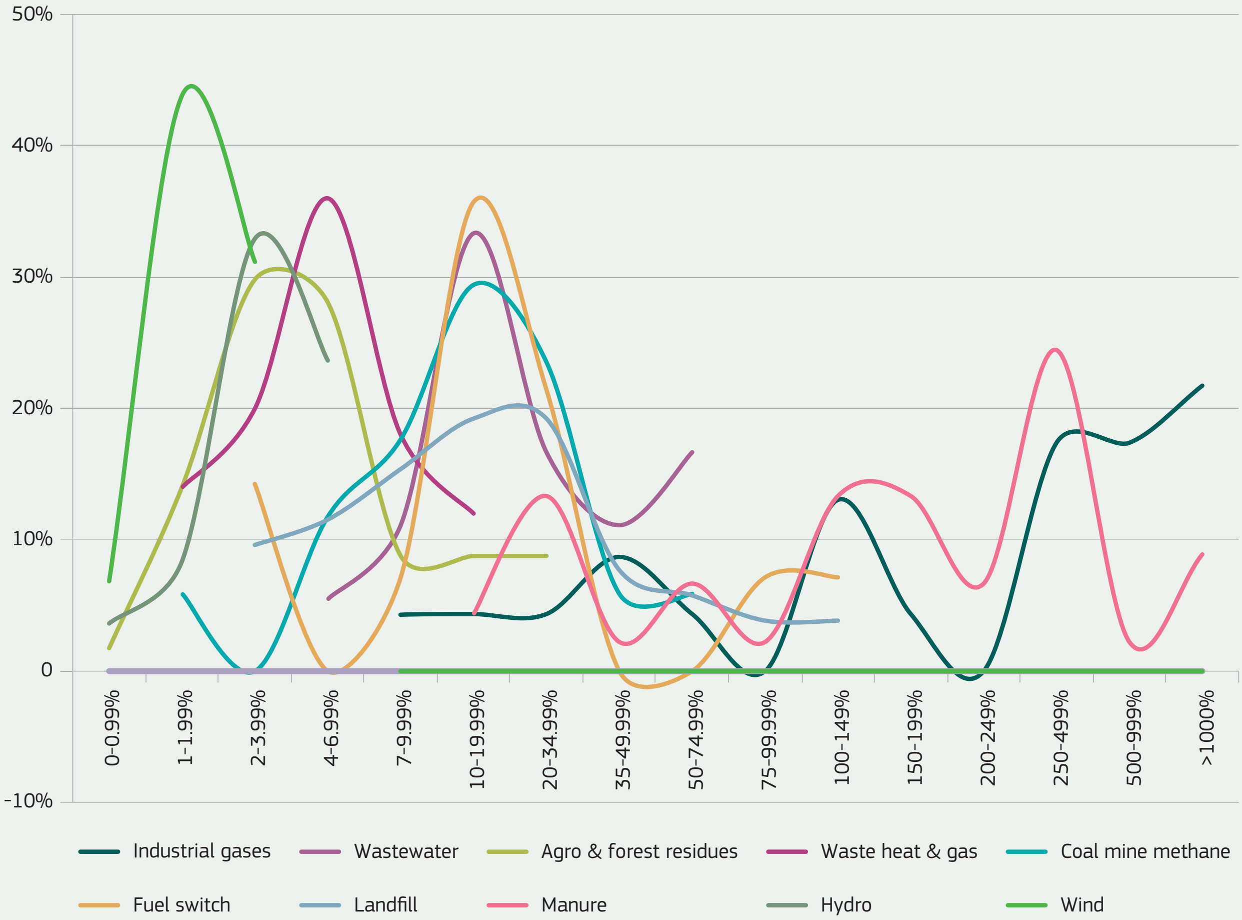
Source: Edendorfer et al. (2011), figure TS 1.9.

Notes: Median values are shown for the following subcategories, listed in the order that they appear in the respective ranges (from left to right): Biomass: 1. Co-firing, 2. Small-scale combined heat and power (CHP), 3. Direct dedicated stoker and CHP, 4. Small-scale CHP (steam turbine), 5. Small-scale CHP (organic Rankine cycle); Solar electricity: 1. Concentrating solar power, 2. Utility-scale PV (1-axis and fixed tilt), 3. Commercial rooftop PV, 4. Residential rooftop PV; Geothermal electricity: 1. Condensing flash plant, 2. Binary cycle plant; Hydropower: 1. All types; Ocean electricity: 1. Tidal barrage; Wind Electricity: 1. Onshore, 2. Offshore.

Finally, on the question of variability of costs across countries and regions, analysis by Schneider, Schmidt and Hoffmann (2010) shows that the impact of carbon revenue on profitability is relatively small for wind, hydropower, biomass and PV, but relatively larger for landfill gas and wastewater. At the same time, regional cost variables have a very large impact on the profitability of wind, hydropower and biomass projects (see figure 17). PV profitability does not vary significantly with local/regional cost variations. While landfill gas and sewage-based power projects are affected to some extent by regional cost variables, carbon revenue is the main driver of increased profitability. The most important regional variable in this analysis is electricity tariffs, which is emphasized in more recent analysis on renewable energy profitability and mitigation cost in developing countries (Schmidt et al., 2012). This suggests that national policies on electricity tariffs for renewable power could be a more important driver of the viability of wind, hydropower and biomass projects than the CDM is.

Given the large impact of carbon revenue on the profitability of landfill gas and wastewater treatment power projects, we would expect the additionality of these projects to be fairly clear and for the CDM to have a significant impact on this technology type. Indeed, the literature and stakeholder inputs that criticize additionality testing almost never mention landfill gas or wastewater treatment projects as having questionable additionality. The concerns in the literature about additionality are primarily about wind, hydropower and biomass projects, which we will now examine in more detail (also discussed in section 4.2).

Figure 16. Annual 'carbon returns on investment' by project type – share of projects with specific carbon returns



Source: Lütken (2012).

Notes: Annual carbon returns on investment calculated as annual CERs x $12/CER / total capital investment. Each x-axis category is a range of carbon return impact, while the y-axis shows the share of total projects within that project type.

5.2.1 Wind power

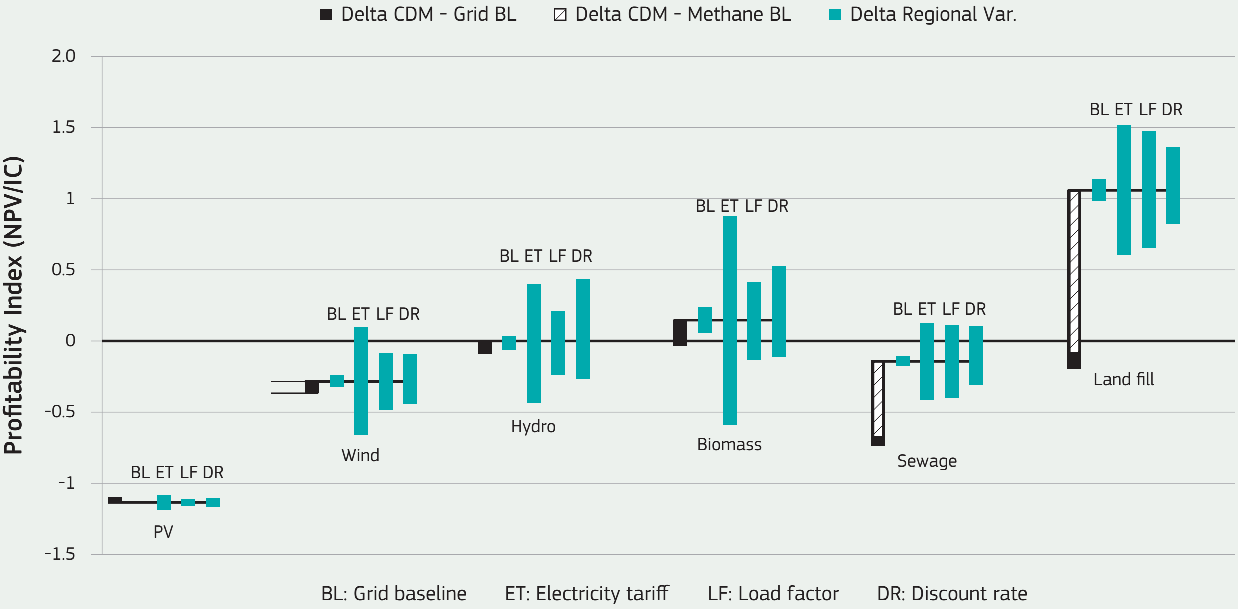
Wind power is the largest renewable energy category within the CDM in terms of installed power generation capacity (see figure 14). More importantly, CDM wind power projects comprise a substantial share of many national wind power markets, sometimes even the entire market. Figure 18 shows CDM project capacity as a share of the installed market capacity for wind power up to the end of 2011. Note that the shares may be greater than 100% because not all registered projects have actually been installed yet (see also Castro et al. (2011) for similar analysis). At the same time, projects only release a monitoring report once they have been operating for a year, so the "operating" column underestimates installed CDM capacity. The actual installed capacity of CDM projects is likely to be between the "registered" and "operating" columns. The column for projects at validation is shown for illustrative purposes only, as some of these projects will neither be registered nor implemented, to show the level of CDM activity in the early project development pipeline.

The growth of the CDM project pipeline and the wind power market over time in these countries shows that in China the growth of CDM capacity and market capacity have been almost identical up to 2010, while in India the market has grown faster than the CDM project pipeline, particularly in the last two years (see figure 19).

Of the top six CDM wind power markets, CDM project capacity covers virtually the entire market for China, Mexico, Morocco and Egypt, but not for India and Brazil (see figure 18).

As discussed earlier, if a renewable technology were far from profitability and carbon revenue had a large impact, then the entire market could well be comprised of CDM projects. This is not the case with wind, however, as the economics are much closer to profitability in many (but not

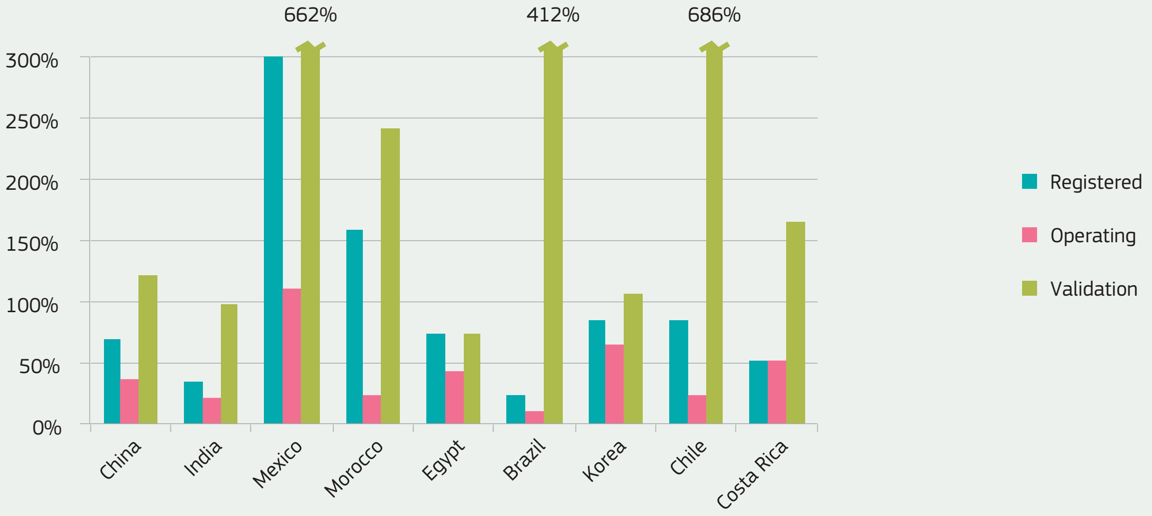
Figure 17. Dependence of the costs of renewable energy technology on regional/national variables



Source: Schneider et al. (2010).

Notes: Black bar shows difference between profitability (measured as net present value divided by investment cost) with and without the CDM based on grid-electricity displacement, while hatched column shows impact of methane avoidance. Grey columns show the variation in CDM profitability due to changes in regional/national variables such as grid emission factor, electricity tariff, load factor and discount rate.

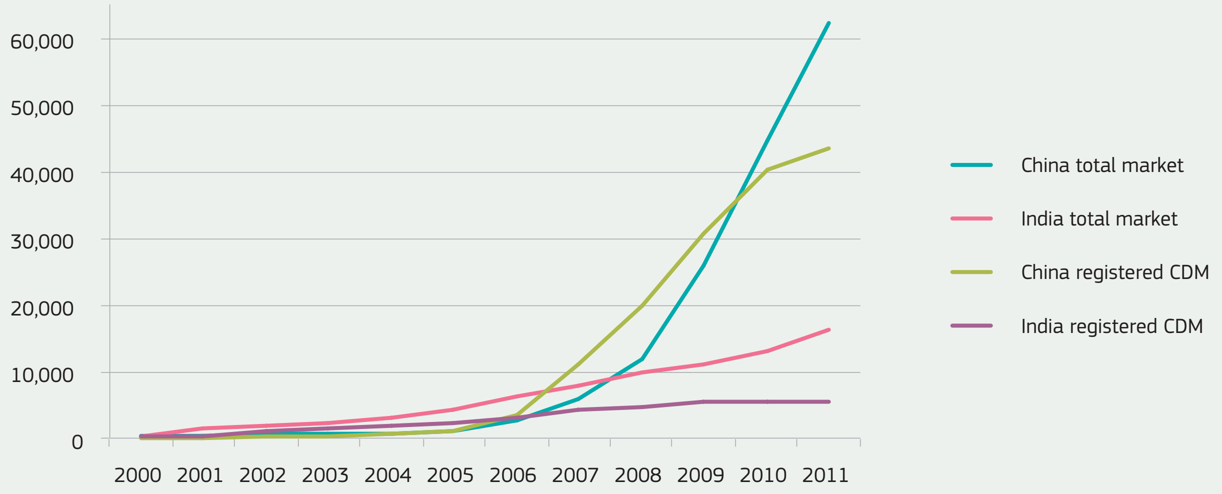
Figure 18. CDM project capacity as a share of total installed market capacity for wind power, 2011



Sources: Data on CDM project capacity from UNFCCC Analytical Database (2012b), as at May 15, 2012. Data on market size from Global Wind Energy Council (2011; 2012).

Notes: Calculated from the total MW capacity for all CDM projects with a start date up to 2011, based on project start date specified in PDD. “Registered” refers to all projects in the registration pipeline, including request for registration, request for review, under review and registered, but excludes projects rejected, withdrawn or at validation. “Operating” means registered projects that have submitted a monitoring report. “Validation” includes all projects at validation or beyond.

Figure 19. Growth of wind power capacity in China and India, total market and registered CDM projects (MW)



Sources: Data on CDM project capacity from UNFCCC Analytical Database (2012b), as at May 15, 2012. Data on market size from Global Wind Energy Council (2011; 2012).

Notes: Year is project start date specified in PDD. Only includes registered projects: request for registration, request for review, under review and registered, but not rejected, withdrawn or at validation.

all) countries and the impact of carbon revenue is far less important than the regulatory regime (i.e. regulated tariffs). What makes the analysis of the impact of the CDM even more difficult is that most of the countries with larger wind power CDM markets also have strong policies and incentives that encourage renewable energy (see table 21). In fact, some researchers have argued that, in practice, CDM revenue has a very limited impact on investment decisions, because of the importance of national regulations and incentives and uncertainty around carbon revenue (Buen & Castro, 2012; Lewis, 2010; Pechak et al., 2011).

The controversy surrounding the additionality of Chinese wind power projects (and other renewable technologies) is therefore not surprising, given the size of the market and the large share of the market covered by the CDM (Castro, 2012). As discussed in chapter 4, Bogner and Schneider (2011) report that virtually all new wind power capacity in China up to 2007 (the latest data available for that study) was registered under the CDM, with Wara and Victor (2008) making the same point about that time period. The concerns raised were both that the data provided in PDDs on feed-in tariffs for wind power were inconsistent and/or incomplete and, more importantly, that Chinese authorities were adjusting (i.e. reducing) the feed-in tariffs so that the wind power projects could all still quality for the CDM (Wara & Victor, 2008; Bogner & L. Schneider, 2011; Lewis, 2010; Wang & Chen, 2010; He & Morse, 2010). The decrease in support, however, could also have been justified by the increasing maturity of the wind power sector and the phase-out of initial, very high, subsidies given to demonstration projects, some of which were supported by official development assistance. In addition, some Chinese authorities could have assumed that the money delivered by the CDM was not conditional upon any assessment of additionality over provincial or national policy and could have taken the opportunity to reduce the tariff without any intention of gaming the system.

In September 2009 the EB noted a declining trend in wind power tariffs in China reported in PDDs. The EB commented that these tariffs had not yet been shown to be an ‘E-policy’[76] and that there was no proof that the reductions were due to the wind power industry becoming more competitive and lower cost (UNFCCC, 2009b, para. 48). Other analysts, however, did not find empirical evidence of declines in tariffs between 2006 and 2009, particularly because of the large variation in tariffs across provinces (He & Morse, 2010). In addition, Wang and Chen (2010), as well as project developers in China, highlight that the tariff reported in the PDD is often higher than what the project owner will eventually receive in the power purchase agreement, and that there had been significant uncertainty in the tariffs during that period. The Chinese DNA wrote a rebuttal of the EB analysis, arguing that the tariffs used by the EB were too high in some cases and not representative (noted in UNFCCC, 2011g). A leading renewable policy expert in China interviewed for this research also noted that capital costs were often higher

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[76] The EB had previously ruled that policies which promote less emission intensive technologies that were implemented after November 11, 2011 (E- policies) did not need to be considered in the baseline selection (see section 4.2 of this report and Buen and Røine (2010)).

Table 21. National incentives to encourage renewable energy in major CDM host countries

Renewable Energy Incentive Mechanisms										
	Feed-in tariff	RPS Quata obligation	Capital subsidies, grants, support	Investment or other tax credits	Sales tax, energy tax, excise tax, VAT reductions	Tredable RECs	Energy production support or tax credits	Net metering	Public investments, loans or financing	Public competitive bidding
CDM Eligible host countries										
1st Tier host countries										
China	🟩	🟩	🟩	🟩	🟩		🟩		🟩	🟩
India	🟪	🟪	🟩	🟩	🟩	🟩	🟩		🟩	
Brazil				🟩					🟩	🟩
2nd Tier host countries										
Mexico				🟩				🟩	🟩	🟩
Chile		🟩	🟩	🟩	🟩				🟩	🟩
Bolivia					🟩					
Guatemala				🟩	🟩					
Hungary	🟩		🟩	🟩	🟩				🟩	🟩
New Zealand			🟩						🟩	
Ecuador	🟩			🟩						
Malaysia									🟩	
Czech Republic	🟩		🟩	🟩	🟩	🟩		🟩		
Nicaragua	🟩			🟩	🟩					
Romania		🟩			🟩	🟩			🟩	

🟪 Provincial/regional application 🟩 In use

Source: Castro et al. (2011).

than anticipated for wind projects and that many firms were losing money during that period, despite claims that the feed-in tariffs were sufficient to ensure profitability.

As a compromise on how to address the tariff issue, the EB tasked the secretariat with updating tariff information from Chinese PDDs for wind projects, so that the highest tariff could be used to judge the validity of the arguments over additionality (UNFCCC, 2011g). A key lesson learned from this controversy is the inherent difficulty (and unreliability) of additionality testing based on understanding the *intent* of the actors involved.

Comparing the Chinese wind power CDM market to other countries' also highlights some important issues. For Mexico, Egypt, Brazil and Morocco, the CDM covers most of the wind power market, although these markets are an order of magnitude smaller than the Chinese one. Interestingly, these markets do not have feed-in tariffs or renewable power obligations, although they have public investment in renewables and fiscal incentives (REN21, 2011). Experts in Brazil contend that the CDM was necessary for wind power because of the dominance of inexpensive hydropower in Brazil and the relatively poor wind speeds. The Brazilian market is maturing, however, with economies of scale driving down costs, and so the CDM is becoming less important. Egypt has not seen any new CDM wind power projects since 2007, while Mexico continues to bring on new projects and has a validation pipeline several times larger than the current installed capacity.

The Indian wind power market evolved differently than the Chinese one (Gangale & Mengolini, 2011) and has relied more on smaller projects than the Chinese market. India, unlike

China, already had some wind power growth prior to the CDM. In the early days of the CDM, the majority of the wind power market did apply for CDM registration. Wind power experts in India argue that, in that phase, most investors did consider the CDM when planning new wind power projects. This shifted over time, owing to confusion in the local market about domestic incentives versus the CDM, problems with the increasing complexity of demonstrating additionality, mounting CDM transaction costs and stricter approval procedures at the DNA. The Indian Electricity Regulatory Commission requires project owners to pass on the benefits from the CDM to their customers, which means that carbon revenue has even less impact on profitability. More recently, even large-scale project developers have been concerned about future carbon price uncertainty, the national policy environment is clearer and most positive for wind power, and the costs of wind power are declining. India has a large domestic wind power manufacturing industry today, with economies of scale all along the value chain for wind power. Because of this, few project developers are now applying for the CDM, even as the market continues to grow. One could argue, therefore, that the CDM provided a necessary boost to the Indian wind power market to make it more sustainable and that this spillover effect has led to market growth beyond the actual CDM projects.

5.2.2 Hydropower

Hydropower is a more mature industry globally than wind or other renewable energy, accounting for 16% of global electricity generation in 2009 (IEA, 2011b). China is the world's leading hydropower producer, with Brazil second and India seventh globally (IEA, 2011b). Most of this capacity is large hydropower production,[77] but small-scale hydropower is also substantial in China, India and some other countries. As table 22 shows, while CDM installed hydropower capacity has a significant market share in some smaller economies (e.g. Uganda, Laos and Guatemala), overall the market share of hydropower CDM projects is much smaller than for wind power. This is partly due to the fact that there was substantial existing hydropower capacity prior to the inception of the CDM, so new capacity additions may be more important.

In terms of new capacity additions, Wara and Victor (2008) show that almost all new hydropower plants in China in 2007 were applying for CDM registration. Bogner and Schneider (2011) show that an increasing share of hydropower plants have applied for the CDM. In 2004 only 3% of the newly installed small hydropower capacity applied for the CDM, while by 2007 that share was 45%. For large hydropower the share went from 0% to 20% over the same period. When the Three Gorges megadam is removed from the 2007 data, however, about *two thirds* of new large-scale hydropower was applying for the CDM. The combination of the high share of the market applying for the CDM, the favourable economics of hydropower in most countries and the small impact of carbon revenue on profitability has led to wide criticism of hydropower projects as not being additional (Haya & Parekh, 2011; L. Schneider, 2009b; Wara & Victor, 2008; Bogner & L. Schneider, 2011; Ruthner et al., 2011).

More recent data show that 2007 was the peak of hydropower CDM registrations in the most active countries. Figure 20 shows the rapid decline in newly registered hydropower CDM projects in the countries with the largest share of CDM hydropower capacity. This is true for the entire hydropower CDM pipeline, with the capacity of newly registered projects falling from 11,215 MW in 2006 to 151 MW in 2011. Even new small-scale CDM capacity fell from 1,338 MW in 2006 to 21 MW in 2011. A major reason for this, however, is increasing delays in validation, meaning that registration may be delayed even for projects that are operational. The actual decline is most likely much less than is shown by the registered project capacity. This is supported by data on the validation pipeline, which still shows significant (and increasing) new CDM applications from hydropower plants (see figure 21).

Experts interviewed in China, India and Brazil have commented that large-scale hydropower is competitive and so not a good candidate for the CDM, but small-scale hydropower often carries a much higher risk, has more variation in costs and may have less policy support (e.g. no feed-in tariff for small hydropower in China), and consequently these markets have been positively affected by the CDM.

Beyond the concerns about the additionality of hydropower projects, stakeholders have highlighted three other major issues in relation to hydropower: the role of hydropower in energy security, local social and environmental impacts and methane emissions from hydropower reservoirs.[78] These concerns were raised in the inputs to the CDM Policy Dialogue[79] and in the research papers to which those inputs referred. On the positive side, stakeholders have commented on the enormous potential for hydropower in many developing countries that has not yet been tapped and on the importance of this resource in providing supply diversity and security. Hydro-

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[77] While the CDM uses 15 MW capacity to define 'small scale', countries have different definitions for their domestic markets, ranging from 10 MW to 50 MW.

[78] The authors acknowledge the useful inputs from Luiza Curado, Sergio Wegue and Claudia Amarante on this topic.

[79] In response to the October 2011 call for inputs to the CDM Policy Dialogue, the following organizations explicitly commented on hydropower projects in their submissions: the Electric Power Research Institute, International Rivers Network, the World Health Organization, Atmosfair, Bárbara Haya and Fundación Rio Napo.

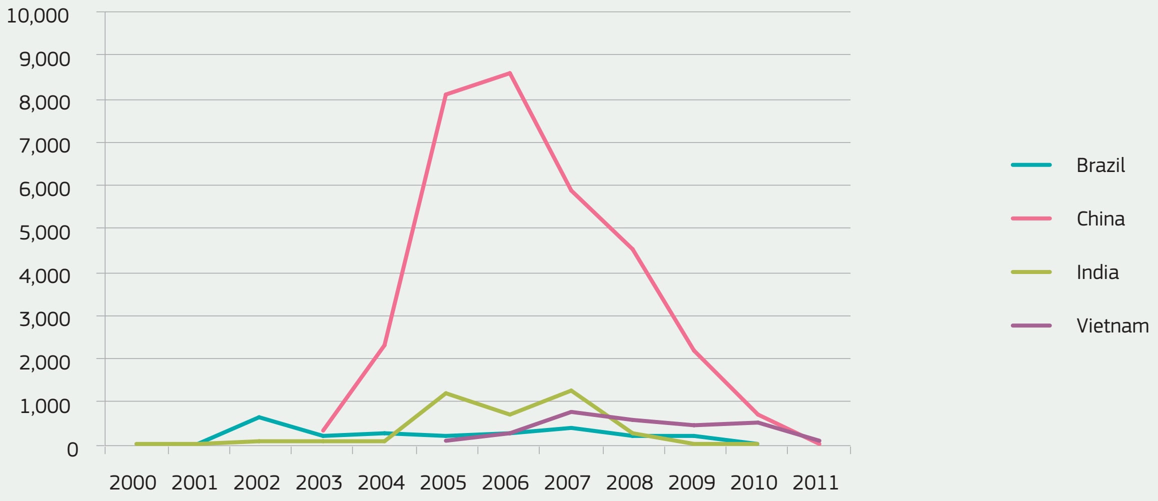
Table 22. Hydropower: total market size and registered CDM projects in selected CDM host countries (MW), 2011

Country	CDM	Total	CDM % total
Total market			
China total	32,743	230,000	14%
India total	3,908	>42,000	9%
Vietnam	1,180	7,400	16%
Brazil	2,561	82,350	3%
Peru	822	3,100	27%
Chile (2010)	546	5,420	10%
Georgia (2009)	466	2,843	16%
Laos (2006)	326	423	77%
Guatemala (2008)	215	777	28%
Uganda	276	560	49%
Mexico	52	11,664	0%
Malaysia	18	5,524	0%
Small-scale only			
China (<10MW, 2008)	3,740	65,000	6%
India (<25MW)	481	3,300	15%
Mexico	22	418	5%
Malaysia	18	38	47%

Sources: Data on CDM project capacity from UNFCCC Analytical Database (UNFCCC, 2012b); data on total market size from REN21 database (REN21, 2011), except Laos (www.energyrecipes.org/reports/genericData/Asia/061129%20RECIPES%20country%20info%20Laos.pdf), China small scale (en.wikipedia.org/wiki/Small_hydro), Peru (www.energyrecipes.org/reports/reports/Peru%20-%20Part%20A%20-%20Country%20info%20-%20070221.pdf), Chile (en.wikipedia.org/wiki/Electricity_sector_in_Chile#Installed_capacity), Georgia (http://ws2-23.myloadspring.com/sites/renew/countries/georgia/profile.aspx), Guatemala (www.energici.com/energy-profiles/by-country/central-a-south-america-a-l/guatemala) and Uganda (www.uetcl.com).

Notes: Years indicate where 2011 market data were not available. Registered CDM capacity and total market are always given for the same year. For total market size, definitions of small scale vary by country. Registered CDM projects only included if the start date specified in the PDD is 2011 or earlier.

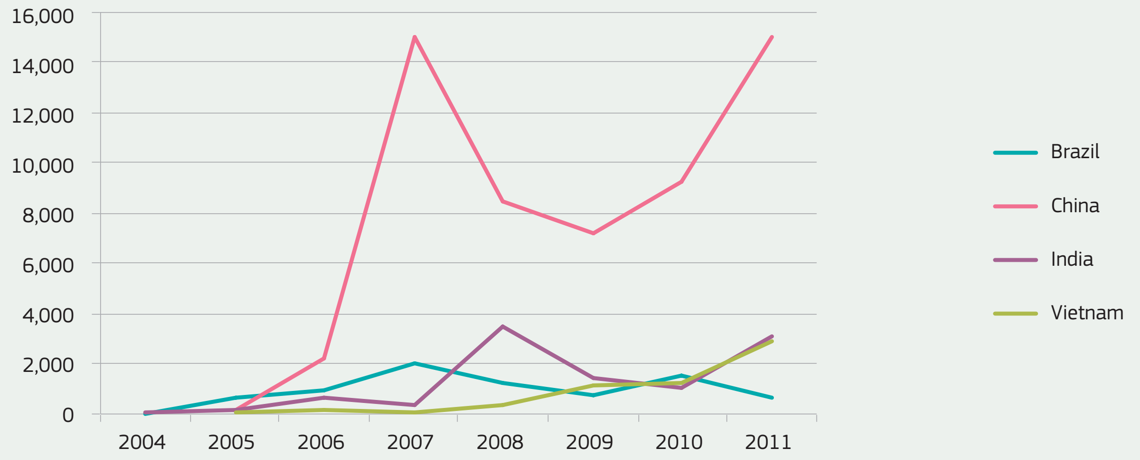
Figure 20. Newly registered CDM hydropower capacity by year for selected countries



Source: Data on CDM capacity from UNFCCC Analytical Database (2012b), as at May 15, 2012.

Notes: Only includes projects in registration pipeline. Year is the project start date specified in the PDD.

Figure 21. New CDM hydropower projects entering the validation pipeline by year for selected countries.



Source: Data on CDM capacity from UNFCCC Analytical Database (2012b), as at May 15, 2012.

Notes: Includes projects at validation and beyond. Year is the start date of validation, not the start date of the project.

power is not only the most widely used renewable electricity source, but can also play an important role in grid stability when complementing intermittent resources such as wind and solar. These stakeholders argue that, as the renewable power source most competitive against traditional fossil fuels, hydropower provides one of the most important and cost-effective low-carbon power sources. The potential for negative social and local environmental impacts, however, is also cited as a major concern. These impacts include the displacement of local communities without compensation or consultation, local ecosystem damage and loss of agricultural land. While the EU has addressed some of these concerns by only allowing access to the EU ETS to hydropower projects following World Commission on Dam (WCD) guidelines (see section 7.6.1), not all stakeholders feel this is sufficient and, in any case, other buyer countries have not taken similar steps. Finally, there is the issue of methane emissions from new reservoirs as a potential negative impact on GHG emissions. While the exact magnitude of emissions from reservoirs is still under debate and varies significantly according to climate and ecosystem, this issue has already been addressed in the principle methodology used for hydropower projects. ACM2 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" includes a leakage penalty for projects with power densities between 4 and 10 W/m^2 and excludes entirely any projects with power densities less than 4 W/m^2.

5.2.3 Biomass

The economics of biomass power plants vary considerably according to the fuel source, scale and technology used (M. Schneider et al., 2010; Edenhofer et al., 2011). Biomass CDM projects have a significant presence in major CDM host countries, but, as would be expected from the economics of this technology, this is not consistent across all countries (see table 23).

The availability and price of fuel is the major driver of profitability for biomass projects, as well as national incentives to encourage renewable energy. Experts in India, for example, explained that, despite early success with biomass CDM projects, supply constraints are hurting existing and new projects, which increases the perception of risk among investors (although this could increase the likelihood of projects being additional). Experts in Brazil note that the change in 2006 of the most important CDM methodology for biomass power, ACM6, to narrow the scope of the methodology and move some other project types to a separate methodology essentially destroyed the market potential in Brazil. The capacity of newly registered projects dropped to zero in 2008, after being at 562 MW over the previous three years, and even the capacity of new projects applying for validation has dropped almost to zero (see figure 22 and figure 23). This may have been due in large part to a mismatch between the applicability conditions of the revised methodologies and the circumstances facing biomass power projects in Brazil. Similar patterns are visible in India and China, where the number of registered biomass CDM projects has declined dramatically in the last three years (see figure 22). However, the validation pipeline in these countries still shows steady growth, suggesting that the decline in registered projects is due to delays at validation and registration and that future CDM capacity increases will be significant (see figure 23).

Table 23. Biomass power: total market size and registered CDM projects in selected CDM host countries (MW), 2011

Country	CDM	Total	CDM % total
India	2,052	3,800	54%
China	1,860	4,400	42%
Brazil	1,334	8,897	15%
Chile	251	183	137%
Malaysia	221	192	115%
Thailand	204	823	25%
Mexico	22	561	4%

Sources: Data on CDM capacity from UNFCCC Analytical Database (2012b); data on total market size from REN21 database (REN21, 2011), except Chile (http://www.osec.ch/sites/default/files/The%20Chilean%20Energy%20Market_Embassy%20of%20Switzerland%20in%20Chile.pdf).

Notes: Registered CDM capacity and total market are always given for the same year. Registered CDM projects only included if the start date specified in the PDD is 2011 or earlier.

Figure 22. Newly installed CDM biomass power capacity by year in selected countries (MW)

Source: Data on CDM capacity from UNFCCC Analytical Database (2012b), as at May 15, 2012.

Notes: Registered CDM projects include those in the registration pipeline and the project start year is that specified in the PDD.

Figure 23. New CDM biomass projects entering the validation pipeline by year for selected countries.

Source: Data on CDM capacity from UNFCCC Analytical Database (2012b), as at May 15, 2012.

Notes: Includes projects at validation and beyond. Year is the start date of validation, not the start date of the project.

5.2.4 Summary on renewable power generation

The impact of the CDM on the renewable energy market has varied significantly across technologies, countries and scales. Projects involving both methane distribution and power generation (e.g. landfill gas and wastewater) make up a smaller share of the total CDM projects but have both been successful at opening up new renewable energy markets and have been less subject to criticism about additionality. For large-scale wind and hydropower, however, the favourable economics without carbon revenue, the limited impact of carbon revenue and the large share of CDM projects in many national markets have led to strong criticism of their additionality. This is not true for all markets; in particular smaller countries may have benefited from the CDM in the terms of the support provided to nascent markets. The other exception appears to be India, where a non-CDM market has continued to grow and the declining share of CDM projects suggests some positive spillovers as the markets mature. Biomass falls somewhere in the middle, with a greater impact of IRR on carbon revenue and widely varying costs across countries and technology subtypes.

Ultimately the challenge with large-scale hydropower and wind is that it will always be very difficult to demonstrate additionality because the ‘signal-to-noise’ ratio (i.e. the impact of carbon versus the influence of other factors on profitability) is so poor. In addition, as He and Morse (2010) point out, using investment analysis for additionality testing makes the fundamental error of applying ‘market analysis’ in a ‘non-market environment’ because tariffs are the main driver of profitability and these are set by national or provincial authorities through regulatory processes.

5.3 Impact on the use of domestic fossil fuels

Most of the most active CDM host countries also have large fossil fuel reserves and a high share of fossil fuel use in the power and industrial heat sectors (IEA, 2011a). Using these fossil fuels more efficiently (either in power stations on within on-site industrial heat and power facilities) and switching to lower-carbon fossil fuels could potentially enhance the security of energy supply. The exception would be if the fuel switch were to an imported fossil fuel source.

Table 24 shows the number of projects, CERs expected and MW installed capacity for the relevant UNEP Risø CDM pipeline project types. The type “EE own generation” is primarily the use of waste heat/gas/pressure for power and heat in industrial facilities. The capacity shown for such projects is the effective capacity added by the project. In essence, these projects are similar to industrial demand-side energy-efficiency projects, in that they make more efficient use of the energy input into the facility by reusing waste energy. The differences would be the scale of investment (i.e. supply-side investments being an order of magnitude or more larger) and the potential lock-in of fuel sources. The latter may also have long-term implications for low-carbon development, since it could influence later national choices to diversify the energy-supply mix.

Other than waste energy use, the largest categories are new natural gas plants and high-efficiency coal power, followed by single-cycle to combined-cycle conversion. The key methodologies are ACM7 “Conversion from single-cycle to combined-cycle power generation”, ACM13 “New grid-connected fossil fuel fired power plants using a less GHG-intensive technology” and AM29 “Grid-connected electricity generation plants using natural gas”. Table 25 shows that India and China have by far the largest share of projects and capacity overall, but Iran is the leader in the single- to combined-cycle conversion category. When the entire validation pipeline is considered, these methodologies are being used by countries with fewer than 10 registered projects, including Iran (eight), Cuba (two), Bolivia (four), Côte d’Ivoire (three), Ghana (zero), UAE (five), Jordan (four), Macedonia (one), Azerbaijan (one), Nigeria (five), Armenia (five) and Dominican Republic (three).

There are several challenges involved in understanding the potential impact of these CDM project categories. As discussed in section 4.2.6, the methodology for high-efficiency coal has come under heavy criticism for potential overcrediting and poor additionality testing, so much so that the EB suspended this methodology in November 2011 pending revisions. Concerns about the use of both high-efficiency coal and natural gas being common practice in most CDM host countries, as well as concerns about policy and market drivers for companies to shift to these technologies even without the CDM, have called into question many project applications. The consequences of non-additional projects are also fundamentally different for fossil fuel versus renewable power projects. Non-additional renewable energy projects weaken the Kyoto Protocol’s overall goals, but they are still part of the low-carbon development trajectory of the host country and send positive economic signals to the

Table 24. Fossil fuel related CDM projects: number, CERs issued up to 2020 and MW capacity

	Registered projects			Projects at validation or beyond		
Project type	**No.**	**ktCO$_2$**	**MW**	**No.**	**ktCO^2**	**MW**
EE own generation	229	373,726	6,312	484	633,274	11,344
EE supply side	33	123,954	20,496	108	492,586	81,091
Cogeneration	9	3,342	84	26	21,556	817
Higher efficiency coal power	7	75,652	17,020	45	327,111	73,897
Higher efficiency oil power				2	30,833	0
Higher efficiency using waste heat	1	1,191	0	5	4,760	0
Power plant rehabilitation	7	717	2	8	775	2
Single cycle to combined cycle	9	43,053	3,390	22	107,549	6,375
Fossil fuel switch	71	385,441	24,202	152	694,859	40,604
Coal to natural gas	5	5,235	0	23	53,500	2,801
New natural gas plant	31	232,643	14,770	57	399,317	24,063
New natural gas plant using liquefied natural gas	9	127,899	8,782	14	200,826	12.230
Oil to electricity				2	65	2
Oil to natural gas	26	19,664	650	56	41,151	1,508
Total	**333**	**883,122**	**51,010**	**744**	**1,820,719**	**133,039**

Source: UNEP CDM Pipeline (Fenhann, 2012a), as at June 1, 2012

Notes: The capacity for EE own generation is the additional effective capacity due to the project. CERs issued up to 2020 based on data from PDDs, without any risk adjustments.

Table 25. Coal and natural gas projects by methodology and country

	Registered projects		At validation or beyond	
Country	**No.**	**MW**	**No.**	**MW**
ACM13	**6**	**16,520**	**42**	**72,897**
India	5	14,520	30	54,910
China	1	2,000	9	15,640
Iran			1	2,162
Argentina			1	100
Brazil			1	85
ACM7	**9**	**3,390**	**18**	**4,390**
Iran	3	2,898	3	2,898
Peru	1	179	2	472
Malaysia	1	110	1	110
Cuba	1	75	2	225
Bolivia	1	68	3	68
Argentina	1	38	2	214
Indonesia	1	22	3	73
Côte d'Ivoire			1	139
Ghana			1	118
United Arab Emirates			1	56
Honduras			1	17
AM29	**40**	**23,552**	**74**	**40,081**
China	25	19,897	31	23,556
India	9	3,015	30	12,921
Jordan	1	300	1	300
Malaysia	1	190	1	190
Indonesia	3	120	4	134
Macedonia	1	30	1	30
Azerbaijan		2	1,286	2
Nigeria			1	650
Armenia		1	480	1
Israel			1	427
Dominican Republic			1	106
Total	**55**	**43,462**	**134**	**117,368**

Source: UNEP Risø CDM Pipeline (Fenhann, 2012a), as at June 1, 2012.

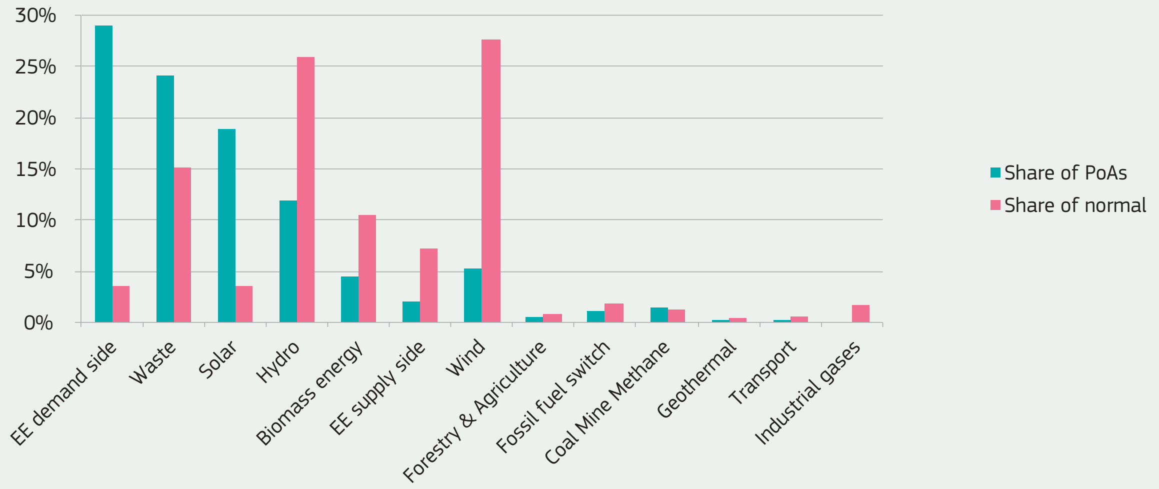
sector, while non-additional fossil fuel projects could send negative signals and lock in the host country to a higher-carbon trajectory (Grubb et al., 2011)

An additional challenge is that some of these projects could be using imported fuels rather than domestic fossil fuel resources. For example, some of the new high-efficiency coal plants in India will be built on the coast and may use imported coal (Remme et al., 2011). Similarly, natural gas plants using LNG as a fuel (a third of planned capacity) may in some cases be using imported LNG. To properly assess the impact of coal and gas power plants on energy security, therefore, would require a plant-by-plant analysis of fuel source for all the plants in the CDM pipeline. In addition, a comparison of CDM capacity with total market capacity growth, similar to what has been presented for key renewable power technologies, would also be important, as some studies have shown that the entire market may be applying for CDM registration in some countries (see section 4.2.6). In addition, it is important to consider the CDM fossil fuel projects in the context of long-term energy sector development plans in the host countries, and whether the lock-in of fuel sources supported by the CDM could preclude future policy choices by the host country (including attracting other climate change finance). This level of analysis was not possible in the time frame of this research for the CDM Policy Dialogue, but requires further investigation.

5.4 Impact on energy efficiency

The success of the CDM in relation to demand-side efficiency has been much less than in relation to renewable energy (Hinostroza et al., 2007; Niederberger, 2008; Tatrallyay & Stadelmann, 2012). As of June 1, 2012, there were only 305 demand-side efficiency projects in the CDM pipeline (i.e. at validation or beyond), with expected CERs up to 2020 of 124 $MtCO_2$. This represents 4% of the projects and 1% of the CERs in the CDM pipeline (Fenhann, 2012a). Most of the approved large-scale demand-side efficiency methodologies have almost no projects, while the small-scale methodologies are used more widely. However, with the growing use of PoAs, we may start to see a shift in this pattern. Demand-side efficiency PoAs constitute almost 30% of the current PoA pipeline, as opposed to 4% of normal CDM projects (see figure 24). One article on the contribution of the CDM to energy efficiency in China notes that in 2008 CDM energy efficiency projects were contributing only 0.14% to China's national efficiency goal (Niederberger, 2008).

Figure 24. Share of PoAs and normal CDM projects, by sector



Source: UNEP Risø CDM Pipeline (Fenhann, 2012a), as at June 1, 2012.

Note: Includes all projects at validation or beyond, excluding rejected or withdrawn projects.

Part of the challenge is that the barriers normally faced by demand-side efficiency are compounded by the CDM rule system (Niederberger & Spalding-Fecher, 2006; Lancaster, 2010). For example, demand-side efficiency projects commonly face a 'split incentives' barrier, where the actor implementing the project (e.g. a building owner) is not the same as the actor who benefits from the energy savings (e.g. the tenant) (Spalding-Fecher et al., 2004). This would be true for the large-scale distribution of efficient lighting and other household appliance technologies as well. Under the CDM, an investment analysis focused on the technology itself may show that it is profitable without carbon revenue, even though the CDM project participant does not benefit directly from the energy savings (Lancaster, 2010; Niederberger et al., 2012). In addition, the monitoring requirements of the large-scale household energy-efficiency methodologies have been too complex and costly for project developers.

Energy-efficient buildings, which are one of the largest areas of global mitigation potential, have not even been touched by the CDM. The reasons for this include the lack of approved methodologies, but, more importantly, the difficulty of monitoring the impact of multiple efficiency interventions while screening out other factors that could influence energy consumption (the 'signal–to-noise' ratio problem again) (Michaelowa & Hayashi, 2011; Michaelowa et al., 2009; Grubb et al., 2011).

Even for energy-efficient lighting, the process has been long and slow (Michaelowa et al., 2009). The only approved large-scale methodology for energy-efficient lighting (AM46) was approved in February 2007 and the first and only registered project was registered in January 2011. Small-scale projects could use a methodology for energy-efficient equipment (AMS II.C) from the start of the CDM, but the first project under that methodology was registered in February 2009 and only five were registered up to June 2012. The breakthrough came in August 2008 with the approval of a methodology for energy-efficient lighting that allowed for 'deemed savings'. In other words, rather than measuring the actual electricity consumption of the lamps, a default value of energy saving per bulb could be used, subject to certain conditions and basic monitoring of the continued operation of the bulbs (Mills, 2010; Schiller, 2011). So far 17 projects and two PoAs have been registered under this methodology, with 33 more projects and 11 PoAs at validation. More importantly, the greatest success story so far is the Indian compact fluorescent lamp (CFL) PoA, "Bachat Lamp Yojana", registered in April 2010. This PoA now has 50 component project activities (CPAs) and is expected to produce 18,179 million CERs up to 2020. By comparison, all of the currently registered conventional CDM projects in the household energy-efficiency category together are expected to produce 12,590 million CERs (Fenhann, 2012a). In other words, this single PoA is larger than the entire group of conventional CDM projects in the same category. The PoA has also had important spillover effects in the Indian market. According to the India Bureau of Energy Efficiency, while the PoA is distributing 25 million CFLs, the total market has grown to more than 340 million CFLs, as a result of the awareness created by the project (ELCOMA, 2011). While this is important progress, the fact remains that, overall, the CDM appears to have had a very limited impact on energy efficiency markets.

6 Impact on technology transfer

6.1 Technology transfer under the Convention and its Kyoto Protocol[80]

Article 4, paragraph 5, of the Convention commits Annex I Parties to “promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention”. This is a key commitment of Annex I Parties, along with a commitment to transfer financial resources to support developing country actions under Article 4, paragraph 7, a commitment to promote and transfer technologies under Article 4, paragraph 1(c), and a commitment to develop processes and mechanisms as part of the implementation of the Convention under Article 10.

While technology transfer is not explicitly included as an objective of the CDM, the preamble to the CDM modalities and procedures notes that “clean development mechanism project activities should lead to the transfer of environmentally safe and sound technology”. Additionally, the original decision on the content of CDM PDDs required project participants to provide: “a description of the project comprising the project purpose, a technical description of the project, including how technology will be transferred, if any, and a description and justification of the project boundary” and a description of the “technology to be employed by the project activity (this section should include a description of how environmentally safe and sound technology and know-how to be used is transferred to the host Party(ies)”.

This chapter assesses the levels and types of technology transfer under the CDM. The research on this topic had three components: (a) an extensive literature review of empirical studies of technology transfer under the CDM; (b) a keyword and textual analysis of a representative sample of PDDs; and (c) an assessment of the degree and type of technology transfer in selected projects from that sample.

6.2 Developments at the Executive Board

The EB launched a call for public input in June–July 2011 on: how to include co-benefits and negative impacts in the documentation of project activities; and the role of the different stakeholders in that process. This implicitly included the topic of technology transfer, because many DNAs consider technology transfer to be a co-benefit of CDM projects. The most recent initiatives to assess technology transfer under the CDM were the two studies commissioned by the UNFCCC secretariat in 2010 and 2011. Unlike sustainable development, for which there is a political process under way concerning how to highlight the co-benefits under the CDM, no similar process has been started specifically focused on technology transfer. [81]

6.3 Technology transfer requirements at the DNA level

DNAs generally define technological benefits of CDM projects using three key criteria:

- Contribution towards the improvement of technologies.
- Technological sustainability.
- Implications of the technology transfer for the host country.

The most frequently used criterion is the contribution of the CDM project to the improvement of the country’s technological base. While some countries require the project to use environmentally friendly technologies that are appropriate to local conditions (Israel, India and Serbia), others

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[80] This chapter is based on a more detailed assessment of technology transfer and the CDM commissioned by the CDM Policy Dialogue (TERI, 2012).

[81] Pedro M. Barata, personal communication dated June 2012.

require the technologies to be the best available and proven (Mali, Uzbekistan and Malaysia). Some countries (Indonesia, Madagascar and Kenya) specifically require the project to ensure that the technologies used are not substandard.

Almost all countries studied in the present analysis identify 'technological sustainability' as a key criterion for CDM projects. While the definitions provided by countries differ, host countries expect the CDM project not only to use appropriate technologies but also to assist in achieving their overall goal of technological self-reliance. The Georgian DNA, which assigns scores to each of its sustainable development criteria, includes decrease in imports as a criterion of technological self-reliance. The DNA states that "when CDM projects lead to a reduction of foreign expenditure via a greater contribution of domestically produced equipment, royalty payments and license fees, and decrease in imported technical assistance, [this] may indicate an increase of technological sustainability". Other countries, like Morocco and Thailand, also stress 'technological autonomy'. Thailand, which also uses scoring indicators, gives a +2 score if the technology utilized is locally developed (which, of course, is the opposite of incentivizing technology transfer).

Furthermore, some countries (South Africa, Mauritius and Brazil) evaluate the replication potential of the employed technology and the project's impact on the diffusion of such technologies within the country. Capacity and skill development, for the community as well as for project workers, are also considered to constitute a contribution to technological sustainability. Transfer of knowledge is an additional criterion that some countries employ (Indonesia and Israel).

While many DNAs provide generic guidelines on the reporting of a project's technological benefits, some DNAs ask for very specific and detailed information. The Peruvian DNA, for instance, asks the project proponent(s) to submit a government-approved technical feasibility study or to demonstrate successful prior experience of the employed technology at a national or international level. While the Thai DNA requires the project proponent to submit a plan for how the project will be sustainable beyond the CDM crediting period.

6.4 Key findings from the literature review

The literature on technology transfer under the CDM is extensive, although, as with sustainable development, relies almost entirely upon registered PDDs as the source of data. The authors of this report surveyed virtually all of the empirical analysis of the CDM's impact on international technology transfer. Except for one study by Schneider et al. (2008), which is also a meta-analysis of previous empirical studies, all other studies were based on an analysis of the information contained in registered PDDs. The most recent UNFCCC (2011a) study also examined registered POAs.

The different studies surveyed, while relatively recent, were carried out at different times and are therefore not completely comparable. Not only have different definitions of technology transfer been used in the studies, the number of projects examined varies, with a few studies also including site visits and a follow-up survey/questionnaire given to various stakeholders. In addition, the UNEP Risoe classification of project types has been revised since 2008 from 21 to 25, so earlier studies have adopted a slightly different project categorization. Requirements for reporting on technology transfer in PDDs have also changed over time (see section 6.2).

6.4.1 Methodological choices in previous studies

While some of the studies mention chapter 34 of Agenda 21, "Transfer of Environmentally Sound Technology, Cooperation & Capacity-Building", most studies refer to the IPCC's (Metz et al., 2000) definition of technology transfer.[82] In its simplest form, international technology transfer has been defined as the import of a technology that is not currently available in the host country. Cools' (2007) operational definition of technology transfer comprises four key elements:

- Foreign origin.
- Degree of novelty (e.g. new to the market, province or specific industrial sector).

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[82] The IPCC defines technology transfer as a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private-sector entities, financial institutions, NGOs and research/educational institutions. According to the IPCC, technology transfer comprises the process of learning to understand, utilize and replicate the technology, including the capacity to choose it and adapt it to local conditions and integrate it with indigenous technologies. This transfer could be on purely commercial terms or on preferential terms.

- Capacity-building (e.g. enhancing the ability to manufacture, operate, maintain and master new technologies).
- Performance improvement (e.g. improved environmental performance, either in terms of more efficient GHG emission reduction or the capacity to generate more CERs compared with existing technologies).

The operational definition from the "EU China CDM facilitation project" is also used in the analysis conducted by the research team presented in section 6.5.

Most of the assessments have primarily included the screening of PDDs, ranging from 63 to 4,984 projects. One study used both a PDD textual analysis and an econometric analysis to analyse the drivers of technology transfer (Dechezleprêtre et al., 2008). A few studies followed up the PDD analysis with surveys of project owners or other stakeholders, or site visits.

6.4.2 Broad trends in technology transfer

According to a study commissioned by the UNFCCC in 2010 (UNFCCC, 2010c), 30% of all projects in the CDM pipeline involve technology transfer, accounting for 48% of the estimated emission reductions. However, the share of projects involving technology transfer could be as high as 44% of all projects, because 24% of the PDDs do not specify whether technology transfer occurs and the survey results suggest that 60% of these may in fact involve technology transfer.[83] The same study showed that the share of projects involving some form of technology transfer appears to have declined between 2007 and 2008.[84] In addition, Seres et al. (2009) found that the frequency of technology transfer claims had declined as a share of the emission reductions but appeared to be relatively stable as a share of the projects. According to their study, the overall share of projects claiming technology transfer fluctuated between 34% and 39%, but the share of the total emission reductions covered by those projects had declined from 66% to 59%. The shares of different types of technology transfer (e.g. equipment and knowledge, equipment only or knowledge only) are relatively stable at 54%, 32% and 14%, respectively. In addition, the shares of the sources of technology, both knowledge and equipment, have remained quite stable over time. Das (2011) estimated that 27% of projects have been found to comply with a narrower definition of technology transfer,[85] accounting for 46% of the emission reductions. Of this 27%, almost all involved imported equipment, accompanied by training in operations and maintenance, with no further capacity-building or technology development ('type III' technology transfer, see footnote 113). Less than 1% of all projects included collaborative technology development or local technology innovation.

Technology transfer is generally associated with larger projects across all project types (UNFCCC, 2010c). Although unilateral and small-scale projects are less likely to involve technology transfer, it is more common among the larger of these projects. 27% of unilateral projects and 25% of small-scale projects involved technology transfer (UNFCCC, 2010c).

In terms of technologies, Dechezleprêtre et al. (2009) found significant differences in relation to technology transfer between two groups of projects. The first group, with generally higher technology transfer rates, comprises the end-of-the-pipe destruction of non-CO_2 GHGs such as HFC-23, CH_4 and N_2O (e.g. chemical industry, agricultural sector and waste management). The second major group comprises primarily energy sector projects. In particular, biomass and industrial energy-efficiency projects tend to use local technologies. Wang (2010) also found high levels of technology transfer, both in terms of equipment and training, in N_2O and HFC-23 decomposition projects. Das (2011) found higher levels of technology transfer for agriculture, and lower levels for hydropower, cement, fossil fuel switching, biomass and energy efficiency.

In terms of countries, some authors find that technology transfer rates are declining steeply over time in India, Brazil and China, but more slowly in other countries. This is attributed to the higher levels of technological capabilities in the former three countries, meaning that technology transfer, particularly for large-scale renewable power generation, becomes less and less necessary over time.

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[83] In the 2010 study a survey of the projects that had been covered by the 2008 study was conducted to verify the type of technology transfer involved. 370 project developers responded to the survey.

[84] The 2007 and 2008 studies showed technology transfer in 39% and 36% of projects, respectively, accounting for 64% and 59% of estimated emission reductions, respectively.

[85] If a CDM project involves a technology and/or equipment import only, it is not considered to be a case of technology transfer in the Das (2011) study. Only when such an import is found to contribute towards technological learning and capability-building in the host country in some form or another is it defined as technology transfer. A CDM project is considered to contribute to technology transfer under the following three scenarios: type 1: a host-country entity develops a technology, specifically for a CDM project, in collaboration with some foreign entity; type II: a technology and/or equipment import is accompanied by in-house technological efforts by the host-country project participant towards adapting or improving upon the imported technology/equipment; type III: a technology and/or equipment import is accompanied by the training of local entities on the operation and maintenance of the imported technology and equipment.

Das (2011) found that projects implemented by subsidiaries of multinational corporations based in Annex I countries or joint ventures with firms in Annex I countries are more likely to include technology transfer. The parent company may facilitate technology transfer by managing the CDM project registration, providing expertise or providing access to capital, among other aspects. Projects with international consultants, who may even serve as technology suppliers, are also more likely to include technology transfer. The same is true for projects with an identified CER purchaser from an Annex I country at registration.

Dechezleprêtre et al. (2008) found that the impact of local technological capabilities on technology transfer is ambiguous. On the one hand, high technological capabilities may be necessary to adapt a new technology (e.g. in the energy sector and chemicals industry); on the other hand, high domestic capabilities may also imply that many technologies are already available locally (e.g. agricultural sector).

In addition, host-country policies can have an impact on the rate of technology transfer (TERI, 2006). This could be through listing technology transfer as one of the sustainable development national criteria for evaluating CDM projects, which could include preferences for cleaner, locally appropriate, more efficient and environmentally friendly technology, or requirements that the project contributes towards improving the local technology base. Finally, host countries may identify and dismantle barriers that continue to block CDM activities in specific sectors.

In summary, the literature cites a range of impacts on technology transfer: from the CDM contributing “significantly” towards technology transfer (UNFCCC, 2010c), through technology transfer taking place in less than half of the CDM projects (Dechezleprêtre et al., 2008), to technology transfer being minimal (Das, 2011). Importantly, the latter study uses a more stringent benchmark for establishing technology transfer than all of the other studies.

6.5 Analysis of reporting on technology transfer in PDDs

As with sustainable development impacts, a new PDD textual analysis in relation to technology transfer was conducted for this study. This section explains the methodology for and results of that analysis.

6.5.1 Methodology for PDD analysis

For the PDD textual analysis in this study, the authors used two definitions of technology transfer: the definition from the IPCC Working Group III Report on “Methodological and Technological Issues in Technology Transfer” (Metz et al., 2000) and the definition developed by Cools (2007) (see section 6.4.1 above for definitions). Several PDDs claimed a technology transfer from one region to another within the same host country, or from one developing country to another. While this is acceptable to certain DNAs, the focus of this analysis was strictly on international technology transfer from developed countries to developing countries.

The sample selection for the analysis is explained in section 3.4.1. The analysis covered technology transfer at two levels. The level I analysis identified projects with an element of international technology transfer (i.e. North–South transfer of technology) by screening the text of the PDD for specific keywords related to technology transfer. This approach excluded South–South transfers and the use of state-of-the-art indigenous technologies. The level I analysis typology used for projects was the following:

- Type 1: Project will not involve technology transfer.
- Type 2: No mention, indication or evidence of technology transfer.
- Type 3: Project expected to involve technology transfer:
    a) The project will use imported equipment;
    b) The project will use imported knowledge;
    c) The project will use imported equipment and knowledge.
- Type 4: Joint venture/collaborative development of new technology with foreign venture partner.
- Type 5: Origin of technology is unknown/unspecified.[86]

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[86] Seres (2009) states that often the source is not known because the technology supplier for a proposed project has not yet been selected; thus the source remains unknown for about 20% of the projects that claim technology transfer.

For the level II analysis, the following elements were used to categorize projects:

- Foreign origin: technology originates from one or more Annex I countries.[87]
- Novelty: new to market, province or specific industrial sector.[88]
- Technology improvement: improved environmental performance either in terms of more efficient GHG emission reductions or the capacity to generate more CERs compared with existing technologies.
- Capacity to operate and maintain the technology.

6.5.2 Results of PDD analysis

As table 26 shows, more than a quarter of all projects in the sample included some form of technology transfer. The most common type was transfer of both equipment and knowledge. The origin of the technology was specified for most, but not all, of the projects claiming technology transfer.

Some additional findings from the level I analysis include:

- Origin of technology transfer: The leading countries transferring technologies or facilitating the transfer of technologies were Japan, Germany, the USA, Denmark, Italy and the United Kingdom.
- Project type: The highest incidence of technology transfer was reported for methane avoidance projects, followed by energy efficiency in industry projects. The afforestation and reforestation and coal bed/mine methane sectors reported no technology transfer. Wind projects also have a substantive share in international technology transfer.
- Project scale: Technology transfer was reported for a larger share of small-scale projects.
- Regions/countries: Asia (excluding China and India) dominates with 20 projects including technology transfer (9.90%), followed by Latin America and the Caribbean, except Brazil, with 10 projects (4.95%), Africa with three projects (1.48%) and Eastern Europe with one project (0.49%).
- Among China, India and Brazil, the shares of projects involving technology transfer are China nine projects (4.45%), India seven projects (3.46%) and Brazil four projects (1.98%).
- Technology mismatches: There were instances where there was a mismatch between the imported technology and local conditions. For example, in the case of

Table 26. Results of the level I analysis, based on five typologies

Typology		No. of projects
T1	No technology transfer	148
T2	No mention or indication of technology transfer in the PDD	2
T3	Expected to involve technology transfer	48
	a) equipment only	*12*
	b) knowledge only	*0*
	c) both	*36*
T4	Collaborative development of technology	2
T5	Technology transfer confirmed but origin unknown/unspecified at the time of writing the PDD	12
Results	Projects with more than one typology	10
	Total projects with technology transfer in the sample (T2+T3+T4+T5)	54
	Total projects in the sample (T1+T2+T3+T4+T5)	202

Source: Authors' analysis.

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[87] Where no details on the origin of the technology were provided, the project was considered to involve no technology transfer.

[88] Novelty was based on three criteria: uncommon in the host country, uncommon in more industrialized countries, or not commercialized even in the supplier country.

the “Retrofit programme for decentralized heating stations in Mongolia”, although the boiler was specifically developed for the CDM project, the Mongolian coal was not suitable. In the case of the “Municipal solid waste composting project in Urumqi, China”, the imported machinery did not match the municipal solid waste characteristics in China, where all types of waste are collected together and mixed.

- Technology development specifically for the CDM: In some cases, there was technology specifically developed for the CDM project. In the case of hydropower in China, all of the technology was domestic. In the case of waste heat utilization in China, the domestic technology was less reliable. Similarly, in the case of China, there was a lack of proven domestic technology, thus necessitating technology transfer for HFC-23.

The level II analysis used the same sample and applied the operational definition of technology transfer discussed above. The key findings were as follows:

- Foreign origin: 72% of projects demonstrated the foreign origin of the technology, while 28% did not specify the country of origin of the transfer.

- Novelty: The technology would be deemed novel by the above definition for 66% of the projects. One project reported that the technology transferred was not widely commercialized at the point of project development, even in the supplier country.

- Technology improvement: 98% of the projects showed improvement in environmental performance, either in terms of more efficient GHG emission reductions or the capacity to generate more CERs compared with existing technologies. Such a result is predictable considering that GHG emission abatement, reduction and avoidance are required for CDM projects.

- Capacity to operate and maintain the technology: 65% of projects reported capacity-building for operation and maintenance. In some cases the need for capacity-development was identified but specific actions were not reported. Most projects reporting capacity-building also reported novel technologies.

Additional findings on trends included the following:

- Regional trends: Asia (excluding India and China) dominates in relation to all four dimensions of technology transfer.

- Sectoral trends: The distribution was similar across most sectors. Methane avoidance projects (project type 18) have most frequent mention of novel technologies and the capacity to operate and maintain them. Interestingly, this sector also has many projects where mention of the origin of the technology is not clear/not identified. Wind projects have the most frequent mention of technology transfer from foreign countries.

6.6 Options for enhancing technology transfer

Several actions could be taken to improve the transparency of technology transfer benefits and to enhance this impact of the CDM:

Improved database and data availability would involve the UNFCCC improving the way in which data are generated from the large number of projects in the pipeline and presented. A database could be created with more information on technological specifications and the name of the technology supplier or technical project developer provided in the PDDs. This may further facilitate technology transfer for new entrants.

Improved reporting on technology transfer could address the issue of the limited information on technology transfer currently provided in PDDs, which is often inadequate in detail and lacking in consistency. There is a need for more comprehensive and clear information on technology transfer, to enable decision-making by DNAs. This would most probably require a revision to the PDD format and guidance.

Guidance from DNAs could assist by providing a clear and more operational definition of technology transfer in the project approval process. The host countries could also influence the extent and nature of technology transfer by including technology transfer within their sustainable development criteria, defining the criteria or indicators of technology transfer clearly and implementing these criteria stringently.

7 Financing for CDM projects

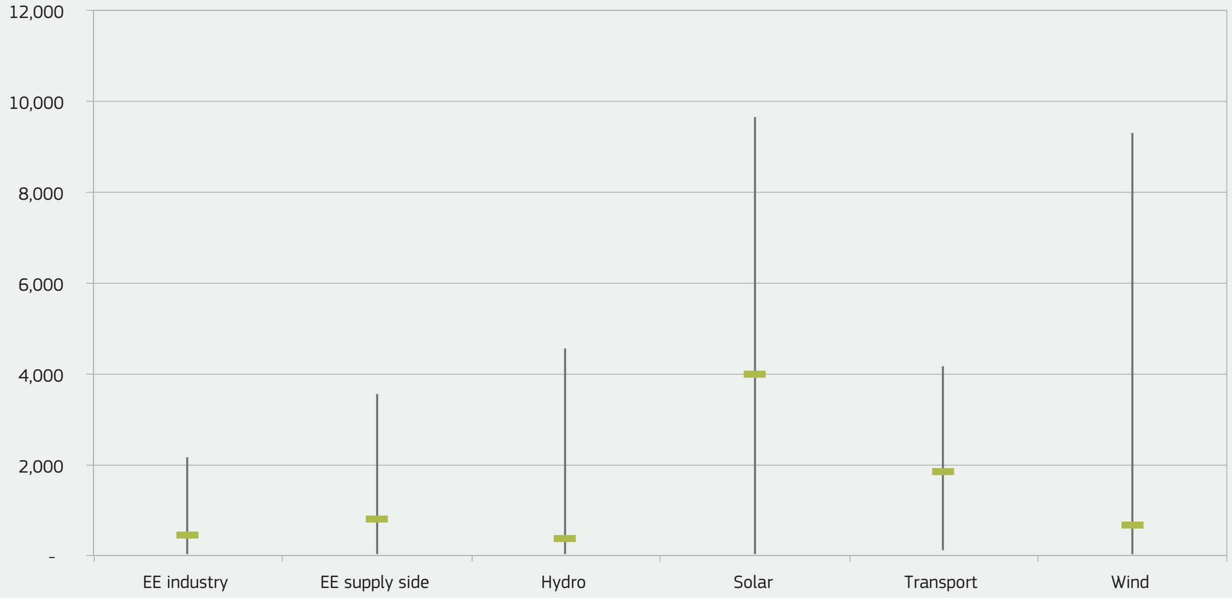
In this chapter the total investment in CDM projects by year, project type and host country is estimated. Geothermal, hydropower, solar and wind CDM projects are compared with similar projects in Annex I countries in terms of average size (MWe), capital intensity ($/MWe) and average investment. The share of foreign investment is also compared for those CDM and Annex I projects. The sources of foreign investment and the types of finance (e.g. debt or equity) for the CDM projects are documented. Finally, barriers to investment in CDM projects are discussed.

7.1 Total investment leveraged by the CDM

A project proponent may include the expected capital investment in the PDD to help demonstrate that the project is additional. Historically, about 69% of proposed projects include the capital investment as part of their investment or barrier analysis. In these cases the expected capital investment is reviewed by a DOE during the validation process. However, information on how closely these estimates correspond to the actual capital investment is not available.

Extrapolating the data on estimated capital costs from PDDs to cover all projects yields an estimate of the total investment in CDM projects. Since all PDDs include the expected annual CO_2e emission reductions, the estimated capital cost per tonne annual CO_2e reduced is a convenient metric for such an extrapolation.[89] The estimated capital cost per tonne annual CO_2e reduced differs significantly by project type, as shown in figure 25 and figure 26, so the extrapolation must be done by project type. The average ranges from \$9/tCO_2e for N_2O projects to \$4,004/tCO_2e for solar projects. Applying these averages to the projects that do not include an investment analysis is a simple way of estimating the total investment (Fenhann, 2012a).

Figure 25. Capital cost per tonne of emissions reduced annually, by project type ($, average, maximum and minimum)



Source: Authors' calculations based on the estimated capital investment and expected annual tonnes of CO_2e emissions reduced as stated in the PDDs for 2,860 registered or soon-to-be registered projects as of June 2012. The average capital cost per tonne of annual CO_2e reduced is the sum of the estimated capital investment for the projects of a given type divided by the sum of the expected annual emission reductions for those same projects. The minimum and maximum capital costs are determined from values calculated for individual projects.

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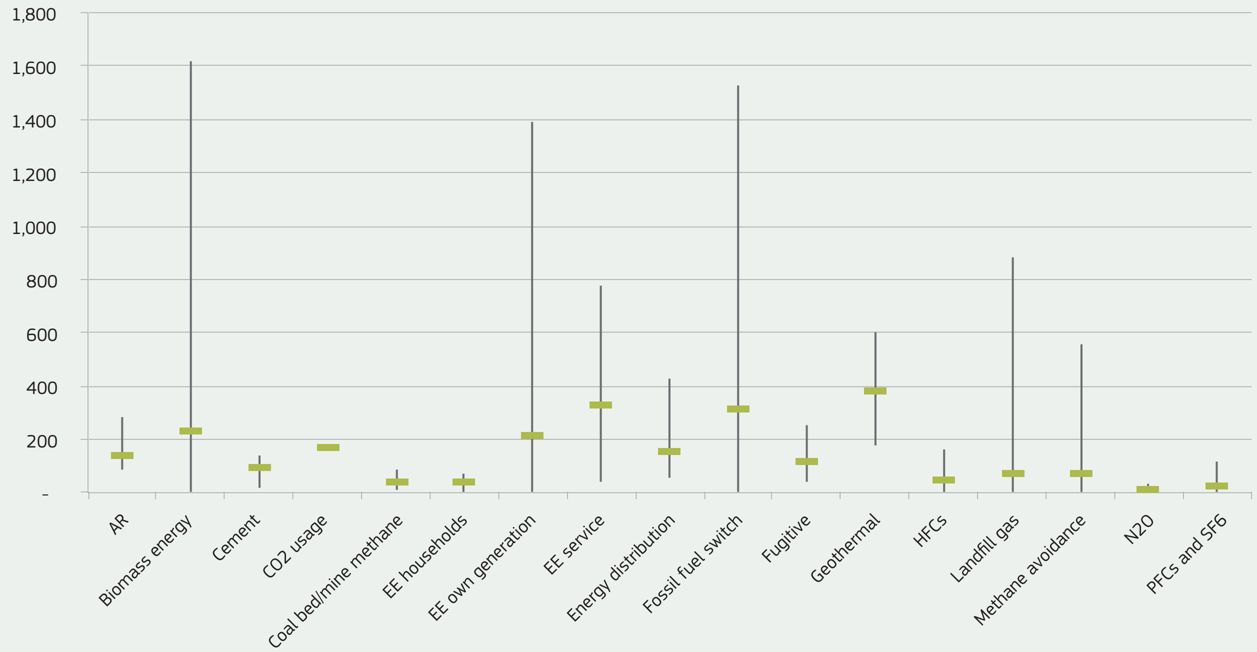
[89] This metric is expressed as \$/tCO_2e but should not be confused with project abatement cost, which is expressed in the same way but is calculated and interpreted very differently.

Figure 26. Capital cost per tonne of emissions reduced annually, by project type ($, average, maximum and minimum) (continued)



Source: Authors' calculations based on the estimated capital investment and expected annual tonnes of CO_2e emissions reduced as stated in the PDDs for 2,860 registered or soon-to-be registered projects as of June 2012. The average capital cost per tonne of annual CO_2e reduced is the sum of the estimated capital investment for the projects of a given type divided by the sum of the expected annual emission reductions for those same projects. The minimum and maximum capital costs are determined from values calculated for individual projects.

The estimated capital investment has been compiled or estimated for 4,832 projects – 2,349 operational projects,[90] another 1,875 registered projects and a further 608 projects expected to be registered shortly. Capital investment estimates from the PDDs for 2,860 of those projects total $147.7billion. When the capital investment for the other 1,972 projects is estimated the total investment in CDM projects amounts to $215.4 billion.[91] Of that total, the investment in operational projects is $92.2 billion, $87.6 billion for other registered projects and $35.5 billion for projects not yet registered. Although a few registered projects will never be implemented, most of the other registered projects were registered recently but have not yet submitted their first monitoring report. Investment in CDM projects is dominated by investment in wind and hydropower projects (see annex C).

The estimated investment in CDM projects by year is shown in figure 27.[92] Annual investment probably peaked in 2008, at between $13.9 (operational projects) and $40.4 billion (all projects). As expected, the investment in registered and soon-to-be registered projects declined sharply thereafter, owing to the time lag associated with the registration process. However, there are a large number of projects undergoing validation and they could lead to a new, much higher, peak for annual capital investment in 2012.

The estimated investment in CDM projects is also reported by UNEP Risø in its CDM Pipeline Overview. The best comparison is the investment in registered projects. The June 2012 edition of the CDM Pipeline Overview covers 4,170 registered projects with an estimated total investment of $195.7 billion. The corresponding estimates in this report are $179.8 billion for 4,224 registered projects.[93] The UNEP Risø total is almost $16 billion higher with 54 fewer projects.[94]

The estimated capital investment in registered and soon-to-be registered CDM projects by host region is shown in figure 28. Investment is concentrated in eastern Asia, which includes China and India and accounts for 65% of the total investment. That region hosts only 45% of the corresponding

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[90] At least one monitoring report has been submitted.

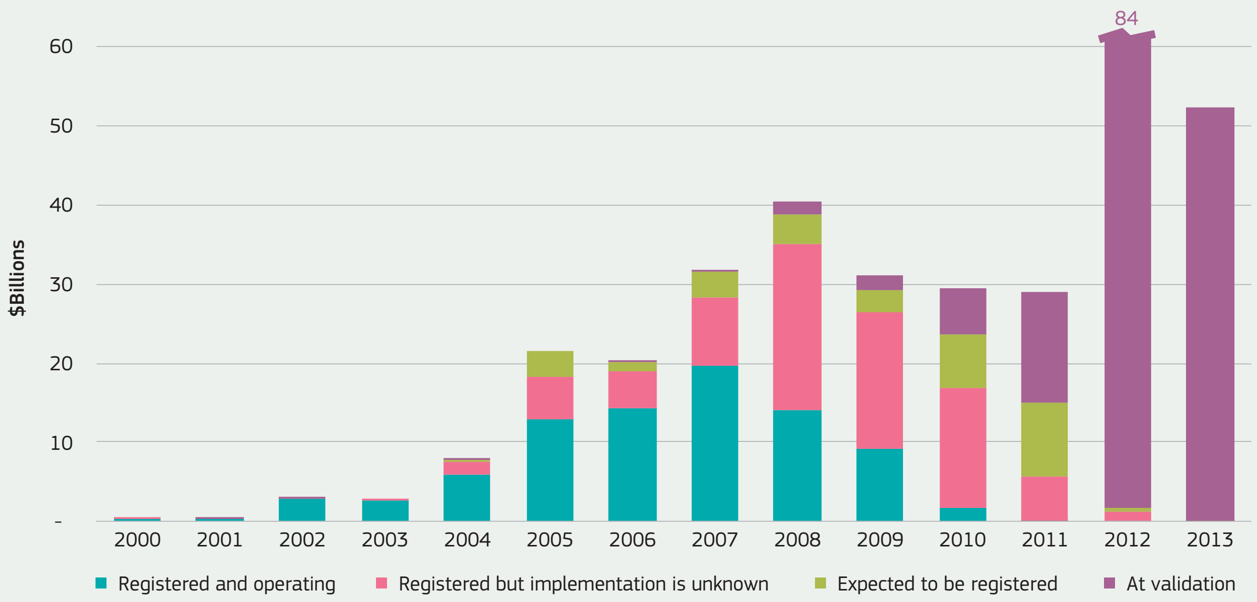
[91] The estimates reported are calculated using the average capital cost per tonne annual CO_2e emission reduction for projects of the same type.

[92] Project start year for registered and soon-to-be registered projects and year of first CER issuance for projects at the validation stage.

[93] $92.2 billion for 2,349 operational projects plus $87.6 billion for 1,875 other registered projects.

[94] The difference is due mainly to two factors, a different procedure for converting other currencies to US dollars and different assumptions used for the extrapolation of missing values.

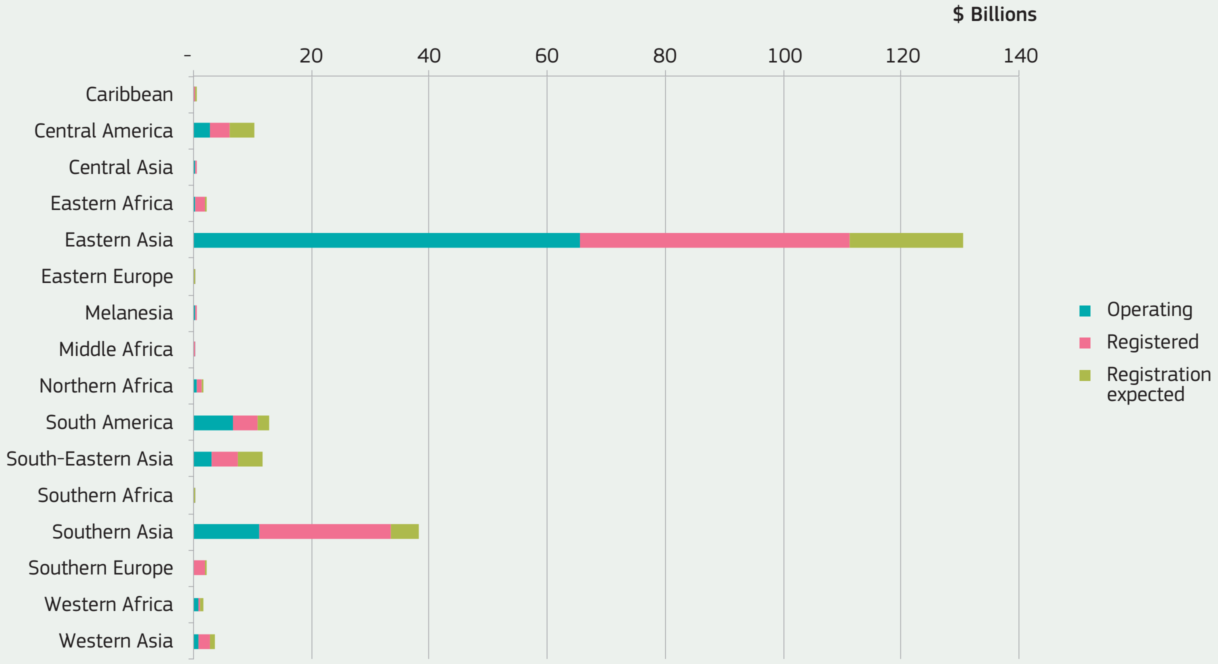
Figure 27. Investment in CDM projects, by year



Source: Authors' calculations based on the reported or estimated capital investment for 4,832 registered or soon-to-be registered projects and 4,472 projects at validation as of June 2012.

projects, so the projects are relatively capital-intensive, on account of the project mix (capital-intensive projects such as wind and hydro) and project size (larger than average projects). In contrast, the capital intensity of the projects in almost every other region is equal to or below the overall average. The estimated capital investment in registered and soon-to-be registered CDM projects by host country is presented in annex C.

Figure 28. Investment in registered and soon-to-be registered CDM projects, by subregion



Source: Authors' calculations based on the reported or estimated capital investment for 4,832 registered or soon-to-be registered projects as of June 2012.

7.2 Comparison of CDM and non-CDM projects

Bloomberg New Energy Finance (BNEF) collects data on capital costs and financing for renewable energy projects. Data are collected for CDM and non-CDM projects. Project finance is arranged prior to construction, so the BNEF figures are estimates of the total investment rather than actual investment figures. The database is compiled from public information, so coverage is not complete but the number of missing projects is not known. Coverage of CDM projects, both registered and still in validation, is good.

The BNEF database includes over 25,000 projects, but the records for most projects are incomplete. For example, 24,798 of 26,853 project records include the capacity but only 10,627 have the estimated asset value (capital cost). Records for CDM projects tend to be more complete: asset values are available for 6,497 of 7,469 CDM projects but only for 4,130 of 19,384 non-CDM projects. For CDM projects, the BNEF asset values match those from the UNFCCC database well: for 3,458 CDM projects, for which both the BNEF and UNFCCC databases have a capital cost, the total investment is $145.9 billion according to the BNEF database and $157.5 billion according to the UNFCCC.

The BNEF database includes only renewable energy projects, so many CDM project types are excluded.[95] Despite those exclusions, the BNEF database covers most CDM projects. The project type codes used by BNEF and UNEP Risø for CDM projects differ, so it is not always possible to match CDM and non-CDM projects. The biofuels (BNEF) and biomass energy (UNEP Risø) project types, for example, are difficult to align. The only landfill gas and methane avoidance projects in the BNEF database are CDM projects. In addition, the non-CDM projects are located mainly in developed countries (19,262 of 19,384 projects) and most of the non-CDM projects located in developing countries were implemented prior to 2000.

Thus, comparisons between CDM and non-CDM projects using the BNEF data are possible for only a limited number of project types, mainly wind, hydropower and solar. The number of projects in each category for which the BNEF database has asset value information is shown in table 27. The numbers of projects for non-CDM projects in developing countries and for tidal projects are probably too small to support robust conclusions.

Figure 29 compares the average capacity (MWe) per project by project type for CDM and non-CDM projects in Annex I countries. With the exception of solar thermal projects, CDM projects are larger than similar non-CDM projects, often three or four times the size. More rapid growth in the demand for electricity in developing

Table 27. Number of projects by project type and category for which the BNEF database has asset values

	CDM	non-CDM		
	Non-Annex I	Annex I	Non-Annex I	Total
Geothermal				
Conventional	26	66	7	99
Hydro				
Existing dam	122	11		133
New dam	540	55		595
Run of river	1,654	96	6	1,756
Solar				
Solar PV	171	895	5	1,071
Solar thermal power	14	74		88
Tidal				
Tidal	2	14		16
Wind				
Onshore	2,281	1,755	14	4,050
Total	**4,810**	**2,966**	**32**	**7,808**

Source: Authors' calculations using BNEF database.

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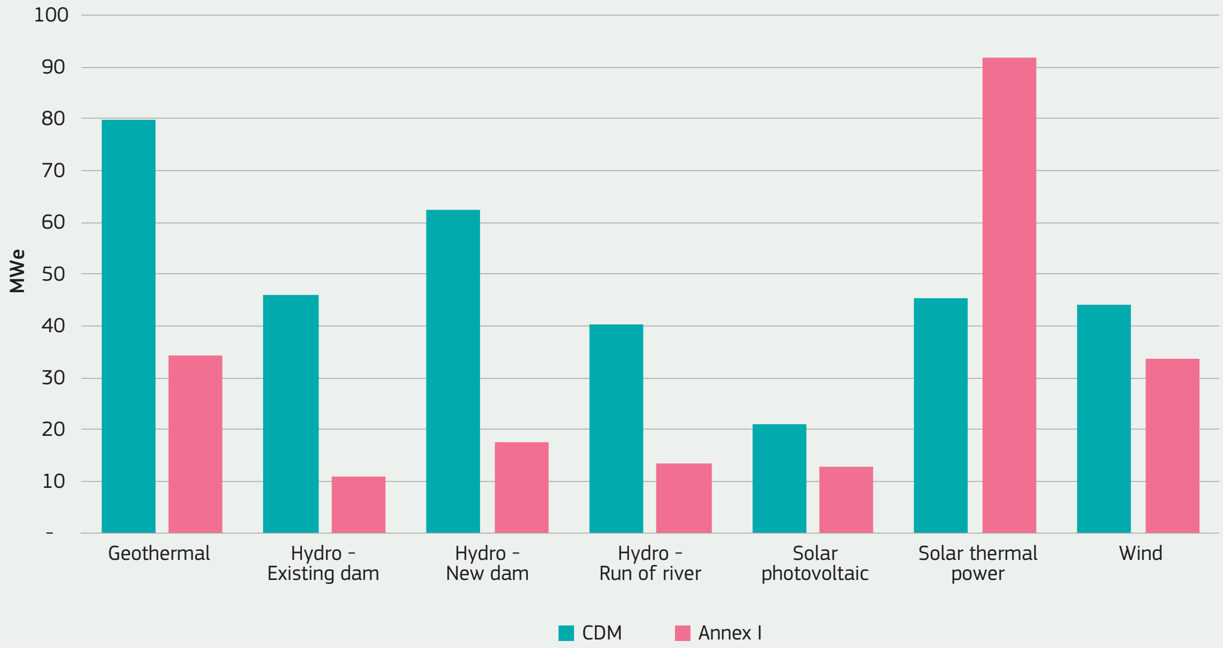
[95] The following project types are not included in the BNEF database: afforestation/reforestation, cement, CO_2 usage, coal bed/mine methane, EE households, EE industry, EE own generation, EE service, EE supply side, energy distribution, fossil fuel switch, fugitive, HFCs, N_2O, PFCs and SF_6 and transport.

Figure 29. Average capacity per project by project type for CDM and non-CDM projects



Source: Authors' calculations using BNEF data for 4,808 CDM and 2,952 Annex I renewable energy projects. See table 27 for the number of projects by project type.

countries creates more opportunity for larger renewable projects in those countries. The hydropower potential in developing countries includes more large sites because developing countries have more and larger rivers than developed countries and their hydropower capacity is less developed. Similarly, the average wind power project in China is generally much larger than is practically possible in Europe, owing to spatial planning regulations.[96] Also, the Chinese government initiative to establish six large wind bases of 10,000 MW each created the opportunity to develop large wind projects.

Figure 30 compares the capital intensity of CDM and non-CDM projects by project type. Capital intensity is the average asset value (capital cost) per unit of capacity ($/MWe). With the exception of existing dam hydropower projects, CDM projects are 15% (solar PV) to 50% (geothermal and solar thermal power) less capital-intensive than similar Annex I projects. This may be due to economies of scale for the larger CDM projects; for some technologies larger projects have a lower capital cost per unit of capacity. Projects in developing countries may also enjoy lower labour costs.

The average asset value per project is the total capital cost divided by the number of projects in any given year. The project size as measured by the average capacity is generally larger for CDM projects, while the capital intensity is lower, but the capital intensity is the dominant factor as the average capital cost per project is significantly lower for CDM projects than for similar Annex I projects. The average capital cost remained lower for CDM projects throughout the period from 2000 to 2012, but the capital cost of both CDM and Annex I projects increased rapidly during that period (see figure 31): from USD 10 million to almost USD 120 million for CDM projects and from USD 35 million to about USD 180 million for Annex I projects between 2001 and 2012. This is most likely due to a sharp increase in the overall size of renewable energy projects between 2001 and 2012.

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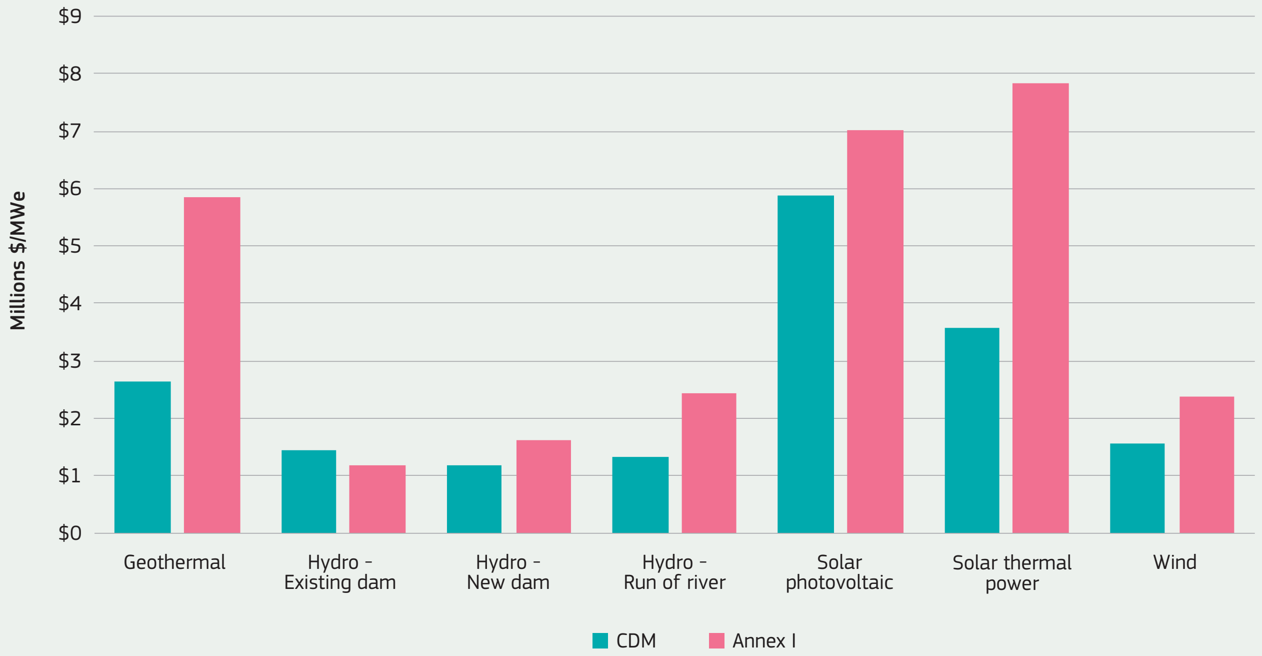
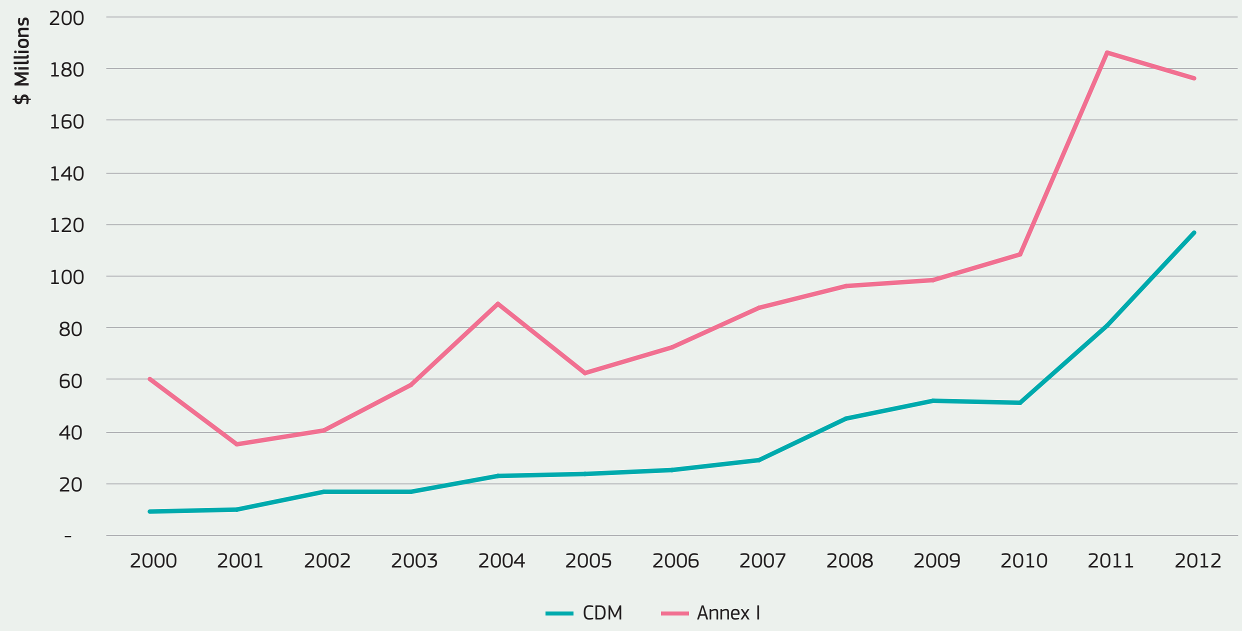
[96] Most of the CDM wind projects are located in China.

Figure 30. Capital intensity (capital cost in $/MWe) by project type for CDM and non-CDM projects



Source: Authors' calculations using BNEF data for 4,808 CDM and 2,952 Annex I renewable energy projects. See table 27 for the number of projects by project type.

Figure 31. Average asset value per project for CDM and Annex I renewable energy projects



Source: Authors' calculations using BNEF data for 4,808 CDM and 2,952 Annex I renewable energy projects. See table 27 for the number of projects by project type.

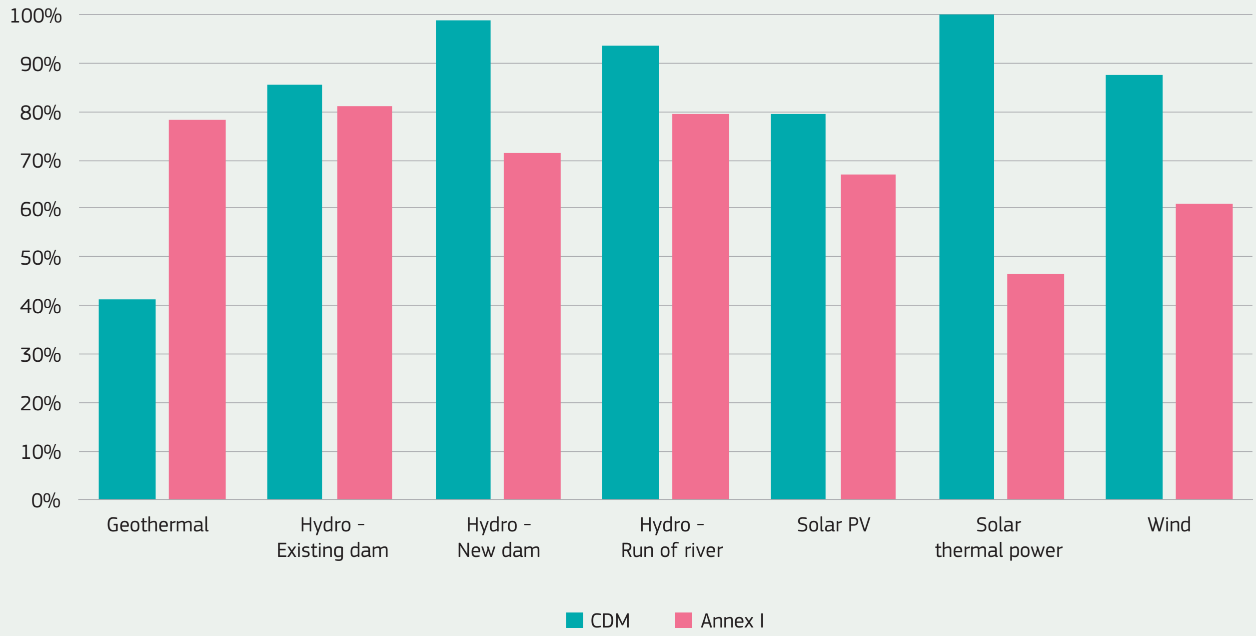
7.3 Foreign and domestic finance

Information on project location and sources of finance in the BNEF database is used to classify projects as being domestically financed. A project is domestically financed if the **only** source of project finance is the host country. All other projects involve some foreign finance, but these projects usually have some domestic finance as well.

The share of domestically financed projects by project type is shown in figure 32. About 90% of CDM projects and 65% of Annex I projects are domestically financed. With the exception of geothermal projects, 80–100% of CDM projects are domestically financed. For Annex I projects the share of domestically financed projects is lower and more variable, ranging from 45% for solar thermal power projects to about 80% for geothermal, existing dam hydropower and run-of-river hydropower projects.

The remainder of the projects – about 10% of CDM projects and 35% of Annex I projects – involve some foreign finance. Almost all of those projects also have some domestic finance, so these percentages overstate the share of total investment from foreign sources. The same calculation can be performed using the asset values rather than the number of projects. Foreign participation is at a higher level for larger projects, so the share of the total asset value of projects with some foreign investment is higher – about 20% for CDM projects and 55% for Annex I projects (see figure 32).

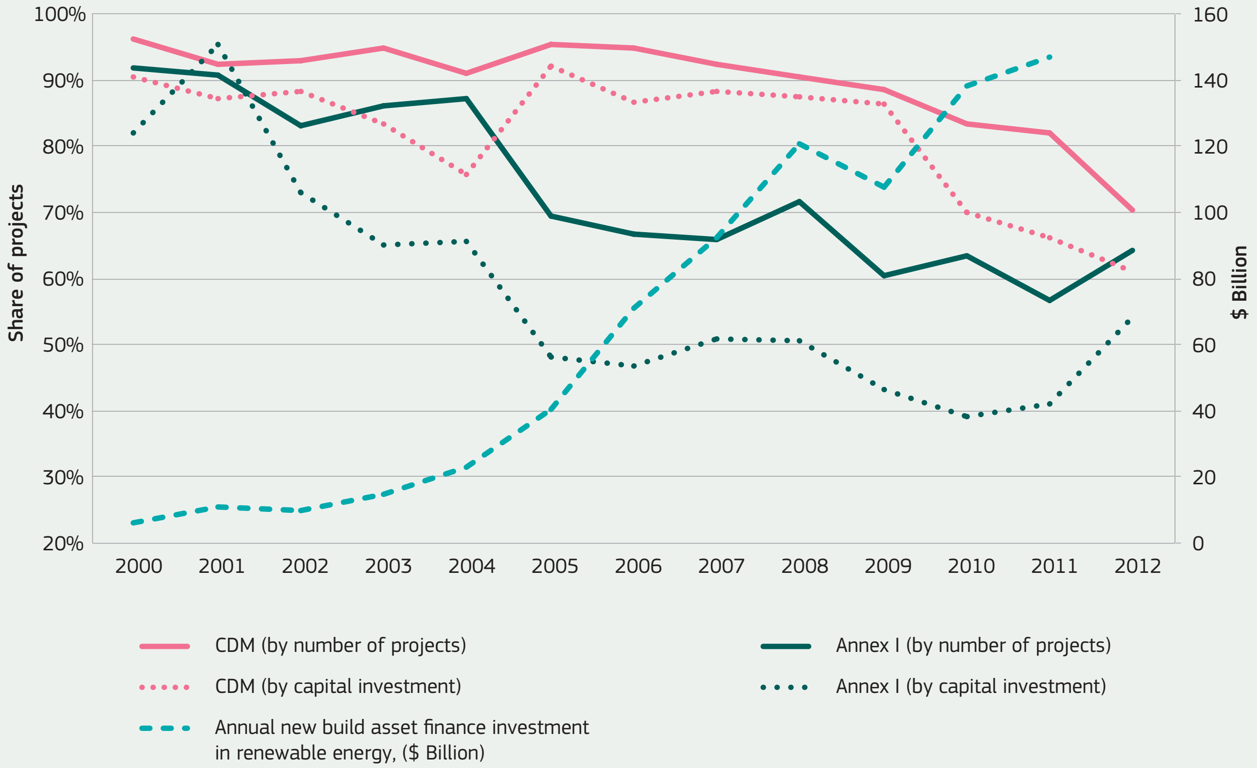
Figure 32. Share of domestically financed renewable energy projects by project type



Source: Authors' calculations using BNEF data for 4,808 CDM and 6,445 Annex I renewable energy projects with known investor origins. See table 27 for the number of projects by project type.

The trend in the share of domestically financed projects is shown in figure 33. Over time the share of domestically financed projects has declined, meaning that foreign investment has become more common for both CDM and Annex I projects. The share of domestically financed CDM projects dropped from 95% for projects that started in 2000 to about 80% for projects starting in 2011 and to 70% so far for projects starting in 2012. For Annex I projects, the domestically financed share dropped from 90% in 2000 to just under 60% in 2011. When calculated on the basis of asset values rather than the number of projects, the domestically financed share dropped from about 90% in 2000 to 60% in 2011 for CDM projects and from about 90% in 2001 to almost 40% in 2011 for Annex I projects.

Figure 33. Trend in the share of domestically financed renewable energy projects



Source: Authors' calculations using BNEF data for 4,808 CDM and 2,952 Annex I renewable energy projects. See table 27 for the number of projects by project type.

The increasing share of projects with some foreign investment is consistent with two other trends. Firstly, foreign investment is more common for projects with a larger capital cost. The BNEF data confirm this pattern for both CDM and Annex I projects (figure not included). Thus the trend towards larger projects shown in figure 31 would suggest a rising share of projects with foreign investment. Secondly, a rising share of projects with foreign investment is consistent with the growth of global investment in renewable energy projects (dashed line in figure 33. As the market has grown, some firms have expanded into foreign markets, leading to a rising share of projects with foreign investment. Finally, most inward foreign direct investment (FDI) goes to developed countries, so foreign investment would be expected to be more common for Annex I projects.

The CDM projects with some foreign investment in the BNEF database account for $23 billion of the total $119 billion investment. Extrapolating that share to the total investment of $215.4 billion in CDM projects yields an upper-bound estimate of $42 billion for total foreign investment. This is an upper-bound estimate because it assumes that the total capital cost of every project with some foreign participation is foreign investment. In practice, virtually every project with foreign participation also has domestic investors.

Carbon funds are a source of foreign investment for CDM projects. Only 29 of 96 carbon funds reviewed in 2010 published financial information (Alberola & Stephan, 2010). Those funds had total capital of €10.8 billion ($14 billion), of which a maximum of 38% was invested in CDM projects (Alberola & Stephan, 2010, figure 7). Scaling that number up to all 96 funds yields an estimated foreign investment of almost $18 billion in CDM projects.[97] This is just another estimate of foreign investment in CDM projects, rather than an upper or lower bound.

In summary, most investment in renewable energy projects in developing and developed countries comes from domestic sources. Accurate data on the share of foreign investment are not available. The indications are that the share has been rising, both for CDM and Annex I projects, as project size has increased and the industry has grown. The share of projects with foreign investment is higher for Annex I projects, but the gap appears to be narrowing.

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[97] 0.38 x (96/29) x 14 = 17.6.

7.4 Sources of foreign finance

Of the 47 CDM host countries with renewable energy projects in the BNEF database, 11 have no foreign investment in their projects (see annex C). Seven host countries have some foreign investment in all of their CDM renewable energy projects, but they have only one or two projects in each case: Ecuador and Georgia with two projects each; and Macedonia, Montenegro, Nicaragua, Senegal and Sierra Leone with one project each.

The remaining 29 host countries have some foreign investment in some, but not all, of their CDM renewable energy projects. The countries with the most projects with some foreign investment are the countries with the most projects. China has 88 projects with some foreign investment (6% of its total), 43 of which involve investment from Hong Kong. India has 40 projects with some foreign investment (5% of its total), 24 of which have multiple foreign investors. Mexico has 24 projects with some foreign investment (71% of its total), 13 of which have multiple foreign investors.

Overall 49% of the projects with some foreign investment have multiple foreign investors. This includes investments from carbon funds that have participants from several countries. For 28% of the projects with some foreign investment, the investment comes from a single Annex I country; for about one third of these projects the investment comes from the United States. For the remaining 23% of the projects with some foreign investment, the investment comes from a single non-Annex I country, mostly (73%) from Hong Kong.

Thus, the pattern of foreign investment in CDM renewable energy projects is complex. About half of the projects with foreign investment receive funds from multiple countries. When the investment comes from a single country, it is a little more likely – 28% versus 23% – to come from an Annex I country than a non-Annex I country. The largest individual flow of investment is from Hong Kong in Chinese projects.

7.5 Types of finance

There are two main categories of asset finance.[98] The first and most common is balance-sheet finance, typically by utilities, whereby a corporate entity borrows money and then invests the proceeds in its new renewable energy projects. The second, project finance, involves equity and 'non-recourse' debt provided to a special-purpose entity that owns the project. This is a typical arrangement for foreign finance (Alberola & Stephan, 2010). The debt must be repaid from revenue generated by the project rather than from the revenues of the project owners.

During construction, the project owners may use various forms of short-term loans, including construction debt, term loans and bridge financing. Once the project is operational, the risks associated with construction (delays, cost overruns, etc.) have been addressed. A financial structure appropriate to the operation of the project can be put in place and the short-term loans are repaid.

Table 28 shows the categories of project finance by type of project for 1,011 CDM renewable energy projects. The vast majority of the finance provided to projects, over 90%, is balance-sheet finance. Construction finance accounts for 6.4% of the total and project debt represents less than 1% of the total. The pattern is the same for all project types, except geothermal, for which the number of projects is too small to conclude that the difference is significant.

This pattern of finance is consistent with domestic investment being the main source of capital for CDM projects. Host-country project participants are likely to use balance-sheet finance for their projects. Project finance is more likely for foreign investment.

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[98] Frankfurt School (2012), p.44. A third category that includes bond finance for projects, and leasing, in which a bank will pay for, and own, the renewable energy equipment and the project owner will pay an annual fee for the use of the equipment, accounts for only a small share of the total finance (see figure 33).

Table 28. Project finance by type of project for CDM renewable energy projects

	Number of projects	Balance sheet		Construction finance		Project debt		Total
		$ million		$ million		$ million		$ million
			%		%		%	
Geothermal	8	3,319	67.2	1,453	29.4	165	3.3	4,937
Hydro	401	110,941	96.2	4,085	3.5	254	0.2	115,281
Solar	141	9,004	95.5	424	4.5	0	0.0	9,428
Wind	461	130,932	90.7	11,596	8.0	1,788	1.2	144,316
Total	**1,011**	**254,196**	**92.8**	**17,559**	**6.4**	**2,208**	**0.8**	**273,963**

Source: Authors' calculations using BNEF data for 1,011 CDM renewable energy projects.

7.6 Barriers to investment in CDM projects

The previous sections highlighted the lack of foreign investment in CDM projects as well as how this has varied over time and across countries. The impact of the CDM would obviously be greater if some of the barriers to investment could be removed. A key research question is, therefore: what are the barriers to both foreign and domestic investment in CDM projects? This section addresses that question, including the difference between international, national and project-level barriers. The focus of this section is on how these barriers affect the total CDM market, while chapter 8 looks more closely at the differences across countries.

There is a wealth of literature about barriers to investment, but often these papers do not distinguish between generic barriers to investment (e.g. related to the country, technology or even global economic factors) versus barriers that are specific to the CDM. This is important because actions within the CDM system may not be able to address barriers that are not directly related to the CDM, although broader development programmes could possibly do so. In addition, the distinction between international, national and project-level barriers is important because interventions must address these barriers at the appropriate level. Table 29 categorizes the most commonly cited barriers to the CDM under these three dimensions, which forms the structure for the remainder of the chapter.

Table 29. Summary of the major barriers to investment in CDM projects

	International barriers	National barriers	Project-level barriers
CDM-specific barriers	Low CER prices Complexity and uncertainty of CDM process Project eligibility and buyer preferences DOE capacity Transaction costs	National mitigation potential CDM institutional capacity and framework CDM inexperience	Access to early-stage finance (e.g. carbon feasibility studies) Data availability Unit transaction costs
Non CDM specific barriers	Global economy/financial markets	General investment climate (economic, technical and regulatory)	Access to project finance (domestic and foreign) High capital costs

Source: Authors' analysis.

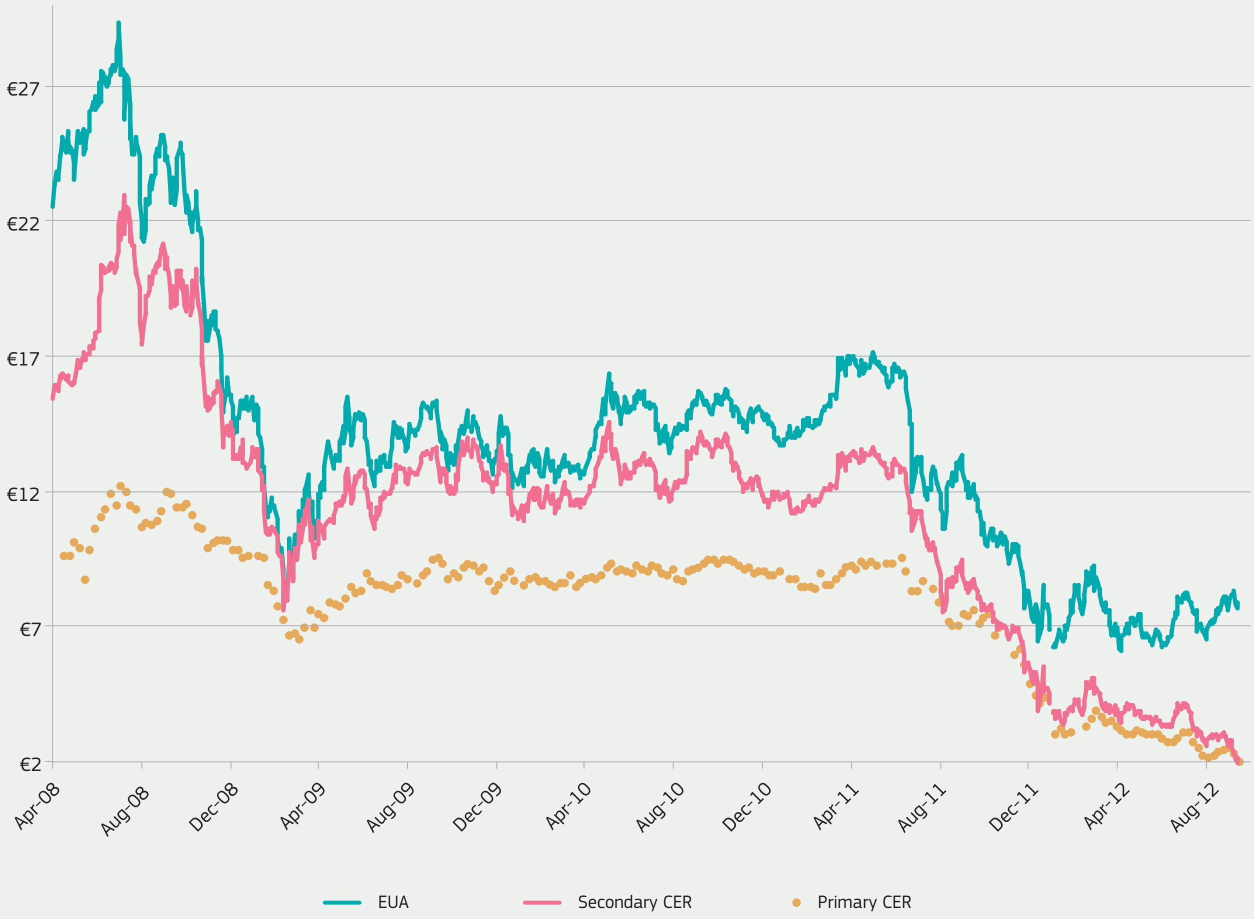
7.6.1 International barriers

International barriers affect all countries and therefore constrain the total size of the CDM market. They must be addressed at the level of the UNFCCC or, more broadly, global institutions, rather than only at a national or project level.

CDM-specific barriers

Low CER prices have become one of the most important barriers to investment in the CDM over the last 12 months. The price of primary CERs fell from €12 in early 2008 to less than €6 at the end of 2011 (Kossoy & Ambrosi, 2010) (see figure 34). The price of secondary CERs, which in the past was higher than that of primary CERs but is now almost the same, fell to €3.6 in June 2012 (Hemery, 2012). Part of this decline is due to the fact that CERs with vintages before 2013 are less valuable because of the surplus of allowances in the EU ETS for its second phase (2008–2012), but more importantly the majority of the pre-2012 CERs are from HFC projects, which will not be allowed into the EU ETS from 2013 onwards. The World Bank reports that transaction prices last year for post-2012 CERs were closer to $11.5 (€9) per CER.

Figure 34. Prices of EUAs, secondary CERs and primary CERs, 2008–2012

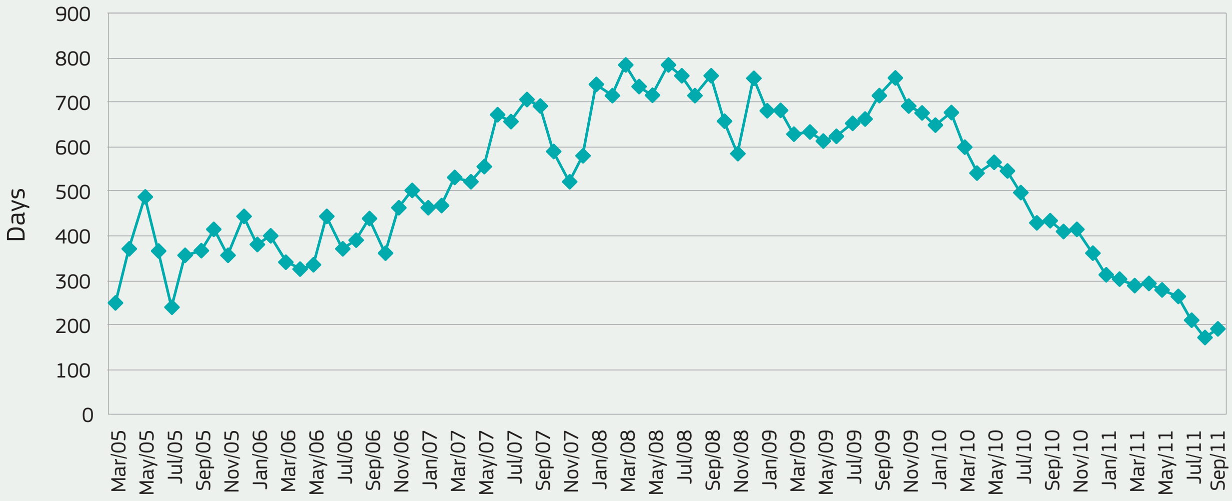


Source: Kossoy and Guignon (2012).

While the 2012 International Emissions Trading Association (IETA) GHG market sentiment survey showed experts predicting CER prices for up to 2020 of €11–12 (IETA, 2012), ThomsonReutersPointCarbon recently cut its average CER price forecast for 2013–2020 to €3.3 (Twindale, 2012). As a result, many projects are no longer viable even with CERs. Conversely, a project seeking registration at such low prices is unlikely to be additional (although project developers may not use current low prices for a 10–20 year crediting period). One project developer of a large Latin American PoA interviewed said that, although they could add CPAs at any time, they are not currently adding any more CPAs because the carbon price is too low. Similarly, the India CFL PoA is considering whether they can add more CPAs given the low carbon price. Most of the analysis showing the impact of carbon revenue on project profitability uses a carbon price of €8 ($10)/$tCO_2$ or more (Kossoy & Ambrosi, 2010; M. Schneider et al., 2010; Lütken, 2012). No amount of reform of CDM processes, promotion by DNAs or engagement of the financial sector will make up for a carbon price of €3/tCO_2. The irony of this is that the efforts of the EB to speed up issuance and unlock bottlenecks in the process have increased supply at a time when demand is crashing.

The complexity and uncertainty of the CDM process is commonly cited as a key barrier to the CDM (Ruthner et al., 2011; Platanova-Oquab et al., 2012; Gillenwater & Seres, 2011; IETA, 2010; Schmidt-Traub, 2011a). Even once methodologies are approved (which can take more than a year), the CDM project cycle is long and unpredictable. This has changed in the last couple of years, however, as CDM rules and procedures have been reformed and the capacity and efficiency of the UNFCCC secretariat has improved. For example, the average time from the start of public comments on validation to the final registration of a project fell from 800 days in mid-2008 to less than 200 days late last year (see figure 35). Similarly, in 2008–2009 increasing scrutiny of projects by the EB and the lack of clarity of many rules and procedures led to requests for review of more than 60% of projects and the rejection of 10% of projects that had already been successfully validated. However, these shares fell to 14% and 2%, respectively, by 2011(see figure 36), owing to a range of reforms and improvements (Platanova-Oquab et al., 2012; Gillenwater & Seres, 2011). So, while the CDM rule system continues to be dynamic, with frequent changes to methodologies, guidelines, forms and protocols, these changes are creating a more efficient system overall and the project development community has more capacity to correctly apply the rules. The ongoing challenge, however, is the unpredictability of the system.

Figure 35. Average time from period of public comment on validation to registration of CDM projects



Source: Fenhann (2012a).

Limitations on project eligibility and buyer preferences have an influence, generally from outside of the CDM rule system, which can also restrict investment in CDM projects from the demand side. Some climate change mitigation project types are currently excluded from the CDM, such as nuclear power and soil carbon sequestration, and carbon capture and storage has only recently been allowed. But buyers may place restrictions on eligible project types. The most important restrictions have been those of the EU ETS. The EU ETS will not accept CERs from large hydropower projects unless they are certified to meet WCD guidelines.[99] The EU will not accept any CERs into the EU ETS after December 31, 2012 from HFC or N_2O adipic acid projects (new or existing) and will not accept CERs from projects registered after December 31, 2012 unless the projects are located in the LDCs.[100] Some carbon funds also focus on projects above a certain size or specialize in particular project types.

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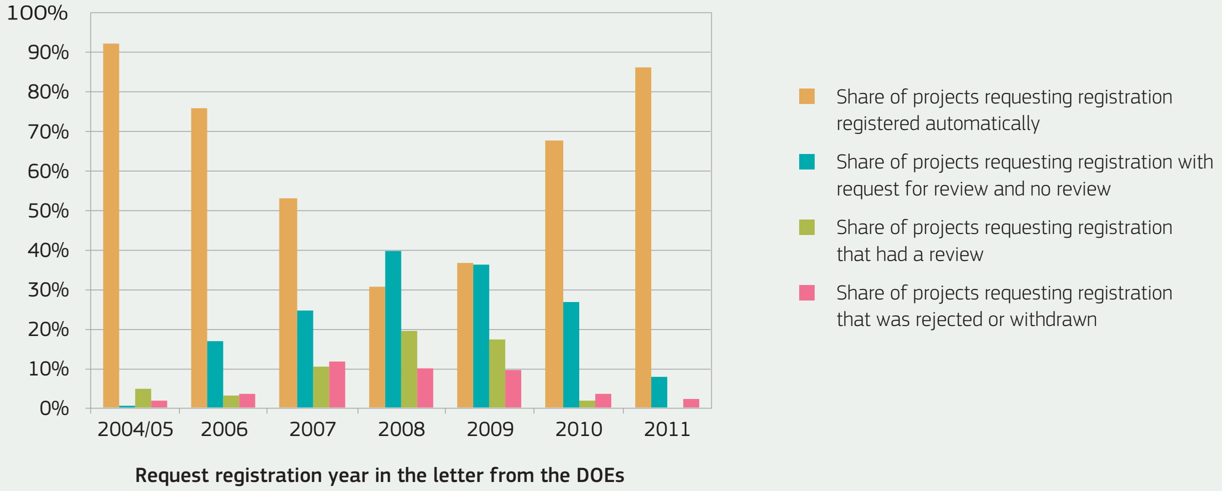
[99] See http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0101:EN:HTML. Note that governments are still allowed to buy from any hydropower plant, as long as it is outside the EU ETS, although an informal agreement among most buying governments has required them to adopt WCD guidelines.

[100] See http://ec.europa.eu/clima/policies/ets/linking/docs/q_a_20111114_en.pdf.

Figure 36. Review and rejection history of CDM projects, by year



Source: Fenhann, (2012a).

Strained DOE capacity has also limited investment in CDM projects (Gillenwater & Seres, 2011; L. Schneider, 2007). The number of DOEs has increased from 22 to 37 since 2007, but during that time the number of new projects going for validation each month has increased from 120 to 240 (Fenhann, 2012a).[101] In the stakeholder consultations with project developers, particularly in Africa the lack of sufficient capacity within DOEs, and the resulting time delays and increased costs of validation, were reported to be causing stress. This bottleneck is also driven by the EU's decision not to allow CERs from projects registered after 2012 unless they are from the LDCs, so that all projects in non-LDCs are now rushing for validation and registration this year.

High transaction costs have long been a concern for the CDM and the trade-off between increased rigour of the CDM rules and reduced project flow (due to higher transaction costs) is emphasized by many analysts and stakeholders (Platanova-Oquab et al., 2012; Schmidt-Traub, 2011b; Castro et al., 2011). Transaction costs relate not only to the specific steps required in the CDM project cycle (e.g. PDD development, validation and registration) but also to the time required for these steps, particularly if they delay implementation of the project.

Transaction costs may be as low as $0.02–0.03 per CER for large projects and as high as $1.20–4.05 per CER for small projects (Gillenwater & Seres, 2011). While this may not appear high when spread over the life of the project (Anger et al., 2007), the high upfront component creates a barrier to entry (Platanova-Oquab et al., 2012). For a large-scale project, upfront transaction costs can range from $50,000 to $250,000, even before paying the UNFCCC registration fee,[102] while for small-scale projects upfront transactions costs can range from $40,000 to $95,000 (Ellis & Kamel, 2007).

In addition, these costs have increased over time, as the cost of validation has risen and the complexity of PDD development has grown (see Kossoy & Ambrosi, 2010, p.23, for information on increasing validation costs). Given the current low CER prices, the transaction costs for small-scale projects could be almost as high as the carbon revenue achieved.

Non CDM specific barriers

Global economic crisis: Since 2008 analysts have noted the adverse impact of the global economic crisis on the CDM market (KPMG, 2009). This affects not only investment but also the demand for CERs, since lower activity in the EU means less demand for imported CERs (Kossoy & Ambrosi, 2010). More recently, in 2011, the euro area sovereign debt crisis had an impact on the supply of debt for the European renewable energy market (Frankfurt School, 2012), which could hurt renewable energy investment in other countries as well.

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[101] Project numbers are the average for 2007 compared with the average for the first six months of 2012.

[102] Registration fee is $0.10/CER for the first 15,000 CERs per year and $0.20/CER for any CERs above 15,000 CERs per year (max $350,000). Projects also pay 2% of CERs to the UNFCCC for the Adaptation Fund. Projects in the LDCs are exempt from registration fees.

7.6.2 National barriers

Because the national-level barriers to the CDM strongly influence the distribution of CDM projects across countries, they are covered in more detail in chapter 8.

CDM-specific barriers

Limited national mitigation potential is a challenge for many smaller countries, but also for large developing countries that do not have a strong industrial base. Several studies have found current national GHG emission levels to be one of the most important drivers of the regional distribution of CERs (Winkelman & Moore, 2011; Grubb et al., 2011; Lütken, 2011; Gillenwater & Seres, 2011). While mitigation potential is not the same as current emission levels, emission levels and economic activity are reasonably good proxies for emission reduction potential (Winkelman & Moore, 2011) (see chapter 8 for more detail).

A weak CDM institutional capacity and framework is still a barrier to the CDM, despite significant capacity-building programmes over the last 10 years (Okubo & Michaelowa, 2010; Arens, Wang-Helmreich et al., 2011; Winkelman & Moore, 2011). Most developing countries have DNAs, but there are exceptions, and even those that have DNAs do not have formalized or published procedures for project approval or sustainable development criteria. Limited staff capacity increases response times and also means that the DNAs cannot actively promote the CDM and raise awareness. Legal issues such as taxation and ownership of CERs are often not clear, raising risks for potential buyers, not to mention investors. In addition, only a few of the most active CDM host countries have a well-established local CDM consulting base, so other countries must depend on higher priced foreign consultants. A key failure of capacity-building programmes is that they have focused only on the DNA staff and not on the broader entrepreneurial and financial community.

Non CDM specific barriers

A poor general investment climate is as an important issue for the CDM as it is for any FDI. Many studies have shown that economic stability, regulatory environment and particularly sectoral regulation (e.g. access to the grid and power purchase agreements in the electricity sector) have a significant influence (Schmidt-Traub, 2011b; UNEP-FI, 2009; Burian et al., 2011; Ellis et al., 2007). In addition, the overall size and technological sophistication of the economy, as well as human capital, affect the attractiveness of the country for hosting CDM projects. The local investment climate also includes domestic capital markets, which may be even more important for the CDM as long as the share of 'unilateral' and domestically financed projects is as high as it has been in recent years (see section 7.3). This is not a barrier easily overcome by CDM capacity-building or other donor-driven interventions, unless the focus of the latter is on overall investment attractiveness, policy reform, improved regulatory capacity and mobilizing private capital within the country.

7.6.3 Project-level barriers

CDM-specific barriers

High unit transaction costs are a barrier to small projects in particular. As discussed above, because the total upfront transaction costs up to registration for a small-scale project may be 50–70% of the costs of a large-scale project, the unit costs (i.e. cost per CER generated) may be an order of magnitude or two higher. This affects the poorest countries most, because they will have fewer opportunities for large-scale projects. In addition, because of the relative capital costs and carbon revenue generation potential, unit transaction costs can vary significantly across project types (see figure 37).

Limited seed financing available for CDM project development will restrict the number of potential project owners that can enter the CDM pipeline. Even projects with financial backers may not be able to raise the additional funding required for carbon feasibility studies and PDD development, particularly for small-scale and microscale projects, because financial institutions do not understand the CDM project cycle. There are exceptions, however, such as Standard Bank – a partner in the African Carbon Asset Development (ACAD) Facility – which secure part of their investment risk by being an active party (i.e. CDM focal point) in their projects (see section 8.4). The new CDM Loan Scheme[103] launched by the UNFCCC in 2012, which will provide small loans for upfront transaction costs repayable after issuance of the CERs, is one example of interventions to address this barrier. Many of the donor-funded CDM capacity-building programmes have also covered the costs of feasibility studies and PDD development, but they can only cover the costs for a very small number of projects. Some carbon purchasers may cover the transaction costs for project owners, although the costs would be recouped from the purchase price.

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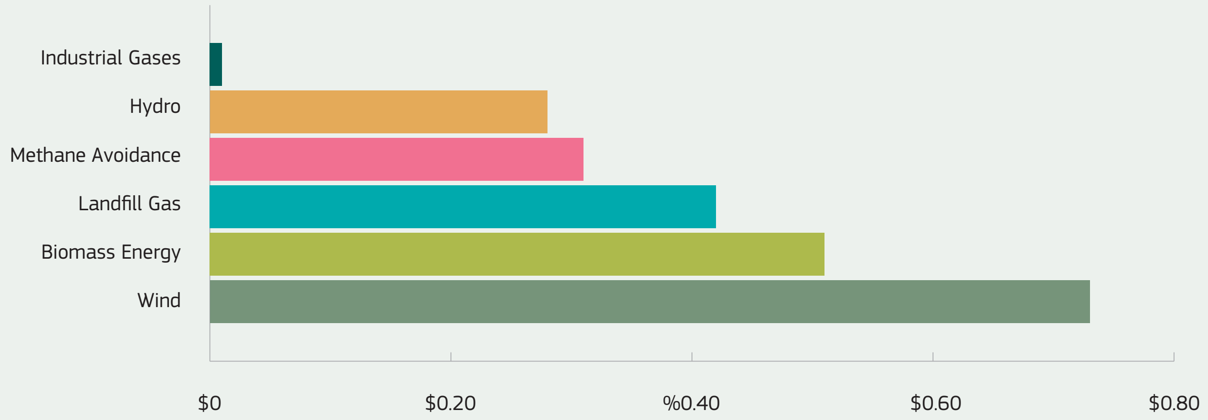
[103] See www.cdmloanscheme.org.

Figure 37. Unit transaction costs for World Bank CDM projects



Source: World Bank (2010).

Note: Only covers World Bank sponsored CDM projects – 53 registered projects included.

Non CDM specific barriers

Lack of access to project finance could be a barrier even if the project can meet all of the CDM eligibility criteria (Schmidt-Traub, 2011b; Burian et al., 2011; Ellis et al., 2007; Byigero et al., 2010). One of the main reasons that registered projects may not be implemented is problems securing project finance. Of the 4,170 projects registered as of June 1, 2012, only 1,580 had been issued CERs and so are definitely operational. This is partly because of the large number that have been registered in the last 18 months, which may not have been constructed yet and which may only be issued CERs after a year or more of operation,[104] plus time for verification. But it also includes a significant number of projects that will not be implemented because of a lack of underlying project finance or other barriers. Given the high share of CDM projects relying on domestic financing, this highlights the importance of building capacity within local financial institutions to work with CDM project developers.

Capital costs are a barrier to specific project types. Many renewable energy technologies, for example, have higher capital costs than their fossil fuel alternatives, even where the levelized costs may be much closer to each other (Edenhofer et al., 2011; Castro et al., 2011). This means that accessing the project finance discussed above is more difficult, given that many financial institutions are not yet willing to treat the ERPA[105] as additional security for the financing, although more institutions are taking the value of the ERPA into consideration.

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[104] Project participants may choose their monitoring periods, so projects will not necessarily be monitored and verified each year.

[105] The ERPA is the contract between the project developers/owner and the purchasers of the CERs.

8 Regional distribution of CDM projects

8.1 A brief history of the regional distribution issue

While the Kyoto Protocol text on the CDM does not make any reference to the distribution of project activities, the concern about regional equity emerged shortly after the agreement on the Protocol was reached (Ellis & Kamel, 2007; Lütken, 2011). The G77 & China submitted questions to the UNFCCC in June 1998 asking "how to ensure that CDM projects are equitably distributed so as to benefit all developing country parties, in particular the least developed country parties, and that the distribution of projects does not exacerbate existing regional/subregional imbalances" (UNFCCC, 1998) (also cited in Lütken, 2011). Subsequently, at almost every session of the CMP questions have been raised about the distribution of CDM projects. At CMP 1, for example, Parties were asked to submit their "views on systematic or systemic barriers to the equitable distribution of clean development mechanism project activities and options to address these barriers" (UNFCCC, 2005). At CMP 2 the need to "promote equitable regional distribution" of CDM projects was emphasized and Annex I Parties were called on to support project development in "least developed countries, African and small island developing States". CMP 2 also saw the launch of the Nairobi Framework to increase access to the CDM in Africa (UNFCCC, 2006a). At CMP 3 the secretariat and the EB were asked to "continue to facilitate the regional and subregional distribution of project activities" and the same three groups of countries were mentioned in relation to where more work on the "equitable regional distribution" of CDM projects was needed (UNFCCC, 2007). CMP 4 had the same emphasis, but added a new group of countries, namely "countries hosting fewer than 10 registered clean development mechanism project activities", that needed attention under the CDM rules (UNFCCC, 2008c). At CMP 5, CMP 6 and CMP 7 similar decisions on promoting equitable regional distribution were made, although the decisions do not always mention the same groups of countries (UNFCCC, 2009a; UNFCCC, 2010a; UNFCCC, 2011b). These decisions illustrate the importance of this issue to the Parties, but the CMP has never defined 'equitable regional distribution'. This means that there is no benchmark against which to compare the evolving distribution of projects. The next section looks in more detail at different ways of analysing regional distribution.

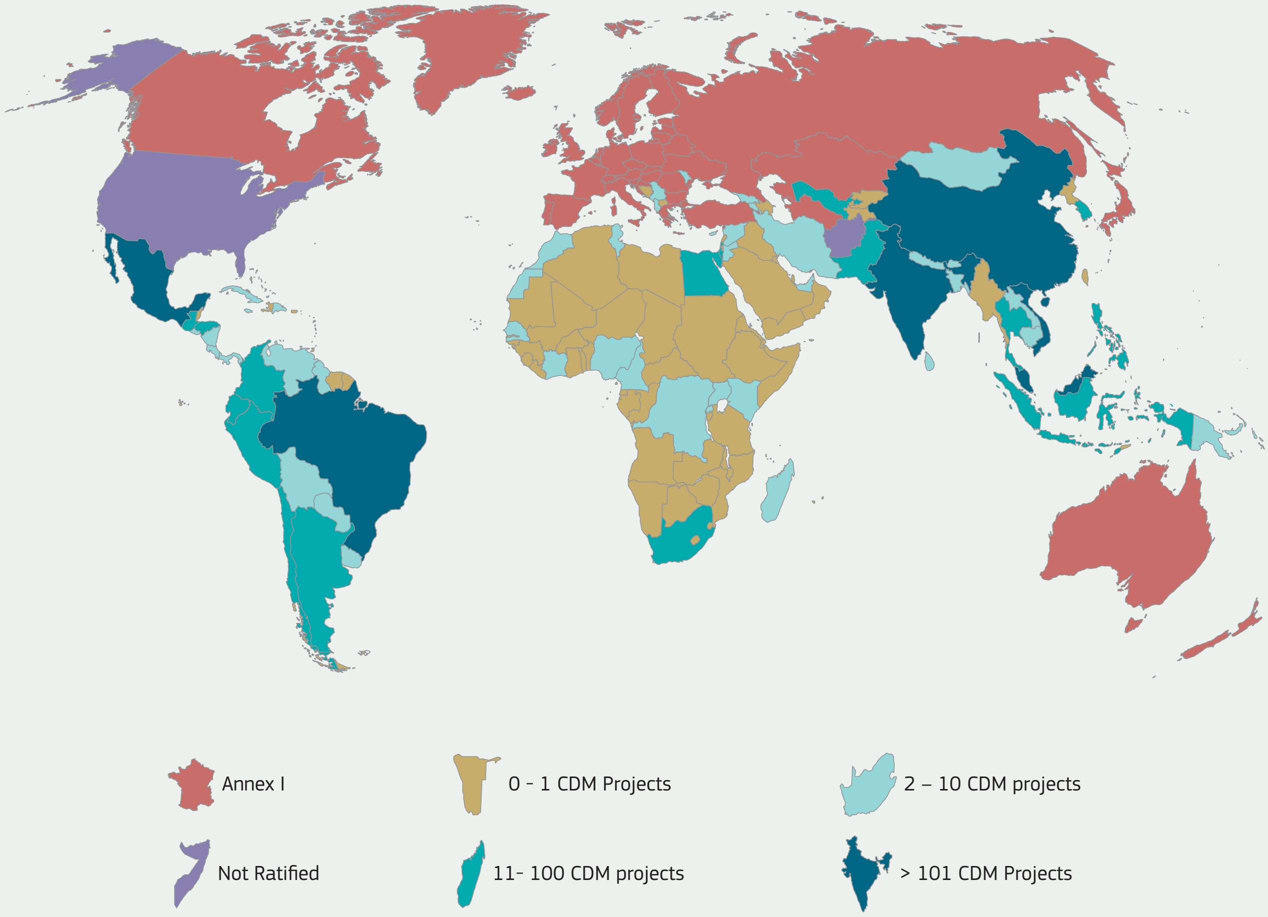
8.2 Status quo of regional distribution

One of the most common concerns about the regional distribution of CDM projects is the fact that many countries do not have any registered CDM projects at all. Figure 38 shows that the countries with no registered CDM projects or only a single project are concentrated in Africa, so it is not surprising that this concern has been raised by many African stakeholders.

As shown in table 30, the number of countries with no CDM projects yet is far higher in Africa, and more broadly among the LDCs, than in other regions, although there are a significant number of countries with no registered projects in the Asia and Pacific region. While many of the countries with no projects do not yet have a DNA, most of the African countries without projects already have an established DNA. The country groupings can be somewhat misleading, however, because non-Annex I Asia and Pacific includes countries that are wealthy oil-producing states (e.g. Brunei Darussalam, Saudi Arabia, Bahrain and Kuwait) as well as states affected by unrest and civil war (e.g. Iraq and Afghanistan). As Lütken (2011) points out, including countries that would be classified as high income (e.g. Antigua and Barbuda and Trinidad and Tobago have no projects), and which may have less interest in and need for the CDM, may also skew the picture. Even within Africa, there are countries that have faced significant domestic political and security problems (e.g. Sudan, Chad and Mauritania) that would almost definitely make developing CDM projects very difficult.

The difference in the level of participation in the CDM shows up more clearly when looking at the share of CERs issued by region. As table 31 shows, both Africa and the LDCs have a very small share of the issued CERs, even when considering only small-scale project CERs. The share of China and India is lower when considering only small-scale projects or when including the entire project pipeline from validation, but the major difference between regions remains.

Figure 38. Distribution of registered CDM projects by country



Source: Adapted from Henk Sa, EcoMetrix by authors, with data from UNEP (Fenhann, 2012b) as of May 1, 2012.

Note: "Registered projects" means projects in the registration pipeline, including request for registration, request for review, under review and registered, but excludes projects rejected, withdrawn or at validation.

Table 30. Numbers of registered CDM projects of different countries, by region

Region	0	0	1–10	11–100	>100	Total
	no DNA	with DNA				
Africa (33)	5	27	18	3	0	53
Asia & Pacific (13)	11	11	17	7	2	48
Europe & Central Asia	1	4	8	1	0	14
Latin America & Caribbean (1)	4	8	12	7	2	33
China & India	0	0	0	0	2	2
LDCs	6	25	15	1	0	47

Source: UNFCCC Analytical Database (UNFCCC, 2012b), as of June 7, 2012.

Notes: "Registered projects" means projects in the registration pipeline, including request for registration, request for review, under review and registered, but excludes projects rejected, withdrawn or at validation. Number in parenthesis after region name is the number of LDCs in that region.

Table 31. Share of CERs issued from registered projects, by region

Region	Total	Small scale only	Large scale only	Three gases only	Validation
Africa	3%	2%	3%	3%	5%
Asia & Pacific	10%	23%	9%	10%	10%
China	68%	41%	70%	67%	57%
India	7%	19%	6%	8%	12%
Europe & Central Asia	1%	0%	2%	2%	1%
Latin America & Caribbean	11%	15%	10%	11%	14%
LDCs	1%	2%	1%	1%	2%

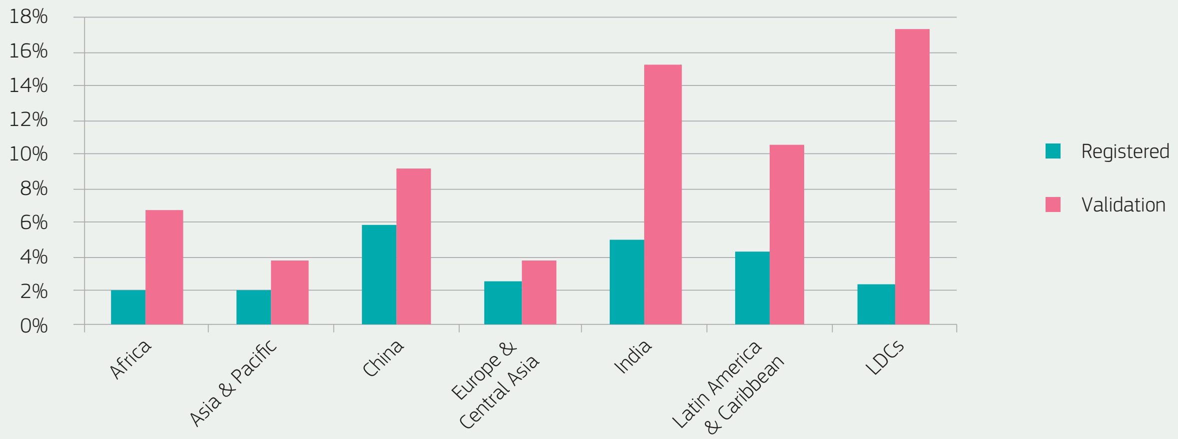
Source: Authors' analysis of data from UNFCCC Analytical Database (UNFCCC, 2012b), as of June 7, 2012.

Notes: Shares are based on total CERs projected over the full crediting period for all projects. First four columns are for projects in registration pipeline. "Three gases" excludes projects reducing HFCs, SF6 and PFCs. Last column is all projects at validation and beyond.

Lütken (2011) has also highlighted the need to compare CER production with national emissions on an individual country basis, because this may show which countries and regions are realizing more of their potential for emission reductions. Figure 39 shows that, for CERs from registered projects, Chinese and Indian CDM projects make the greatest contribution to reducing their national emissions. When projects in the validation pipeline are included, however, the picture shifts. Now the CDM projects in the LDCs have potentially a larger impact on national emissions than in other regions, largely because of the relatively low emission levels in the LDCs. Africa also shows a stronger performance on this indicator compared with India and China, although it is still behind other regions. This is again due in large part to the current low emission levels in Africa, as well as to the fact that methane emissions are not included in this measure of national emissions. Some might argue that China and India's large number of industrial gas projects skews this picture, but excluding HFCs, PFCs and SF_6 CDM projects from the analysis does not significantly change the outcomes shown in figure 39.

Another positive sign for regional distribution is recent experience with PoAs. The distribution of PoAs, as shown in figure 40, includes many more projects in Africa and in the LDCs than the distribution of conventional CDM projects, and the share of the Asia and Pacific region is much lower.

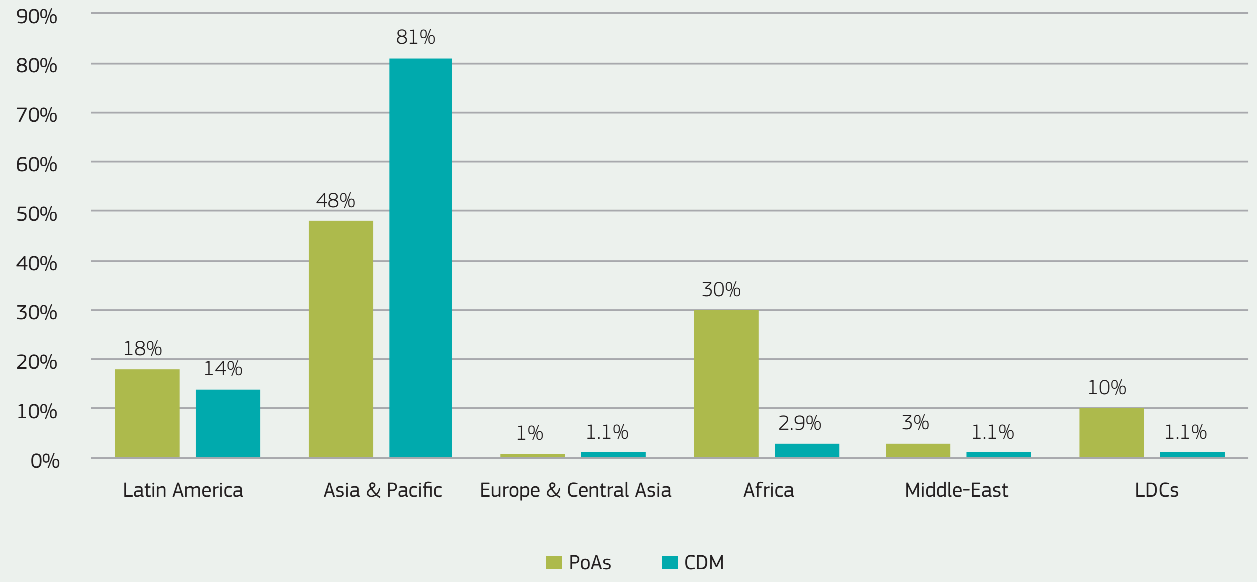
Figure 39. Issued CERs as a share of national CO_2 emissions



Sources: Data on CERs from UNFCCC Analytical Database (UNFCCC, 2012b), as of June 7, 2012; data on CO_2 emissions for 2010 originally from the World Resource Institute.

Notes: CERs are annual CERs, as stated in the PDDs. "Registered" means projects in the registration pipeline, including request for registration, request for review, under review and registered, but excludes projects rejected, withdrawn or at validation. "Validation" is all projects at validation or beyond. National CO_2 emissions do not include emissions of non-CO_2 gases (methane, N_2O, HFCs, PFCs and SF_6), but CERs do include emission reductions of such gases (although removing the latter does not change the overall findings).

Figure 40. Share of PoAs and share of traditional CDM projects, by region



Source: UNEP CDM Pipeline and PoA Pipeline (Fenhann, 2012b).

Notes: Includes all conventional CDM projects and PoAs at validation or beyond. Asia and Pacific, Africa and Latin America all contain LDC countries.

The purpose of this discussion is not to suggest that regional distribution is already 'equitable', but rather to illustrate the challenges of addressing this issue without any definition of what 'equitable' means. African countries and the LDCs (as well as small island developing States (SIDS)) in particular have clearly had fewer CDM projects. The question is what drives the distribution of projects and how can access be increased for countries that have had limited exposure to date? These are the subjects of the next two sections of this report.

8.3 Drivers of regional distribution

What factors influence CDM implementation in particular countries and constrain CDM investments in particular regions and the LDCs? One way to address this question is to consider the 'barriers to investment' (see section 7.6) and how these may have a different impact on the LDCs, Africa and other specific country groups. For example, if one of the barriers is transaction costs, this could affect the LDCs more if the average project size is smaller and so the transaction costs per CER are much higher.

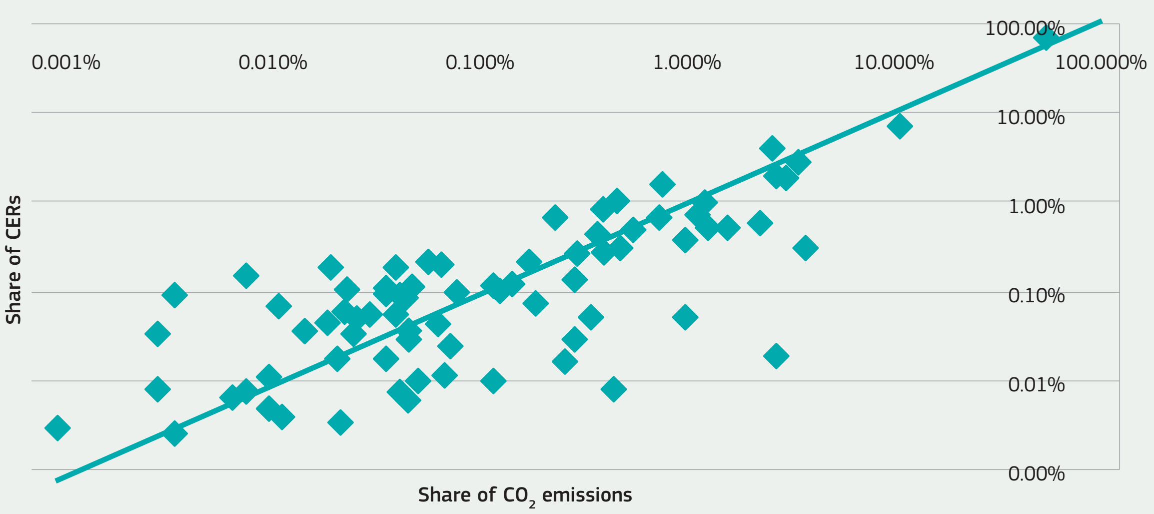
The literature clearly shows that one of the strongest drivers of CER distribution is **mitigation potential**, which is usually represented by current national GHG emission levels. Winkelman and Moore's (2011) statistical analysis supports this view using regression analysis and demonstrates that national emissions are a critical factor in determining the share of CERs of a country. The carbon intensity of the economy is also relevant, as is cumulative experience with the CDM. Lütken's earlier cited analysis shows similar results (Lütken, 2011). Other papers on barriers to projects in Africa and the LDCs also cite national emission levels as a key factor (Okubo & Michaelowa, 2010; Castro & Michaelowa, 2011; Ellis & Kamel, 2007; Gillenwater & Seres, 2011). Many analysts have pointed out that, given that the CDM is a market-based mechanism for achieving low-cost emission reductions, we should expect that most of the projects – or, more importantly, more of the issued CERs – would be where there are significant GHG emissions that can be reduced or avoided at a relatively low cost.

This is not to say that there is no potential for emission reductions in poorer countries, however. The World Bank (de Gouvello et al., 2008) released a study on mitigation potential in the energy sector in sub-Saharan Africa in 2008. The analysis showed the potential across sub-Saharan Africa in 23 technology areas for more than 3,200 projects reducing 740 $MtCO_2$/year, with an investment cost of $158 billion and using only existing approved CDM methodologies. The research has recently been updated by the Wuppertal Institute and GFA Invest (Arens, Burian et al., 2011), for 11 countries and 16 energy sector related technologies, and shows a technical potential for emission reductions of 128 $MtCO_2$/year. As both of these studies focus on technical potential rather than on economic or market potential (Spalding-Fecher et al., 2004), they will overestimate the potential CDM market, but they still point to the potential for more projects and emission reductions.

In terms of the relationship between issued CERs and national emission levels, a more recent analysis of UNFCCC data is shown in figure 41, in which the relationship between emissions and CERs is clear and statistically significant.[106] Other variables such as share of gross domestic product (GDP) and FDI also have a statistical relationship with the share of CERs, but this is not as strong as with the share of CO_2 emissions (although emission levels and GDP are obviously correlated in most countries).[107] The outliers in the figure that are below the line (i.e. higher share of emissions relative to share of CERs) include some of the oil-producing and/or wealthy countries discussed earlier, where interest in the CDM may be lower.

The investment climate in host countries is also an important driver for regional distribution cited in many studies, and an area in which many LDCs and African countries (though certainly not all) face challenges (Castro & Michaelowa, 2011; Byigero et al., 2010; Schmidt-Traub, 2011b; Burian et al., 2011; Michaelowa & Buen, 2012). The size of the economy, economic growth and energy sector growth are cited by some studies as influencing regional distribution (Winkelman & Moore, 2011; Michaelowa & Buen, 2012), while most reports rating CDM host countries make reference to ease of doing business, investment climate and corruption levels as important influences (Okubo & Michaelowa, 2010; Burian et al., 2011; Ellis & Kamel, 2007).[108] The investment climate is not purely a question of the attractiveness of the country for foreign investment, however, but also relates to the strength of local capital markets and commercial banks. This is because most CDM projects are domestically financed, so the weak financial sectors in poorer countries would be a major barrier to project development (Michaelowa & Buen, 2012). Unlike national emissions, this factor may be more in the control of the host country government, but it is not an issue that has generally been addressed by CDM capacity-building programmes (Okubo & Michaelowa, 2010; Ellis & Kamel, 2007; Ellis et al., 2007; Castro & Michaelowa, 2011). Investment climate could also include the strength of the sectoral regulatory and policy environment in CDM-relevant sectors (Castro & Michaelowa, 2011; Burian et al., 2011; Arens, Wang-Helmreich et al., 2011; Michaelowa & Buen, 2012).

Figure 41. Share of CERs from registered projects versus share of non-Annex I CO_2 emissions



Sources: Data on CERs from UNFCCC Analytical Database (UNFCCC, 2012b), as of June 7, 2012; data on CO_2 emissions for 2010 originally from the World Resource Institute.

Notes: CERs are the total over the full crediting period of all projects, not adjusted for any possible changes at the renewal of the crediting period. "Registered projects" means projects in the registration pipeline, including request for registration, request for review, under review and registered, but excludes projects rejected, withdrawn or at validation. CO_2 emissions are from fossil fuel combustion and cement.

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[106] The R^2 parameter of share of CO_2 emissions versus share of CERs is 0.98.

[107] The R^2 parameters for shares of GDP and FDI versus share of CERs are 0.87 and 0.94, respectively.

[108] See also the country ratings from Point Carbon, which raise similar issues, available at: http://www.pointcarbon.com/research/carbonmarketresearch/cdmhostcountryrating/historicratings/.

National CDM capacity is another significant factor, although analysts note that this is a necessary but insufficient factor in itself for attracting CDM projects (Okubo & Michaelowa, 2010; Castro & Michaelowa, 2011; Byigero et al., 2010; Burian et al., 2011; Arens, Wang-Helmreich et al., 2011). There are still some LDCs and African countries that do not have DNAs (e.g. Somalia, Sao Tome and Principe, Central African Republic, Republic of the Congo and Seychelles), as well as four SIDS (Kiribati, Tuvalu, Vanuatu and Seychelles again). Most of the countries that have fewer than 10 CDM projects, however, do have DNAs, albeit with limited staff and skills. In many countries it is rather the lack of local CDM consulting capacity and lack of awareness in the public and private sectors (particularly the financial sectors) that continue to be barriers to the CDM, even after the DNA has been formally established (Arens, Wang-Helmreich et al., 2011).

For countries affected by the above barriers, the lack of **CDM experience** becomes an additional factor that may limit access. In other words, countries with even a few CDM projects are able to build some awareness and local private-sector capacity, which in turn can help them to attract more projects (Okubo & Michaelowa, 2010; Winkelman & Moore, 2011; Burian et al., 2011; Arens, Wang-Helmreich et al., 2011). This testifies to the importance of the capacity-building programmes that focus on 'learning by doing' and securing the approval of one or more PDDs during the course of the programme (Arens, Wang-Helmreich et al., 2011).

Finally, while the **complexity of the CDM system**, and the associated uncertainty and time delays, may be a barrier for all countries (Platanova-Oquab et al., 2012), the effects on the LDCs, Africa and other underrepresented groups are more severe because of their lack of capacity and experience with the CDM (Schmidt-Traub, 2011b; Byigero et al., 2010). Countries without a local skills base in private-sector consulting and research will find it even more difficult to keep up with CDM rule changes. More importantly, it is difficult to imagine DNAs with already strained capacity and skills taking on greater roles in relation to standardized baselines or other new innovations that involve host-country input.

8.4 Options for enhancing the regional distribution of and access to the CDM

A number of options are available for enhancing the distribution of CDM projects in order to give more access to countries with few or no projects so far. Ideally this should begin with a clear definition of 'equitable regional distribution', or the definition of a goal for the policy interventions against which their effectiveness may be judged. The previous decisions of the CMP do not provide this. Even the literature on barriers to the CDM in Africa and the LDCs does not provide a standard against which to measure regional distribution.

The stakeholder consultations that formed part of the CDM Policy Dialogue, however, made it very clear that most stakeholders want to see greater access to the CDM for underrepresented countries. Some of the earliest discussions after the Kyoto Protocol was agreed raised the issues of quotas or the allocation of CDM projects (see earlier discussion of G77 & China's submission in section 8.1). This was even included as an option in more recent technical papers (e.g. UNFCCC, 2008a), but virtually none of the stakeholders consulted as part of the CDM Policy Dialogue proposed such an intervention. Instead, most stakeholders agree, in principle, with the EB's statement that "each non-Annex I Party should have an opportunity to realize its full potential to access the opportunities offered by the CDM, especially LDCs and with particular attention to African countries and small island developing States", but that "the term equitable distribution should not be taken to mean equal distribution of CDM project activities (e.g. the same number of projects in each country; preferences for small- or large-scale projects; an equal number of CERs generated)" (UNFCCC, 2006c). That said, the EU has taken the position that, for projects registered after January 1, 2013, the EU ETS will only allow CERs from projects in the LDCs. While this is not a quota system within the UNFCCC process, it is a buyer-imposed quota system that will have a dramatic impact as the EU is by far the dominant buyer of CERs (see section 4.1). Other countries that plan to participate in the second commitment period of the Kyoto Protocol could also choose to place restrictions on CER purchases from particular countries or regions in order to shift the regional distribution of CDM projects, but this would be outside of the UNFCCC negotiating process. However, Castro and Michaelowa (2011) show that using preferential access measures without complementary support mechanisms is unlikely to address the lack of CDM projects in the LDCs.

At a practical level, if almost all non-Annex I countries do not have at least a few CDM projects, it will be difficult for those Parties to engage in the negotiations on the future market mechanisms under the UNFCCC. This report will now therefore look at options for how to increase the number of CDM projects in countries without significant experience to date, bearing in mind that the national mitigation potential in these countries could be lower than in those countries that already have significant numbers of projects. The strategies chosen should be suitable for the LDCs and Africa in particular, since these are the most underrepresented groups. Note that, given the focus of this report on impacts rather than on the operation of the CDM, these options are presented only briefly for discussion. A more detailed institutional analysis and feasibility study of these types of changes to the CDM can be found in the report on the governance of the CDM (Classens, 2012).

Capacity-bulding for the local financial sector to mobilize domestic finance

One of the criticisms of previous CDM capacity-building exercises, particularly those in Africa and the LDCs, is that they have not succeeded in catalysing registered CDM projects because they focused mainly on governments and a small set of project developers (Okubo & Michaelowa, 2010). A key stakeholder that was not addressed in many programmes was the domestic financial sector (Arens, Wang-Helmreich et al., 2011). This is particularly important in the light of the finding that most CDM projects are financed by domestic capital (see chapter 7). Enhancing the awareness and capacity of the local financial sector in underrepresented countries could increase the flow of CDM projects (Byigero et al., 2010). Efforts could also be made to develop financial products linked to CDM projects, such as loans tied to ERPAs or lines of credit from development finance institutions, to assist with project financing.

Include Africa in the 'LDC track'

Several reforms initiated by the EB to streamline access to the CDM for the LDCs are in place or under way. These include, among other provisions:

- Microscale additionality rules, which provide for automatic additionality for certain microscale projects in the LDCs.
- Guidelines for the objective demonstration of barriers, according to which a lower burden of proof is required for projects in the LDCs.
- A tool to calculate the emission factor for an electricity system, which allows the LDCs to apply a simplified emission factor calculation with less data required.
- Exemption from registration fees for projects in the LDCs, as well as exemption from the 'share of proceeds' adminstrative fee collected by the secretariat.

Given that the guidance of the CMP on 'equitable regional distribution' always specifies Africa as a relevant group of countries, alongside the LDCs and countries with 10 or fewer CDM projects, African countries could be included in all of the special provisions made for the LDCs. Most of the LDCs are African countries, but there are 20 African countries that are not LDCs. This inclusion might need to be qualified according to the number of projects that the African countries already have registered.

Focused DNA support and regional approaches

Many of the earliest capacity-building programmes focused on national workshops and training DNA staff. This shifted over time to focus more on project development, in parallel with setting up national institutions and procedures (Okubo & Michaelowa, 2010; Arens, Wang-Helmreich et al., 2011). Given that many LDCs and African countries still have not registered projects, future support could focus on sharing experience within these regions on what *has* worked. There are, for example, some African countries that have had more success with the CDM, so sharing lessons learned could be useful within the region. More importantly, fostering regional (or subregional) approaches to DNA capacity-building, knowledge sharing and project development could address the barriers related to small economies and limited mitigation potential. Examples include regional grid emission factors (Arens, Wang-Helmreich et al., 2011; Burian et al., 2012), regional PoAs and regional financing facilities.[109] This would also allow for collaboration among DNAs on LoAs for regional PoAs. Note that this support could also target countries that do not yet have a publically available list of sustainable development criteria and project approval procedure, thus ensuring the removal of at least that barrier.

Grants and/or loans for transaction costs

In response to a call at CMP 5 in Copenhagen for the UNFCCC to provide loans to underrepresented countries to cover transaction costs, the CDM Loan Scheme was launched in 2012.[110] This scheme is available to countries with 10 or

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[109] See the example of the ACAD Facility at www.acadfacility.com.

[110] See www.cdmloanscheme.org.

fewer registered CDM projects, which would include 126 non-Annex I Parties to the Kyoto Protocol as of June 1, 2012, of which 21 do not yet have DNAs (group includes all of the LDCs, except Uganda). The scheme provides loans for upfront transaction costs and monitoring and verification costs and will be adminstered by the UNEP Risoe Centre and the UN Office for Project Services on behalf of the UNFCCC. This is an important step forward, given that transaction costs are an important barrier to the CDM in the poorest countries.

During the negotiations at CMP 5 in Copenhagen, however, the original proposals were for a grant scheme rather than a loan scheme and the total funding for the scheme was not limited to the interest on the surplus of the EB (Castro & Michaelowa, 2011). More importantly, the responsibility for repaying the loan rests on the project developer/consultant and not on the buyer, which has raised concerns among both project developers/consultants and major carbon purchasers (who do not want increased risks outside of their control). Given the importance of addressing transaction costs, including feasibility studies (Arens, Wang-Helmreich et al., 2011), a bolder approach to such a scheme could be to widen it to include all African countries (or those with fewer than 10 projects), to provide some level of grants and to seek additional funding beyond the $1–2 million per year in interest available. At a minimum, the new scheme should be reviewed within one year to assess its effectiveness at increasing the number of registered projects in the relevant countries.

Mobilizing project finance

Providing support for countries to afford the CDM transaction costs, and even feasibiltiy studies, is not sufficient if project owners cannot access project financing. Given that this financing has largely come from domestic sources so far, mobilizing the local financial sector around specific facilities for the CDM is critical. An example of this coming out of the Nairobi Framework initiative is the ACAD Facility.[111] ACAD was launched in late 2009 as a partnership between UNEP and Standard Bank, funded by the German Environment Ministry, to provide technical and grant-based financial assistance to projects prior to financial closure to boost their bankability. ACAD also provides training on carbon finance to local financial institutions, including both targeted workshops and extended in-house expert placements. In its first phase the Facility supported 14 projects in nine countries, including the first registered wind power projects in Africa. The Facility launched a second phase in June, with additional funding from Germany and France, and intends to support an additional 20 projects while enhancing the internal capacity of at least one other regional bank. In its second phase, ACAD is also undertaking market research with a view to the possible placement of a non-grant, guarantee-based financial product which could serve to leverage greater private capital in the African carbon market.

Making the link between project financing institutions, including the regional development banks, and CDM project developers (and even the carbon buyers) will be critical to securing the underlying project financing for CDM projects (Schmidt-Traub, 2011b; Ellis et al., 2007). While some national carbon funds would, until recently, provide substantial forward payments against the signed ERPA, this has not been the case with many private funds (Schmidt-Traub, 2011b). Innovative financial products linked to ERPAs, such as guarantee mechanisms, are necessary for carbon financing to play a meaningful role in the capital investment for CDM projects.

Standardization of parameters, including standardized baselines

The standardization of the parameters and calculations required for project development is an important tool for increasing access to the CDM in underrepresented countries. This is not only because of the different impact of transaction costs on smaller projects, but also because the lack of data in the poorest countries can itself be a barrier to CDM projects. Standardization can include default factors (e.g. emission factors and plant efficiencies), deemed values (e.g. fixed baseline emissions per installation) and common calculation methods (e.g. grid emission factors), as well as baseline standardization through the use of performance benchmarks, positive lists and market penetration levels (Platanova-Oquab et al., 2012; Hayashi et al., 2010; Broekhoff, 2007). The potential for standardization to reduce costs and increase overall access to the CDM is discussed in detail in the report on the governance of the CDM commissioned for the CDM Policy Dialogue (Classens, 2012), but a few important points relevant to underrepresented countries are made below.

Firstly, much of the work on standardized baselines is currently focused on large-scale industrial CDM projects (e.g. cement, iron and steel and power), including the data collection and quality control procedures needed to inform the processes for setting these benchmark levels (Platanova-Oquab et al., 2012; Broekhoff, 2007; Hayashi et al., 2010; Butzengeiger-Geyer et al., 2010). The LDCs, African countries and other underrepresented groups, however, generally have very few large-scale industrial facilities and much more of the potential for both avoiding emisisons and having a positive impact on sustainable development is in the household sector (Schmidt-Traub, 2011a). Trying to apply the same

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[111] See http://www.acadfacility.com/.

guidelines and principles for standardized baselines in the cement sector and for lighting in poor households is not only impractical, owing to differences in data availability (du Monceau & Brohe, 2011; GERES & CDC Climat, 2011), but also inappropriate, because the historic energy-use patterns do not provide adequate service levels (see option 8). A special standardized baseline track for household-level services (e.g. electrification, water purification and cooking) should be created, with rules and procedures that are appropriate to those technology areas and needs.

Secondly, additional guidance on specific standardized parameters (e.g. fraction of non-renewable biomass by country, recently published by the EB) should be provided by the EB. Thirdly, using positive lists for additionality testing and default baseline technologies may be more appropriate for many household-level technologies and the poorest countries, rather than the performance benchmark concept of standardized baselines. Finally, it is essential to minimize the demands on DNAs with limited capacity, so the background research and analysis for the approval of standardized baselines must be done at the international level through the EB rather than requiring host countries to initiate this.

Standardization and simplification of procedures

Several stakeholders, including project developers, have suggested the possibility of standardized and simplied procedures in addition to standardized parameters as an option for improving both the efficiency of the CDM and access to it in underrepresented countries (see, for example, PDF (2012) and Platanova-Oquab et al. (2012)). These standardized procedures could apply to all projects or might be restricted to projects applying standardized baselines and/or PoAs for small-scale or microscale actitivites. A recent report from the World Bank (Platanova-Oquab et al., 2012), for example, outlines some specific proposals on process simplification for projects using standardized baselines and PoAs for microscale activities.

The standardization and simplification of procedures could include the following:

- Standardized registration procedures that provide for automatic registration based on a standardized registration template for specific technologies covered by standardized baselines, followed by the combined verification of eligibility and actual emission reductions after the project is implemented (Platanova-Oquab et al., 2012). This approach could be applied to all microscale and small-scale projects, rather than only to projects using standardized baselines (PDF, 2012). The approach would still ensure that no CERs were issued without DOE verification, but could substantialy shorten the validation and registration process and increase certainty for project participants. The question will be for which countries, projects types or methodological approaches (e.g. standardized baselines versus conventional) such a procedure should be allowed.
- Standardized PoA procedures that allow the CME to include CPAs or individual units without DOE review, based on a standardized template, as well as simplified monitoring procedures covering only a sample of the total units across the PoA. Verification would still involve a review of CPAs or units within the PoA by a DOE prior to issuance. The World Bank's proposal (Platanova-Oquab et al., 2012) limits this to microscale activities and proposes eliminating the CPA level entirely, but this approach could also be used with the current CPA definition and for small-scale as well as microscale projects.
- Removal of the scale thresholds for household-level services. This could include residential lighting, electrification, water purification, water heating, space heating and cooking and would mean that all projects could use small-scale procedures, given that the scale of the individual units (i.e. at the household level) is by definition well below these thresholds.

Accounting for suppressed demand

The issue of suppressed demand is addressed in detail in chapter 9, but is mentioned here because of its particular importance in relation to the LDCs and African countries. Given the very low levels of basic household services in these regions (e.g. low electrificaiton rates and use of 'three-stone' biomass stoves), historical energy use and emission levels do not provide an appropriate baseline, as such a baseline does not equate to the same service levels as CDM project activities in these areas (Castro et al., 2011; GERES & CDC Climat, 2011; Winkler & Thorne, 2002). For example, a solar water heating system may provide many times the amount of hot water that a poor household may have heated over a wood fire, or a solar home system with even one compact flourescent lamp may provide 20 to 30 times more lighting than tradition kerosene wick and hurricane lamps. Accounting for suppressed demand will increase the potential for CER issuance in poor countries and communities whose emission levels are currently very low. The relevant detailed recommendations, and comments on the progress within the EB to address this issue, are covered in chapter 9.

9 Suppressed demand

One of the challenges of applying GHG accounting approaches in poor communities is that the current consumption of many household services (e.g. heating and cooking energy, lighting and potable water) may not reflect the real demand for those services. This could be a result of lack of infrastructure, lack of natural resources or poverty, particularly the high costs of these services relative to household incomes. The situation of 'suppressed demand' creates a problem for setting baselines, because the CDM rules say that the baseline scenario selected for a project should provide the same level of service and quality as the project scenario. This is clearly not the case if the project scenario provides a much higher service level, owing to low historical consumption. At the same time, the CDM rules state that "the baseline may include a scenario where future anthropogenic emissions by sources are projected to rise above current levels, due to the specific circumstances of the host Party" (UNFCCC, 2006b, para. 46) and in 2009 the CMP directed the EB to "further explore the possibility of including in baseline and monitoring methodologies, as appropriate, a scenario where future anthropogenic emissions by sources are projected to rise above current levels due to specific circumstances of the host Party" (UNFCCC, 2009a). This section explains how suppressed demand has been addressed so far in the CDM system, as well as discussing the need for and implications of increasing use of suppressed demand in the GHG accounting within the CDM.

9.1 Background and definitions

Household energy services for poor non-electrified communities are an important example of the need to consider suppressed demand, because historical energy consumption may not be a good proxy for future energy demand. Even if we know the energy source used historically (e.g. kerosene for lighting), the quantity of fuel used historically may not represent the actual energy *service* demand. Energy services include lighting, cooking, space heating and motive power. These are measured not with energy units (kWh or GJ) but in units that reflect the actual service delivered (e.g. lumens of lighting, average indoor temperature or litres of water heated to a certain temperature). This distinction is very important because, for the same energy consumption and emissions, two different technologies can deliver vastly different energy service levels.

There are two main reasons why historical energy consumption may not be a good proxy for future energy consumption or future energy service level demand after electrification. These same two concepts could be applied to any other project type that provides services qualitatively and quantitatively different from historical service levels:

- Firstly, as incomes grow over time, energy service demand and consumption would increase, so that even without access to electricity it is likely that energy consumption in the 'without project scenario' would rise over time. This is the 'income effect'.
- Secondly, and more importantly, the combination of low household incomes and high unit costs of energy can mean that individual households cannot afford sufficient energy for their basic needs. In other words, since households face a budget constraint and must trade off purchasing energy services with other household needs, poor households may be forced to choose levels of energy services that are inadequate to meet their basic needs. If the households had access to a less expensive energy service (i.e. because of the availability of a less expensive source with lower unit cost, such as electric versus kerosene lighting), those households would consume significantly more energy services *even without a change in total household income*. This is the 'price effect'[112] and it is due to a combination of lack of physical access to an energy source or technology (i.e. the 'lack of infrastructure' barrier cited earlier) and a high unit cost of existing energy services.

Both the income effect and the price effect have been described as 'suppressed demand' for energy services that must be considered in setting the baseline for CDM projects that target energy services for poor communities (UNFCCC, 2011e; Winkler & Thorne, 2002; Thorne et al., 2010; Gold Standard, 2011). The two concepts, however, have different implications for how to construct an alternative baseline scenario. In addition, the income effect is accepted as a way to adjust historical energy use to create a baseline, while the price effect has only recently been explicitly implemented in approved methodologies. The implications for the baseline of these two components of suppressed demand are as follows:

- Baseline service level increase due to 'income effect': If the main issue were the growth of energy consumption over time as **incomes** increase, and the costs of

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[112] As mentioned earlier, this is similar to the 'rebound effect' described in the "Guidelines on the consideration of suppressed demand in CDM methodologies" (EB 62 report, annex 6).

the energy service are fairly constant, then an appropriate baseline could start with historical energy consumption and increase this each year after project implementation, proportional to the increase in average household income in the target community. This is similar to the concept of a 'trend-adjusted' energy use projection in approved small-scale methodology "AMS I.A". It could also include, for example, the household investing in more-efficient lighting technologies, owing to increased access to capital (e.g. kerosene pressure lamps, which are more expensive than hurricane lamps and therefore rarely used by the poorest communities).

- Baseline service level increase due to 'price effect': The second concept, whereby historically households have not been able to purchase adequate levels of energy services, implies that a change in the **unit cost** of those services (e.g. $/lumen-hour, not $/kWh) could lead to an immediate and significant increase in energy service demand. Switching from kerosene lighting to electric lighting, for example, can reduce the unit cost of lighting by 90% or more and consumption of lighting services (lumens) may jump by a factor of 40 (ESMAP, 2002; IEG, 2008).

The CDM Gold Standard, as part of the development of an improved cook-stove methodology, has considered the concept of suppressed demand: "Where a group of people are deprived of a reasonable level of human development in comparison to their peers, and the opportunity to achieve a satisfactory level of service is available through carbon financing calculated from the baseline level of service of their peers or from the project level of service achievable, then the appropriate adjustment to the baseline can be made" (Gold Standard, 2011). This is an example of the 'price effect'. The Gold Standard biogas-digester methodology has a similar definition of suppressed demand to the one provided here.

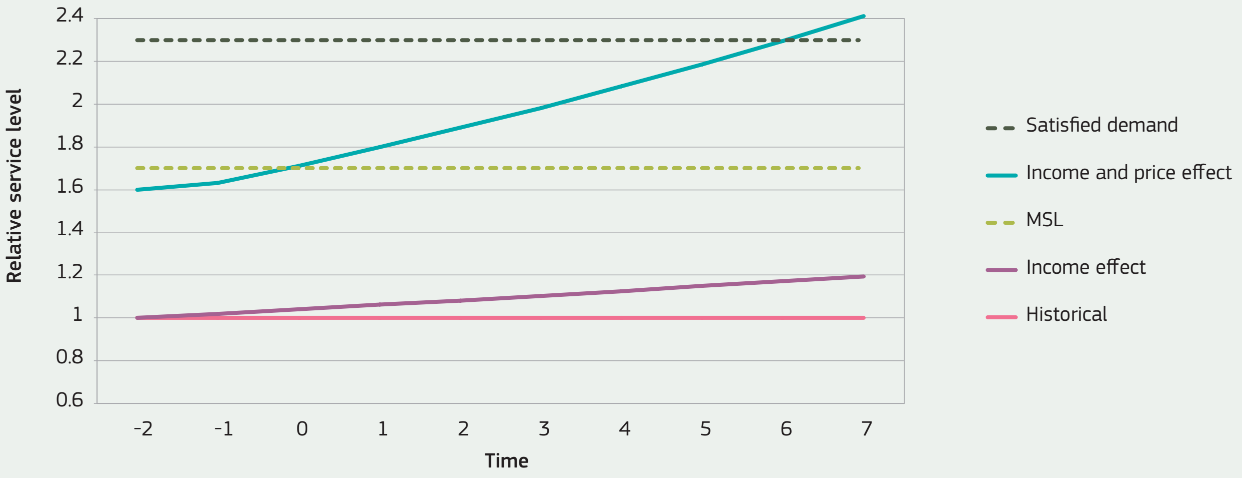
'Satisfied demand' is the level of energy services that would be reached with access to better quality and more affordable services and increases in income. In other words, 'satisfied demand' is the level of energy service demand of households in a given area when the 'income effect' and the 'price effect' have been overcome. A CDM activity may overcome the 'price effect' by introducing a technology that dramatically reduces the unit cost of an energy service (e.g. CFLs with grid electricity). While a CDM project will not overcome the 'income effect' directly, this is most likely much smaller and also has already been considered a reasonable adjustment to make to the baseline in cases such as AMS I.A.

Another way of understanding the relationship between these concepts is the following: the reason historical energy service levels are not a good proxy for the 'without project' baseline is that 'satisfied demand' for those services has been 'suppressed' by both an 'income effect' and a 'price effect'. The difference between the satisfied demand and the actual observed level of demand is the sum of these two effects. This means that there are multiple options for setting a baseline, depending on the degree to which suppressed demand is considered. In addition, another option for the baseline is a 'minimum service level', which would reflect the minimum necessary to provide for adequate, basic human needs.

The concept of a minimum service level is common not only in the energy sector (see review of targets and measures in Bazilian, Nussbaumer et al., 2010) but across many sectors, from the Millennium Development Goals (MDGs), to proposals for minimum levels of clean water per household, adequate household comfort levels (related to space heating and cooling), adequate nutritional levels and even 'threshold' poverty levels that represent a household's ability to achieve MDG service levels (Howard & Bartram, 2003; Baer et al., 2008; Falkenmark, 1989; Thorne et al., 2010; Modi et al., 2006). This concept is also included in the recently approved "Guidelines on the consideration of suppressed demand in CDM methodologies" (EB 62 report, annex 6).

Figure 42 illustrates the service levels of these different baseline concepts, showing how the suppressed demand effects discussed above and 'minimum service level' compare with historical service levels. The "income effect" line simply shows the gradual expected increase in service demand resulting from increasing household income within the affected communities (assuming per capita income is growing, which is not true for all developing countries). In other words, it is the service level without the income effect suppressing that demand. The "income and price effect" line shows the step change in service levels that would occur if the services were suddenly as inexpensive (per unit) as they will be once the project has been implemented. For example, in the Philippines the estimated cost of lighting with kerosene is 36 US cents per kilolumen-hour (klmh), while the cost of lighting with grid electricity is 0.75 US cents per klmh (ESMAP, 2002). If the household had been able to pay 0.75 US cents per klmh for kerosene lighting historically, they would have consumed far more lighting services. This is why the "income and price effect" line has a significantly higher service level than historical consumption. Note that this line still slopes upwards, as household incomes grow. The "satisfied demand" line is the level of services at which the entire income and price effect has been removed over a longer time period (e.g. 10 years). The "minimum service level" line is flat because it reflects a standard 'adequate' demand for basic services for a typical rural community, rather than being based on the current income of the households in that community. The 'minimum service level' is lower than 'satisfied demand' because most households would want more than the most basic services if they could afford it.

Figure 42. Relative service levels for different baseline assumptions about suppressed demand effects and minimum service level

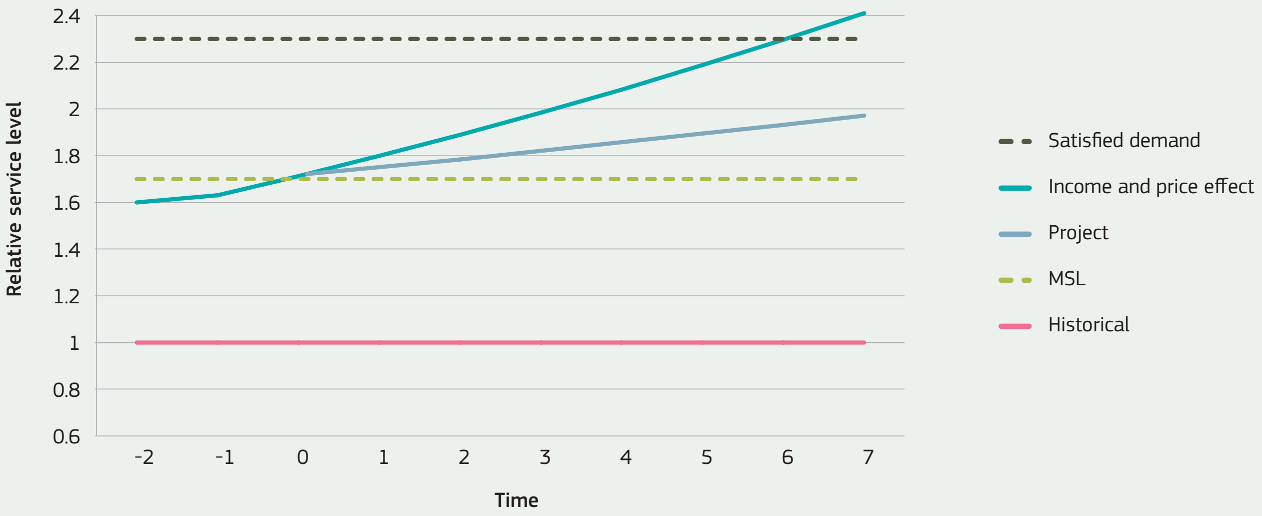


Source: Authors' analysis.

Notes: Time is relative to the start of a CDM project activity. MSL = minimum service level.

Figure 43 illustrates how *project* service levels could compare to the baseline scenario alternatives. Project service levels are much higher than historical service levels because of the impact that the CDM project has on the unit cost of services. Service levels could reach the minimum service level almost immediately owing to dramatically lower unit costs, but may still take time to reach 'satisfied demand' because of the income level of the households or other specific characteristics of the community (e.g. energy taxes and subsidies, or appliance prices).

Figure 43. Baseline and project service levels under different assumptions of suppressed demand effects and minimum service level

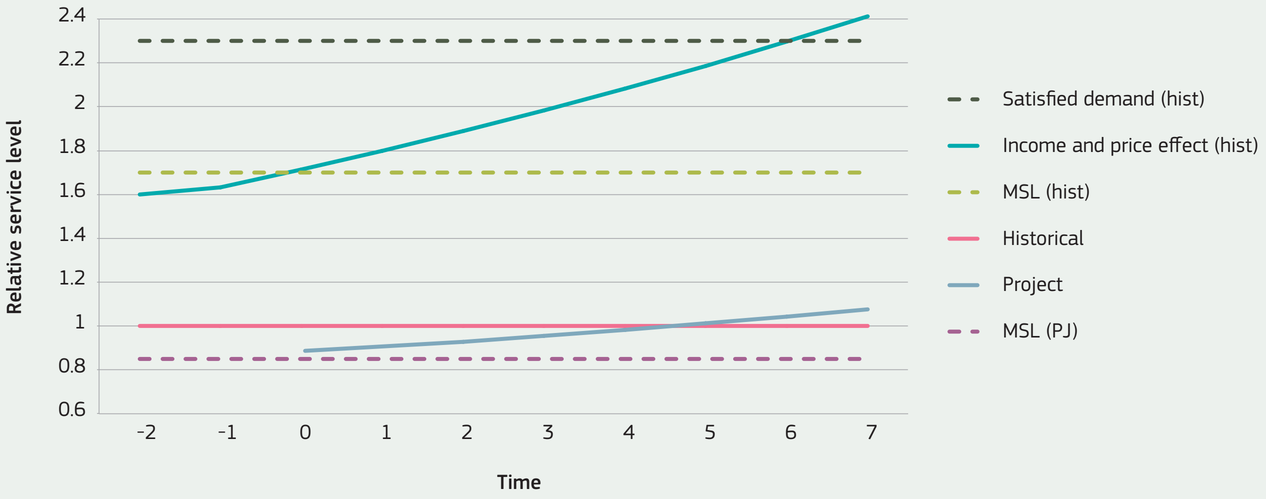


Source: Authors' analysis.

Notes: Time is relative to start of CDM project activity. MSL = minimum service level. Income effect line has been removed for simplification.

Energy consumption (GJ or kWh, as opposed to service level) in each scenario depends on the technology used to provide the service. For example, providing the minimum service level with the project technology would use less energy than providing the same service using the historical technology. The project scenario might provide several times the service level of historical technology, but use less energy – in fact, this is what we would expect. Over time, however, the project scenario might use more energy than the household historically used, because the service level delivery is so much higher. This is particularly true if the project activity is grid electricity from a fossil fuel based electricity grid. Figure 44 illustrates this possibility. The energy consumption of the baseline scenario alternatives in figure 44 is shown using historical technology and is so marked "hist", while the project scenario obviously uses the project technology. This shows how the project technology can meet the minimum service level and still be below historical energy consumption, because the project technology is so much more efficient at meeting the minimum service level. Of course, this figure does not provide an exact representation of these levels for all projects, but rather shows the possible relative differences. The relative emission levels would follow a similar pattern to the energy consumption levels, but obviously adjusted for the emission intensity of the fuels. The calculation of CERs would obviously be very different if comparing the project with the minimum service level using historical technology, instead of using historical energy consumption to calculate baseline emissions.

Figure 44. Baseline and project energy consumption under different scenarios (historical versus project technology)



Source: Authors' analysis.

Note: The energy consumption levels are marked with (hist) to indicate the efficiency of the historical technology. For example, the minimum service level can be provided at a much lower energy consumption using project technology. This implicitly assumes that the project technology is much more efficient than baseline technologies.

9.2 Suppressed demand under the CDM

Suppressed demand has been implicitly considered in methodologies for greenfield projects that do not use any historical consumption or production levels for the baseline. For example, ACM2 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" and AMS I.D "Grid-connected renewable electricity generation", the most widely used methodologies, do not require the project participant to demonstrate that the CDM plant actually displaces another plant or that production is reduced elsewhere. The renewable power plant is essentially compared to the mix of power plants that would have been run or built to meet *additional demand* that exists but is currently not met owing to supply constraints. In the case of a geothermal or low power density hydropower plant, this could mean that *total* emissions from the electricity grid actually increase as a result of the project, even though the emission intensity declines. This is reasonable, given the continuous and rapid growth in demand for electricity demand in almost all developing countries, and because of the large development benefits from increased access to and consumption of electricity.

Historically, this approach has not been applied to household energy services. Until recently, in the only methodology for household-scale renewable electricity provision, historical energy use was one of the baseline options, with the others being a diesel generator producing the same electricity or the electricity consumption in the closest grid-connected communities. While the last option could have addressed suppressed demand, the cost of monitoring is prohibitive for a small-scale project. The diesel generator option is also problematic because the default emission factor used in the methodology is for a 200 kW capacity generator or larger. This implies that the most realistic alternative to household-scale renewable electrification is a local diesel mini-grid, when the capital cost for the latter would clearly be beyond the reach of that community even if the demand for energy services were there.

New methodologies and approaches are now emerging, along with important guidelines from the EB, to address suppressed demand. In early 2011 a methodology for water purification was approved (AMS II.AV) which used project water-consumption levels to determine baseline emissions, even if the households did not boil that much water historically owing to lack of time and income. For rural electrification, AMS I.L (for household-scale off grid) and AMS III.BB (for grid connection) approved this year both explicitly define a minimum service level and baseline technology for household lighting and household total electricity use and use a default baseline emission factor to represent that minimum service level. Baseline emissions therefore do not require monitoring, which simplifies the monitoring process considerably.

In July 2011 the EB approved guidelines on the treatment of suppressed demand in CDM methodologies (UNFCCC, 2011e). The guidelines provide methodological approaches for identifying the baseline technology/measure at which there is suppressed demand and identifying the baseline service level used to calculate baseline emissions. The EB defined the minimum service level as “the service level that is able to meet basic human needs (e.g. basic housing, basic energy services including lighting, cooking, drinking water supply). In some situations, this service level may not have been provided prior to the implementation of the CDM project activity”. The guidelines apply to any situation “when a minimum service level, as defined above, was unavailable to the end user of the service prior to the implementation of the project activity”. The guidelines outline the approach and principles for setting a minimum service level “that satisfies basic human needs and makes possible the development of the type of project”. The following guidance is also provided:

14. The minimum service level should be realistic and reasonable but not overly conservative. The minimum service level should be so chosen that over a long time horizon, it will always be reached (with rare exceptions, such as a protracted conflict or a regional/global economic collapse).

15. For establishing a minimum service level the following approaches may be used:
    (a) National/international peer-reviewed research or relevant studies;
    (b) Benchmarks that take into account that emissions will rise to achieve the international/national development goals.

16. Further, in setting the minimum service level, the following should be taken into account:
    (a) Environmental integrity of the emission reductions has to be safeguarded;
    (b) Financial viability of the CDM project cannot be the predominant determining criteria;
    (c) Normative decisions have to be clearly referenced and explained;
    (d) Decisions regarding suppressed demand have to be re-evaluated and updated periodically based on recent data to ensure they are based on realistic assumptions.

More recently, the EB proposed a work programme on suppressed demand, which includes identifying methodologies for revision, public and expert consultation, revising methodologies and revising the guidelines themselves (UNFCCC, 2011i). In May 2012 the EB agreed on a list of priority methodologies to be revised to account for suppressed demand (see box 2). The criteria for choosing these methodologies included the opportunity to enhance the regional distribution of CDM projects, the wide use of the methodology by communities, whether minimum service levels can be considered in that technology area, and the exclusion of methodologies addressing industrial gases, processes and large-scale grid power generation (UNFCCC, 2012a).

Box 2. Priority methodologies for revision to account for suppressed demand

The following methodologies were made priorities by the EB in May 2012 for possible revision to accurately account for suppressed demand:

(a) AM0025 "Avoided emissions from organic waste through alternative waste treatment processes";
(b) AM0046 "Distribution of efficient light bulbs to households";
(c) AM0086 "Installation of zero energy water purifier for safe drinking water application";
(d) AM0094 "Distribution of biomass based stove and/or heater for household or institutional use";
(e) ACM0014 "Mitigation of greenhouse gas emissions from treatment of industrial wastewater";
(f) ACM0016 "Mass rapid transit projects";
(g) AMS-I.A "Electricity generation by the user";
(h) AMS-I.E "Switch from non-renewable biomass for thermal applications by the user";
(i) AMS-II.E "Energy efficiency and fuel switching measures for buildings";
(j) AMS-III.AR "Substituting fossil fuel based lighting with LED/CFL lighting systems".

In addition, AMS III.F "Avoidance of methane emissions through composting" was revised to account for suppressed demand.

Source: EB 67 report.

9.3 Implications and concerns

The main concern raised by stakeholders regarding accounting for suppressed demand is that increasing baseline emission levels beyond historical emission levels could inflate the number of CERs issued and therefore undermine the environmental integrity of the CDM (e.g. Kollmuss, 2012). This concern does not imply that the household-level projects are not important, or that they are currently treated fairly, but that perhaps the CDM is not the best mechanism to address these project types.

The risks of increased crediting depend on the rate at which project beneficiaries would increase their emissions without the project, and how the minimum service level or other benchmark service level is set for that technology. If minimum service levels are set at levels that are achievable within a reasonable time frame (e.g. five to 10 years), this reduces the risk of inflating CER issuance. On the other hand, stakeholders have not criticised ACM2 for allowing crediting without actually displacing other power generation (current or future) and this is the most widely used CDM methodology. There is an underlying 'equity' issue here and a need for consistency across sectors and methodologies.

A related concern is that, even if the minimum service level is agreed, the choice of baseline technology has a dramatic influence on the baseline emissions. For example, the small-scale water purification methodology (AMS III.AR) allows the project participants to use boiling with non-renewable biomass as the baseline technology, even though many households may use low or non energy intensive solutions (e.g. chlorination).

While some case studies are available on specific project types and how the concept of suppressed demand might be applied (GERES & CDC Climat, 2011; Thorne, 2012), there is no research yet on the overall impact on CER generation or emission reduction that could come from including suppressed demand in baselines. The methodologies prioritized for revision represent only 4% of the CDM pipeline so far, and 13% of the PoA pipeline, so clearly there is scope to expand their use. While there may be some tension between increasing the CDM's contribution to sustainable development and ensuring that emission reductions are 'real' and 'measurable', recognizing the future growth in emissions, and incorporating that into baselines, is clearly a priority for the Parties given the decision at CMP 5 in Copenhagen that initiated the EB's effort.

A final concern is how to establish the minimum service levels in a way that is "realistic and reasonable but not overly conservative". This may require not only substantial expert input but also more stakeholder consultation than methodologies typically have received in the past. Because setting minimum service levels is a normative decision and involves expert judgement, the process must be transparent and thorough. This is similar to the challenge faced in setting standardized baselines (see section 8.4).

Building on the ongoing work of the EB on suppressed demand, additional recommendations include:

- Limiting methodological changes to account for suppressed demand to the technologies and sectors that directly address household-level services.
- Developing a clear plan for approving ‘minimum service levels’ and baseline technology choices, including which stakeholders and experts will be involved and how.
- Providing guidance on the time frame within which the ‘minimum service levels’ should be achievable.
- Ensuring that the ‘minimum service levels’ are universal and not country specific.
- Using the methodology revision process to establish consistency across all sectors.
- Providing guidance on how often the ‘minimum service level’ and/or baseline technology should be reviewed and, if necessary, updated.

10 Conclusions

The purpose of this final chapter is to highlight the key findings of the research and to provide a summary of the options for enhancing the impact of the CDM. While some of these findings and options have been presented previously in individual chapters of this report, this chapter combines them all and highlights some additional findings that cut across the chapters' themes.

10.1 Key findings on the impact of the CDM

Impact on the cost of compliance for Annex I countries

The analysis presented in this report suggests that the lower bound of savings for Annex I countries through the CDM is $3.6 billion. This is based on both government and private-sector savings. For the private sector, the CDM may have reduced compliance costs for firms in the EU ETS and Japan by at least $2.3 billion for the period from 2008 to 2012. These savings were estimated based on the extent to which CER prices have been below EUA prices. Since CERs have also had the effect of lowering the price of EUAs, the overall savings are likely to have been understated. For the public sector, the use of CERs by Annex I governments to meet their national emission limitation commitments will yield an additional $1.3 billion in savings.

Impact on sustainable development

At an operational level, DNAs articulate the concept of sustainable development to include at least three dimensions: the social, the economic and the environmental. The actual definition of sustainable development criteria and indicators, however, differs significantly across countries.

The majority of the studies on the impact of the CDM agree that the CDM has a positive impact on the various facets of sustainable development in the host countries. Employment generation was one of the most widely reported impacts in the literature. Studies note that the CDM is the only climate change mechanism that offers an innovative solution to the challenge of how to incorporate sustainable development considerations into emission mitigation activities. Even some of the studies that question the extent of its sustainable development impacts find that the CDM has contributed to the development of a global carbon market, allowing for temporal and spatial flexibility in achieving emission reduction targets.

A common view among stakeholder inputs to the CDM Policy Dialogue is that **capacity-building for low-carbon development within developing countries may be one of the most important sustainable development impacts of the CDM**. This capacity-building has not only engaged the local private sector in climate change mitigation and increased awareness of mitigation opportunities, but has also laid the foundation for domestic climate change policy, including emissions trading and other programmes, in many major developing countries.

In terms of project types, most studies conclude that industrial gas projects have fewer co-benefits than renewable energy and forestry projects, but a few studies challenge this finding, arguing that industrial projects can also have significant benefits. All studies agree that renewable energy projects can be particularly beneficial to developing countries. A study comparing project impacts in different countries suggests that Indian projects bring greater benefits for infrastructural development than either Chinese or Brazilian projects, but with the involvement of less technology transfer. On the other hand, Chinese projects contribute strongly to the protection of the local environment and natural resources. A comparative assessment of the performance of labelled projects (i.e. projects with additional certification from outside of the UNFCCC, such as GS and CDCF projects) versus non-labelled ones concluded that, overall, labelled projects do not significantly surpass non-labelled ones in terms of sustainable development benefits. However, the influence of labelled projects on the social aspects of sustainable development tends to exceed that of comparable ordinary activities, while the opposite holds true for their contribution to economic development.

In addition to reviewing the literature, this study conducted an analysis of 202 registered PDDs to assess the reported contribution to sustainable development. **The results of the PDD analysis show that 99% of PDDs reported sustainable development benefits: 96 % mentioned economic benefits, 86% mentioned social benefits and 74% mentioned environmental benefits.** Most of the PDDs mentioned more than one sustainable development benefit. Among sustainable development indicators, most of the PDDs mentioned benefits in terms of: improved local quality of life (82%), employment generation (80%) and contribution to national energy security (76%). In the sample of 79 small-scale and 123 large-scale projects, sustainable development benefits are mentioned more often in relation to small-scale projects than to large-scale projects. In the case of around 5% of the large-scale projects the PDDs did not mention any sustainable development benefit other than the transfer of technology.

Impact on Annex I Party ambition levels under the Kyoto Protocol

While in retrospect it is clear that the CDM has reduced the compliance costs for Annex I countries to meet their commitments under the Kyoto Protocol, the prospect of reduced costs due to the CDM does not appear to have been a factor in defining the ambition of the quantitative emission reduction commitments made by Parties in Kyoto in 1997. The complexity of the negotiations, the focus on other issues and the lack of information on the potential of the CDM meant that negotiators did not make quantitative links between the availability of the CDM and the emission reduction targets in the final agreement. The current negotiations on the future of the climate change regime, however, are very much informed by the quantitative analysis of various flexibility mechanisms and that analysis will be very likely to influence any future emission reduction targets.

Impact on net GHG emissions

The CDM was intended as a zero-sum instrument, allowing increased emissions in developed countries in exchange for corresponding decreased emissions in developing countries, with no net impact on global GHG emissions. In practice, however, to the extent that some CDM projects may not have been additional, or may have been awarded more credits than the actual emission reductions achieved (e.g. due to overly high baselines, leakage or perverse incentives), the CDM could lead to a net *increase* in global GHG emissions. By contrast, if CDM projects have caused more emission reductions to occur than the number of credits issued and used (e.g. baselines are conservative and technologies outlast their crediting periods), then the CDM could lead to a net *decrease* in global GHG emissions.

This report finds that, to a large extent, assessment of the net mitigation impact of the CDM hinges on judgements regarding the additionality of CDM projects in the power sector, especially wind and hydro, but also natural gas, coal, waste gas capture and biomass energy power projects. These project types are projected to be the source of over half of the CERs issued by 2020. Researchers have expressed concerns that a substantial portion of these projects should be considered non-additional, leading to a significant net increase in global GHG emissions. Project developers, in contrast, have asserted that these concerns are “outdated” or “unfounded”. If these projects are indeed largely additional, they would represent a potentially large source of undercrediting, owing to the potential for these projects to operate well beyond their 10- or 21-year crediting periods. The difference in views on power sector project additionality translates to a wide divergence in the total net mitigation impact of the CDM.

Industrial gas (HFC and N_2O) destruction activities have been among the most controversial CDM projects and by far the most important sources of CERs to date (i.e. accounting for 75% of issued CERs). While evidence suggests that perverse incentives and leakage have thus far led to more credits being issued than actual emission reductions achieved, methodological changes and the expected decrease in the share of CERs issued and used for these project types mean that these projects are relatively less important in terms of the net emissions impact of the CDM going forward.

Impact on energy security

While most CDM project types have the potential to increase security of energy supply by utilizing domestic resources or improving efficiency, it is difficult to see this impact at the national level. In terms of supply security, most of the major host countries are more dependent on imported energy than they were a decade ago. In addition, some of the proposed advanced fossil fuel CDM projects are located in coastal areas and will import their fuel, even though most of these projects use domestic resources. In terms of access, the CDM has had a limited impact on increasing access to energy services, but this is changing with the growth of PoAs focused on basic energy services and efficiency.

Impact on clean energy investment

Almost all countries have significant renewable energy resources, the development of which could increase national energy security. **Large-scale renewable power is the largest CDM project category and, within this, wind, hydropower and biomass are the largest contributors to new electricity capacity.** Registered CDM projects have accounted for more than 110,000 MW of renewable electricity capacity over the last 10 years, which is roughly the total power generation capacity of Africa. More than

90% of this renewable electricity capacity is in five countries: China, India, Brazil, Vietnam and Mexico. **The challenge is that the underlying economics of these large renewable-power projects, which are favourable in many markets, and the small contribution of carbon revenue to profitability make it very difficult to judge whether the projects are driven by the CDM or other widespread national incentives** for renewable power development. Stakeholder views and the literature suggest the CDM may have had a major impact on smaller renewable energy markets and catalysed market development in the wind power sector in India, but that projects may have been driven primarily by national incentives rather CDM benefits in some sectors in China. **Demonstrating additionality conclusively will always be challenging with these technologies, owing to the small financial impact of CERs.**

The CDM also includes substantial investments in natural gas (~27,000 MW) and high-efficiency coal (~16,000 MW), as well as in power generation using waste heat and waste gases (~6,000 MW). **While these fossil fuel projects are generally based on domestic energy resources, some also use imported fossil fuels** and there is no distinction made between these two types of projects, despite the associated implications for energy security. High-efficiency and lower-carbon fossil fuel projects have faced accusations of being common practice, both because almost all new projects (particularly in India and China) are applying for the CDM and because the financial impact of carbon revenue is small, as is the case for wind and hydropower. **Unlike the renewable power projects, however, the additional challenge for non-additional fossil fuel projects is that they lock in developing countries to relatively high-carbon growth trajectories.**

Energy efficiency has been almost entirely left out of the CDM, with few approved methodologies and projects, because the traditional barriers facing energy efficiency (e.g. split incentives, information asymmetries and transaction costs) have been amplified under the CDM. The success of the Indian CFL programme notwithstanding, many experts argue that tapping energy efficiency potentials requires either a new, more focused, mechanism or significant changes in the CDM rules.

Impact on technology transfer

While technology transfer is not explicitly included as an objective of the CDM, other decisions of the COP have alluded to the importance of technology transfer under the UNFCCC. In summary, the literature cites a range of impacts on technology transfer: from the CDM contributing “significantly” to technology transfer (UNFCCC, 2010), through technology transfer taking place in less than half of the CDM projects (Dechezleprêtre et al., 2008), to technology transfer being minimal (Das, 2011). Importantly, the latter study uses a more stringent benchmark for establishing technology transfer than all of the other studies.

According to previous empirical studies, 27–39% of CDM projects report technology transfer as a component of the project design. However, because projects are not required to report technology transfer, a substantial portion of projects that do not explicitly claim this benefit may nevertheless involve some form of technology transfer. For example, a recent study based on a follow-up survey after an analysis of PDDs indicated that the actual proportion of projects involving technology transfer could be as high as 44%. Technology transfer is reported more often for large-scale projects. Most, but not all, studies find that unilateral and small-scale projects are less likely to involve technology transfer. Host-country policies can also have an impact on the rate of technology transfer. In addition, previous studies indicate that the frequency of technology transfer claims has remained stable as a share of the number of projects but has declined as a share of the estimated annual emission reductions.

According to **the PDD analysis carried out for this study, 27% of registered projects analysed reported some form of technology transfer**. Most of these projects reported both transfer of equipment and knowledge. Some sectors, such as coal mine methane and reforestation, did not report any technology transfer within this sample, while others, such as renewable energy and methane avoidance, reported higher than average levels of technology transfer. Higher levels of technology transfer are reported for small-scale projects than for large-scale projects, which is surprising given the findings of previous studies and may reflect the smaller sample size. The analysis found that the leading countries in terms of transferring technologies were Japan, Germany, the USA, Denmark, Italy and the United Kingdom.

Financing for CDM projects

The estimated capital investment for 4,832 registered or soon-to-be registered CDM projects is $215 billion. Annual investment peaked in 2008 at about $41 billion. A large number of projects are undergoing validation and they could lead to a new, much higher, peak for annual capital investment in 2012. Capital investment is dominated by wind and hydro projects and is concentrated in eastern Asia.

Most investment in CDM and Annex I renewable energy projects comes from domestic sources. The indications are that the share of projects with foreign investment has been rising, both for CDM and Annex I projects, as project size has increased and the industry has grown. The share of projects with foreign investment is higher for Annex I projects than for CDM projects, but the gap appears to be narrowing.

The pattern of foreign investment in CDM renewable energy projects is complex. About half of the projects with foreign investment receive funds from multiple countries. When the investment comes from a single country, it is a little more likely to come from an Annex I country than a non-Annex I country. The largest individual flow of investment is from Hong Kong in Chinese projects.

A comparison of CDM and Annex I renewable energy projects (e.g. geothermal, hydro, solar and wind) finds that CDM projects have a larger average capacity than similar projects in Annex I countries, often three or four times larger. CDM projects are 15% (solar PV) to 50% (geothermal and solar thermal power) less capital-intensive ($/MWe capacity) on average than similar Annex I projects. The average capital investment in both CDM and Annex I renewable energy projects has increased significantly over the past decade.

Many of the barriers to investment in CDM projects (e.g. poor investment climate and regulatory frameworks) are not specific to the CDM project cycle, but are generic challenges faced in relation to domestic and foreign investments in developing countries. In addition, barriers at the international level (e.g. CDM rule complexity) may affect all countries, while national and project-level barriers (e.g. access to finance and lack of migration potential) influence the distribution of CDM projects and CERs across countries. Important CDM-specific barriers at the national level are the CDM regulatory framework and institutional capacity, which goes beyond the DNA to include lack of project consultants, auditors and financiers within the host country.

Regional distribution of CDM projects

As a market mechanism, the **distribution of CDM projects and CERs has generally matched the distribution of mitigation potential across countries**. This has meant that many countries with small economies and low emission levels have been left out of the CDM entirely, although the number of countries participating continues to grow. The emissions of many countries in Africa and in the group of the LDCs, as well as some in Asia, constitute a very small share of non-Annex I emissions, so many do not yet host any CDM projects and those that do account for only a small share of the CERs issued.

While the most important driver of project distribution is national mitigation potential, the general investment climate is also critical. Having a strong CDM institutional capacity and framework is necessary but not sufficient in itself to attract projects. At the project level, lack of access to early-stage seed funding for CDM costs and the high unit transaction costs are important barriers to CDM project development in many poorer countries, but it is often the lack of underlying project finance that prevents CDM projects from moving ahead in the underrepresented countries.

Because of their low emission levels and small national economies, **opening up CDM opportunities for underrepresented countries will require simplification and streamlining of the CDM rules, innovative approaches to the development of national capacity and the mobilization of financing for both transaction costs and underlying project investments**.

Suppressed demand

One of the challenges of applying GHG emission accounting approaches in poor communities is that the current consumption of many household services (e.g. heating and cooking energy, lighting and potable water) may not reflect the real demand for those services. This could be a result of lack of infrastructure, lack of natural resources or poverty, particularly the high costs of these services relative to household incomes. The situation of 'suppressed demand' creates a problem for setting baselines and has negatively affected CDM project development in Africa, the LDCs and other underrepresented areas. Ironically, although new large-scale power plants do not have to show that they actually displace other plants (existing or new), many small-scale energy projects can only claim credit for displacing historical (very low level) emissions from households. **The new guidelines from the EB on accounting for suppressed demand are an important step forward; implementing them will require significant expert and stakeholder input to ensure that simplification is balanced with maintaining overall environmental integrity.**

10.2 Options for enhancing the impact of the CDM

The options below have been developed on the basis of reviews of the literature, stakeholder inputs to the CDM Policy Dialogue process, interviews with experts in the field and the analysis conducted by the research team. Given that the focus of this research was on the impacts of the CDM, the options for the future have not been subject to a feasibility analysis or an analysis of the politics surrounding their implementation. For more detailed institutional analysis and context, readers are referred to the two other research reports prepared for the CDM Policy Dialogue on the governance of the CDM and the future context of the CDM.

Not all of the options below can be implemented by the EB, as many would require approval by the CMP or may even be implemented by actors outside the UNFCCC. The actors involved in each option are illustrated in table ES1.

Sustainable development

For most stakeholders sustainable development is one of the most important impacts of the CDM and there is a desire to enhance this impact. In addition, almost all stakeholders would agree that any interventions should not infringe upon the host country's right to determine if a given CDM project meets its sustainable development priorities. There is broad commonality across countries as to how they define sustainable development criteria at a high level, even if the detail of this application varies widely.

Depending on individual stakeholder priorities, there are three possible objectives of interventions related to sustainable development impacts: (a) increasing the overall sustainable development benefits originating from the CDM project pipeline; (b) measuring and reporting those benefits to the DNAs and other stakeholders; and (c) systematically preventing negative impacts. However, there may be differences amongst stakeholder groups in prioritizing interventions. For example, stakeholders that feel that CDM projects are generally delivering many positive benefits may want to focus on preventing negative impacts rather than increasing the monitoring of benefits. On the other hand, stakeholders that feel that negative impacts are best addressed at a national level may instead focus more on the measurement of impacts and enhancing benefits. The caveat to these choices is that it will be difficult to measure progress towards either greater positive impacts or fewer negative impacts without some form of monitoring and reporting system.

Providing a 'menu' of sustainable development indicators could enhance the documentation of the sustainable development benefits of the CDM. This menu could be compiled from current criteria or other international sources. Given that most DNAs already have criteria, they could also make these more accessible by reporting their own sustainable development criteria on the UNFCCC website, just as the national definitions of forest are currently reported.

Revising the PDD format to provide more guidelines on how project participants should declare their sustainable development contributions could assist DNAs in their decision-making process, whether or not the guidelines were linked to a list of specific indicators.

Improved voluntary reporting of sustainable development benefits could go a step further, providing for both initial and ongoing declarations. These declarations could rely on either DNA-specific guidelines or draw on international reporting options. Any monitoring would have to be designed in such a way as to minimize the transaction costs.

Mandatory monitoring of sustainable development benefits would provide a much more robust information base for the DNAs and other stakeholders than simple declarations in the PDD. There are many variations to monitoring, but none of these should infringe on the host country's sovereign right to determine if a project meets its own sustainable development criteria. The DNA and project participants could choose which indicators were appropriate for the specific project, in the light of the host country's priorities. The monitoring could be supervised by the DNA, according to national criteria and procedures, or could be part of the UNFCCC project cycle. Verification could be conducted at validation and/or during verification (i.e. after project implementation). While this would add transaction costs, without some verification it is unclear how reliable any reporting would be.

Safeguards against negative impacts, such as human rights violations, corruption and labour exploitation, could also be strengthened in several ways. As a first step, the DNA could ensure that claims of negative impacts were taken up within the legal structure and processes of the host country. In addition, the PDD could be expanded to include a checklist of key safeguard issues. As with the reporting of benefits, the reporting of safeguards could happen at the start of the project only, or they could be reported periodically after implementation. The verification of compliance with safeguards could be undertaken by the DNA along with the verification of sustainable development benefits.

The consequences of inadequate performance could range from project developers being provided with information to assist them with compliance through to suspending the further issuance of CERs for a project. This could be based on the project not following through on sustainable development benefits and/or the project violating one of the safeguards. The DNA could decide on this, however, according to national criteria and procedures.

Preferences for specific project types or technologies could be established to differentiate eligibility and procedures across project types, scales or regions. This would require broad political agreements as well as a sound empirical evidence base upon which to prioritize.

Capacity-building for DNAs could strengthen the ability of DNAs, particularly those with the least resources, to apply their national criteria for sustainable development in the project approval process. This could include the sharing of experiences at a regional and subregional level and providing information on 'best practice' in project evaluation.

Although not discussed in detail in this report, an **enhanced stakeholder consultation and appeals process** could also strengthen positive sustainable development impacts. The options for this are discussed in the report on the governance of the CDM. DNAs could work towards strengthening the process of local stakeholder consultation. The relevant local authorities could be made more aware about sustainability issues and their role in the effective implementation of sustainable development benefits. Negative sustainable development impacts could be one of the possible grounds for a grievance. The governance reforms proposed under an enhanced stakeholder consultation and appeals process are also relevant to sustainable development impacts, particularly negative ones.

Regional distribution

Given the importance that the Parties have placed on the regional distribution issue, the following measures could increase access to the CDM in underrepresented countries and regions:

Capacity-building for the local financial sector to mobilize domestic finance – Given that CDM projects are mostly domestically financed, enhancing the awareness and capacity of the local financial sector in underrepresented countries could increase the flow of finance to CDM projects. Host countries in which availability of capital is a constraint could also take steps to encourage greater domestic investment in CDM projects and to facilitate foreign investment in CDM projects.

Including Africa in the 'LDC track' – Given that the guidance of the CMP on 'equitable regional distribution' always specifies Africa as well as the LDCs and countries with fewer than 10 projects, African countries could be included in all of the special provisions made for the LDCs in the CDM rules.

Focused DNA support – Focusing on the sharing of experiences and best practices, particularly within regions, to faciliate joint decision-making on regional PoAs.

Grants and/or loans for transaction costs – The CDM Loan Scheme should be critically reviewed after one year to determine its effectivenss at removing barriers related to transaction costs. In addition, a grant scheme could be considered for some portion or all of these transaction costs, for particular project types or area where the loan scheme is not effective.

Standardization of parameters, including standardized baselines – The creation of a special standardized baseline track for household-level services (e.g. electrification, water purification and cooking). Guidance on specific standardized parameters (e.g. fraction of non-renewable biomass by country) should also be provided by the EB.

Standardization of procedures – A further simplified project cycle could be applied to projects from underrepresented regions, including automatic registration (e.g. the elimination of validation procedures in favour of listing projects with the UNFCCC on the basis of clear templates and checking these requirements at initial verification). This could also be done on the basis of project scale, with micro-scale projects benefiting from expedited procedures.

Technology transfer

Several actions could improve the transparency of technology transfer benefits and enhance this impact of the CDM:

Improved database and data availability would involve the UNFCCC improving the way in which data on technology components and transfer are generated from the large number of projects in the pipeline and presented. A database could be created with more information on technological specifications and the name of the technology supplier or technical project developer. This may further facilitate technology transfer for new countries and potential project participants.

Improved reporting on technology transfer could address the issue of the limited information on technology transfer currently provided in PDDs, which is often inadequate and inconsistent. More comprehensive and clear information on technology transfer would enable better decision-making by DNAs. This would most probably require a revision to the PDD format and guidance.

Guidance from DNAs could assist by providing a clear and more operational definition of technology transfer in the project approval process. Host countries could also influence the extent and nature of technology transfer by including technology transfer within their sustainable development criteria, defining the criteria or indicators of technology transfer clearly and implementing these criteria stringently.

Net emissions impact

Shifting towards the sectors with the highest degree of confidence in the additionality of their projects would improve the overall integrity of the CDM, but it would not lead to a net decrease in emissions. To achieve that objective other approaches such as discounting or shorter crediting periods would be needed. There are several options available that could potentially improve or increase the net mitigation impact of the CDM. Each option carries with it a set of advantages and limitations (discussed in detail in the main text of this report) and, in many cases, may run the risk of missing opportunities for otherwise-additional projects to proceed. The findings of this research indicate that:

Discounting credits from particular project types may be a particularly effective option for increasing the net mitigation benefit of project types with relatively certain additionality and very low abatement costs (e.g. HFC destruction at HCFC-22 plants and N_2O destruction at adipic acid plants).

Shorter crediting periods may be a more effective option than discounting for increasing the net mitigation benefit of project types with higher capital costs (and lower recurrent costs) or where it is likely that projects are serving to accelerate the pace of technology adoption.

Creating 'negative lists' (i.e. excluding certain project types) would be the most straightforward approach for project types where additionality cannot be determined with a high degree of confidence, such as some large-scale power generation project types, as discussed below.

Other interventions, such as positive lists, standardized baselines and additionality, and transitioning to policy- or sector-based crediting, could all potentially lead to net mitigation benefits; however, the mitigation outcome would be highly dependent on how such interventions would be implemented (e.g. baseline levels and crediting thresholds chosen).

Large-scale power generation: wind, hydropower, natural gas and coal

Determining additionality with a high degree of confidence is only possible for sectors or technologies for which the incentive provided by the CDM (i.e. carbon revenue) can be clearly demonstrated as the main cause of the project. This means that much more caution is needed in relation to sectors where the incentive provided by the CDM is small relative to other decision-making factors and, as a result, the ratio of the 'signal' (CDM intervention) to 'noise' (other factors) is low. Research findings suggest that the likeliest incidence of a low 'signal-to-noise' ratio is in large-scale power generation, particularly wind, hydropower, natural gas and coal projects. Several options could address this concern:

The improvement of the current additionality approach could seek to increase consistency, transparency and objectivity of investment analysis and common practice analysis. This should be based on detailed research on project economics to clarify the 'signal-to-noise' ratio for these project types. This research would involve detailed analysis of not only the impact of carbon revenue on registered projects (i.e. including assessment of actual carbon prices in contracts), but also the magnitude of this impact relative to variability in other key parameters (e.g. electricity tariffs, capital costs and other public incentives and measures). While there is substantial research on this topic already, as cited throughout this report, no one has taken a comprehensive look at the financial details for these CDM project types. Nevertheless, there could be scope to improve consistency (e.g. whether to use common discount rates across a country rather than those in the PDD) and transparency (e.g. verifying some of the assumptions in the PDD by referring to independent sources) for these projects, so as to clarify the share of truly additional projects.

Alternative additionality determination approaches could also be used for technologies where market-based investment analysis is not appropriate (e.g. where the main determinant of profitability and investment is public decision-making). Market penetration rates, default technology comparisons or other criteria could be used to test additionality rather than the current additionality tool. While the current standardized baseline development process of the EB does not include power generation yet, this could be expanded. The challenge of applying standardized baselines, however, would be that all renewables (except some large hydro and geothermal) are zero-emission sources, so they cannot be ranked by emissions, and the current standardized baseline guidelines still consider financial attractiveness as a key criterion.

Shifting some technologies to sectoral or policy-based (e.g. NAMA crediting) approaches, other new market mechanisms or non-credited climate finance instruments could reduce uncertainty within the CDM. Note, however, that similar challenges of identifying the impact of the carbon market signal on the development of the power sector must still be addressed under any market mechanism if it is to be used for offsetting (and even more so if it is to be used for net reductions).

The restriction of eligibility by geography, scale or subtype could directly address the strongest additionality concerns related to market maturity, public incentives and low 'signal-to-noise' ratio for specific technologies by limiting the CDM to the geographies, project scales or subtypes for which there is the highest likelihood of conclusive additionality testing with investment analysis.

The exclusion of entire categories or technology types would eliminate any uncertainty about additionality for those sectors, but this is obviously more politically difficult and also carries with it the risk of missed opportunities.

Suppressed demand

Building upon the current work of the EB on suppressed demand, options include: (a) limiting methodological changes to account for suppressed demand to methodologies relevant to household services; (b) developing a clear plan for approving 'minimum service levels' and baseline technology choices, including who will be involved and how, and the time frame within which the 'minimum service levels' should be achievable; (c) ensuring that the 'minimum service levels' are universal and not country specific; (d) using the methodology revision process to establish consistency across all sectors; and (e) providing guidance on how often the 'minimum service level' and/or baseline technology should be reviewed and, if necessary, updated.

Table 32. Summary of options for enhancing the impact of the CDM and which actors would implement them

Option	EB	COP	DNAs	Others
Sustainable development				
Provision of menu of sustainable development indicators	✖		✖	
Revision of PDD format with regard to guidelines on reporting sustainable development contributions	✖			
Improved voluntary reporting of benefits	✖		✖	
Mandatory monitoring and reporting of benefits		✖	✖	
Safeguards against negative impacts	✖	✖	✖	
Consequences for inadequate performance		✖		
Preferences for project types		✖	✖	
Capacity-building for DNAs	✖		✖	✖
Enhanced stakeholder consultation and appeals	✖	✖		
Regional distribution				
Capacity-building for local financial sector				✖
Inclusion of Africa in the ‘LDC track’	✖	✖		
Focused DNA support	✖			✖
Grants and/or loans for transaction costs	✖	✖		
Standardization of parameters and baselines	✖			
Standardization of procedures		✖		
Technology transfer				
Improved database and data availability	✖			
Improved reporting in PDDs	✖			
Guidance to project owners on DNA preferences			✖	
Net emissions impact				
Discounting		✖		
Shorter crediting periods		✖		
Negative listing		✖		
Large-scale power generation				
Improvement of current additionality approach	✖			
Alternative additionality approaches	✖	✖		
Shifting technologies to sectoral approaches		✖	✖	
Restriction of eligibility by geography, scale and subtype		✖		
Exclusion of entire categories or types		✖		
Suppressed demand				
Procedures, minimum service levels, technology choice and updates	✖			

Note: Others include the Nairobi Framework partners outside of the UNFCCC, such as UNEP, the World Bank and the African Development Bank.

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Annexes

Annex A Research questions from the terms of reference

This annex contains the original questions from the terms of reference for this research and the chapter/sections of this report in which those questions are addressed.

1. How has the CDM contributed to sustainable development? What options are available to strengthen this contribution?

Research questions	Section
How is a CDM project's contribution to sustainable development currently assessed?	3.1
What criteria do host countries currently use to determine whether a CDM project contributes to its sustainable development?	3.2
What concerns have been raised about the sustainable development impact of the CDM? What options are there to address these and increase the contribution to sustainable development?	3.2.1, 3.6
What evidence is there that indicates contribution to sustainable development from CDM projects? What are the options to strengthen this contribution?	3.2.1, 3.4

2. Has the CDM allowed Annex I Parties to increase their mitigation ambition by reducing mitigation costs?

Research questions	Section
What has been the CDM's impact on minimizing costs to date?	2.1, 2.2
What impact did the availability of the CDM have on first commitment period ambition among Annex I Parties?	2.3

3. How has the CDM contributed to gross and net mitigation of GHG emissions? How could it in the future?

Research questions	Section
What is the projected gross and net emissions impact of the CDM?	4.1, 4.2, 4.3 , 4.4
What options exist to improve the net emissions impact of the CDM? What are their respective strengths/ weaknesses?	4.5

4. How has the CDM contributed to increased clean energy investments in developing countries?

Research questions	Section
What has been the impact of CDM projects on the share of renewable energy sources and on improved demand-side energy efficiency at the national level?	5.2
What are the views on the inclusion of large-scale hydropower power plants in the CDM?	5.2.2

5. How has the CDM contributed to technology transfer? How could this contribution be strengthened?

Research questions	Section
What are the observed levels of technology transfer under the CDM? Can any trends be identified with regard to technology or region? What options are there to increase this contribution?	6

6. How has the CDM leveraged new and additional financing for mitigation?

Research questions	Section
What are the total and marginal investments that have been leveraged in CDM projects?	7.1-5
What are the trends in terms of CDM investments and investments from other sources in different types of CDM projects? Are any project types more successful in attracting private-sector investments?	7.1-5
What are the key barriers to investment in CDM projects?	7.6

7. How could the CDM increase the regional distribution of projects and mitigation activities?

Research questions	Section
What is the current regional distribution of projects and mitigation activities?	8.2
What factors influence CDM implementation in particular countries and constrain CDM investments in particular regions and LDCs?	7.6, 8.4

8. How have standardized baselines and accounting for suppressed demand been considered and applied under the CDM? How could they be addressed in the future?

Research questions	Section
To what extent has suppressed demand for energy and other services as a result of poverty, lack of infrastructure or natural resources been recognized as a means of carbon accounting and operationalized as a source of future avoided emissions?	9.1, 9.2
To what extent have standardized and other default baseline emission levels become standard practice in the CDM? (Most of this discussion was moved to the governance report)	8.4
Are suppressed demand and standardized baselines pertinent issues for the future of the CDM, what are the implications if these are taken into account and how should CDM procedures be reformed in this regard?	9.3+

Annex B Data sources and projections of CERs

This report was drafted by several authors who based their research and analysis, in part, on different datasets or on the same datasets but at different periods. As such, the reader should bear in mind that the values presented in this report are consistent with one another but may not be exactly the same. The sources are:

- BNEF as of May 2012. BNEF's Asset Finance Channel is a database of all major financing events related to specific renewable energy assets worldwide. It includes the asset values (capital investment) for individual projects for Annex I and non-Annex I countries from 1978 to 2035 by year of financial closure, the originating country of the investment and debt/equity information.

- UNFCCC (CDM) Analytical Database as of June 2012. This database is compiled from data available from the UNFCCC secretariat for individual projects and augmented with many other variables. It includes, inter alia, project status, project-specific data on the expected and issued CERs, the crediting period chosen and several dates used for time series (e.g. PDD submission, registration, monitoring and issuance dates). The database also includes data captured from PDDs during several PDD capture campaigns. In some cases there may be slight differences in the day upon which a dataset is valid, because the database does not allow for extracting datasets retroactively (i.e. a June 6 dataset will have all projects registered as of June 6, but cannot show all projects with their status as of June 1). This database was also used to calculate average project lifetimes for power projects, as reported in chapter 4.

- The last capture campaign provided data for all registered CDM projects and for a selection of projects at various stages of validation as of April 2012. For this report, these data as contained in the UNFCCC (CDM) Analytical Database were used to determine the capital costs expected for projects as well as their operational costs and revenues.

- Data captured by the Tata Energy and Resources Institute from a random sample of 202 PDDs of registered CDM projects as of June 2012 to evaluate the impact of the CDM on sustainable development and technology transfer.

- The UNEP Risø Centre CDM Pipeline as of June 1, 2012. This monthly data source was used to classify projects by UNEP type and subtype, to analyse power generation capacity and to contribute to the capital cost data.

- The IGES CDM databases as of May and June 2012. The June 1 CDM Project Database was used to establish the start date of CDM projects and to assemble the statistics presented in chapter 4 on project registration and issuance to date and is captured by IGES from the PDDs. The May 15 version of the CDM Investment Analysis database was used to analyse the impact of carbon revenue on project profitability. The May 1 version of the CDM Project Data Analysis & Forecasting CER Supply spreadsheet was used for forecasts of CER issuance by project type for projects in the pipeline as of that date (chapter 4). Where IGES categories were too aggregated to allow for analysis of project types that are a significant focus of the additionality literature, IGES forecasts were disaggregated into other project types or subtypes using project data in the June 1 version of the CDM Project Database.[113]

- Data on national carbon dioxide emissions (World Resources Institute), GDP (World Bank), population (World Bank) and FDI (World Bank) as of 2010, contained in the UNFCCC Analytical Database.

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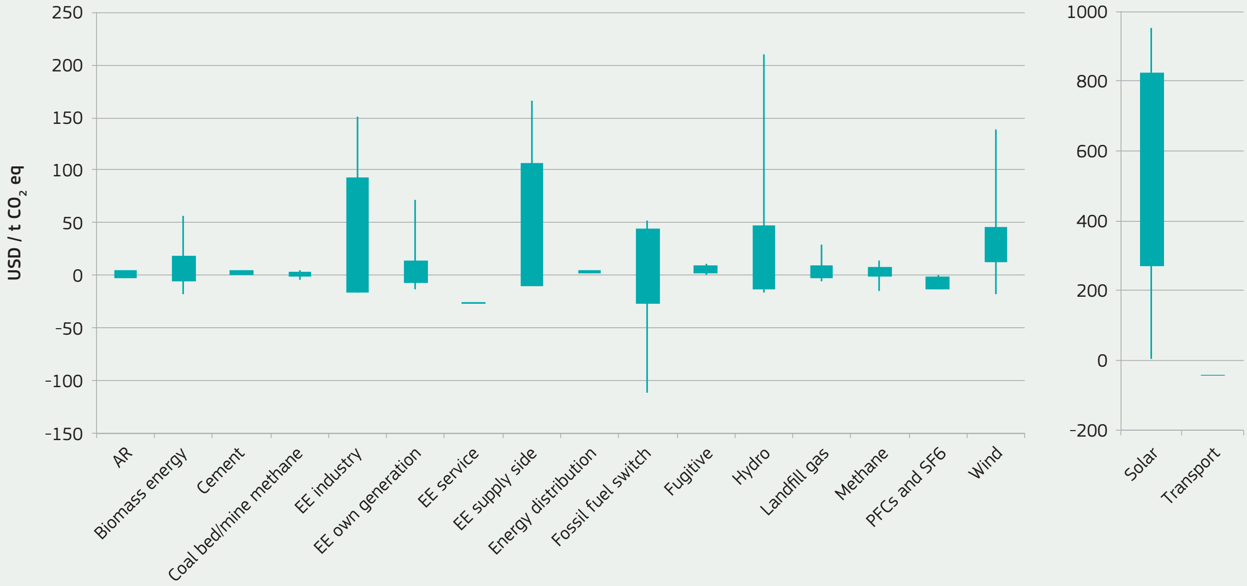
[113] Disaggregation was used mostly to split N_2O into adipic and nitric acid as well as to further disaggregate coal mine methane, landfill gas, iron and steel waste gas and fuel-switching projects. No adjustments or disaggregation were conducted within HFCs, hydropower, wind and other renewables (the largest sectors for historical and future CERs).

Annex C Detailed mitigation costs by length of crediting period

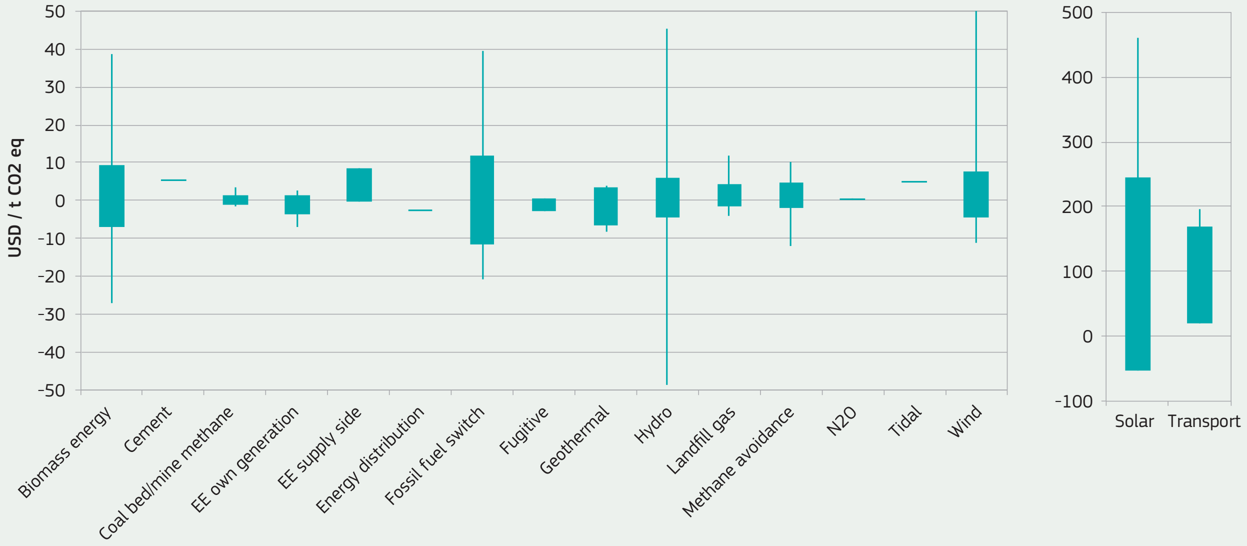
The two figures below are supplementary material for chapter 2.

Figure 45. Project mitigation costs for fixed (10-year) crediting period



Source: Authors' calculations using BNEF data for 4,808 CDM and 6,445 Annex I renewable energy projects with known investor origins.

Figure 46. Project mitigation costs for renewable (up to 21-year) crediting period



Source: Authors' calculations using BNEF data for 2,638 CDM and 8,199 Annex I renewable energy projects with known investor origins.