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Sustainable Development Benefits of Clean Development Projects

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Abstract: The Clean Development Mechanism (CDM) is part of the global carbon market developing rapidly in response to global warming. It has the twin objective to achieve sustainable development (SD) in host countries and assist Annex-1 countries in achieving their emission reduction targets in a cost-efficient manner. However, research has shown that trade-offs between the two objectives exist in favour of cost-efficient emission reductions and that left to the market forces, the CDM does not significantly contribute to sustainable development. The main argument of the paper is the need for an international standard for sustainability assessment – additional to national definitions - to counter weaknesses in the existing system of sustainability approval by Designated National Authorities in host countries. The article develops a new methodology, i.e. a taxonomy for sustainability assessment based on text analysis of the 744 Project Design Documents (PDDs) submitted for validation by 3 May 2006. Through analysis of the SD benefits of all CDM projects at aggregated levels the strengths and limitations of the taxonomy are explored. The main policy implication of the research is to propose the taxonomy as the basis of an international verification protocol for Designated Operational Entities (DOEs) for reporting, monitoring and verifying that potential SD benefits described in the PDDs are actually realized.

Keywords: Clean Development Mechanism (CDM), Sustainable Development Benefits, Methodology

1. Introduction

Political differences between the North and the South over the framing of global climate change and sustainable development as an environmental or a development problem are reflected in the Clean Development Mechanism's (CDM) double aim to achieve sustainable development (SD) in developing countries and cost-effective reduction of greenhouse gasses in developed countries. In Marrakech 2001 at the annual Conference of the Parties (COP-7) to the Climate Convention and the Kyoto Protocol, where the main part of the 'rule book' for operating the CDM was decided upon, the responsibility for achievement of SD was delegated from the international to the national level in host countries. Rather than setting international standards for sustainable development, which developing countries argued would impinge on their sovereignty, Designated National Authorities (DNAs) in developing countries are mandated to issue a Letter of Approval (LoA) or reject CDM projects according to each country's own national SD criteria.

Since the COP-7 issues about the CDM's contribution to SD have not directly been addressed in international policy negotiations but have rather been repackaged and addressed more indirectly in debates such as programmatic CDM[1] (Figueres, 2005a, Figueres, 2005b, Bradley and Baumert, 2005, Bosi and Ellis, 2005, Sterk and Wittneben, 2005, Baron and Ellis, 2006) and how to promote a more equitable distribution of CDM projects (Jung, 2006). In a recent review of the research literature on how the CDM contributes to sustainable development, it was found that left to the market forces, the CDM does not significantly contribute to sustainable development (Olsen,

[1] At COP/MOP-1 in Montreal, December 2005 a decision on programmatic CDM (par. 20) brought together three previously discussed concepts; sector, policy and private sector based initiatives. The common idea of these concepts is to overcome weaknesses of the current project-approach limiting the scope of the CDM. Shortly described the aim is to broaden the scope of the CDM by using sector or policy standards rather than project baselines. For example a target can be set for mixing bio-fuels into petrol or promoting a certain share of energy sources coming from renewable sources. The concept of programmatic CDM is not only relevant for the current Kyoto regime 2008-12 but have opened discussions on the principles for future commitments post 2012 including both developing and developed countries. A fast growing body of literature has developed up to COP/MOP-1 and afterwards discussing the methodological challenges of implementing programme CDM project activities and its future potential.

2005). At the heart of the CDM's inability to achieve SD is the existence of trade-offs between carbon benefits valued in the carbon market and non-carbon benefits such as SD benefits that are not monetized in the carbon market (Sutter, 2003, Kolshus et al., 2001). To address the problem several researchers and policy actors have proposed an international standard for measuring and monitoring the CDM's sustainability contribution (Sutter and Parreno, 2005, Cosbey, 2006, Cosbey et al., 2005).

However, as of yet no such methodology for sustainability assessment of all CDM projects at the global level exists. Furthermore, the potential merits and drawbacks of an international sustainability standard are contested. This article argues for the need of an international standard for sustainability assessment additional to national definitions. According to Article 12 of the Kyoto Protocol stating the twin objective of the CDM, the achievement of SD in developing countries is an equally important objective as reductions of GHGs. Hence, we argue that SD benefits should be 'real' - even if they are not 'measurable' – as GHG reductions are.

The article develops a new methodology for sustainability assessment of all CDM projects globally. Based on text analysis of 744 Project Design Documents submitted for validation by 3 May 2006 the SD benefits of all the CDM projects are assessed. The findings describe *how* CDM projects at an aggregated level contribute to SD. As the nature of the methodology is qualitative there is *no* basis to conclude *how much* the CDM contributes to SD.

The article is structured to propose and illustrate the scope and limitations of a taxonomy for assessment of sustainable development benefits as a way to address the problem of the CDM's poor performance with regard to achievement of sustainable development in developing countries. First, weaknesses in the existing practices of how DNAs define and approve CDM projects' sustainability contribution are identified. A taxonomy is developed and the findings of applying the taxonomy are presented. Policy implications are discussed and finally the article concludes that the taxonomy can be used as an international standard for qualitative sustainability assessment to support verification on whether or not potential SD benefits are actually realized.

2. Designated National Authorities – practices for approval of CDM projects

Since Marrakech in 2001 and especially since Russia's ratification allowing the entering into force of the Kyoto Protocol at 16 February 2005, the main global uncertainties have been clarified and more countries in Asia, Africa, the Middle East and Europe have embarked on institution building to manage and approve CDM projects. However, development of host country institutions is not a new process as it has been ongoing since the early phase of Activities Implemented Jointly (AIJ) from 1999 and onwards (Michaelowa, 2002) supported by capacity development initiatives (Michaelowa, 2004). By 11 August 2006 there were 107 DNAs globally; 88 DNAs in developing countries and 19 DNAs in developed countries (UNFCCC, 2006).

2.1. Global overview of DNAs

In a global overview of DNA's from different regions *Latin America* has the advantage of an early start but this has not resulted in strong institutional frameworks according to Figueres (2004). *Asia's* DNAs are generally younger but development differs highly from one country to another. Some are leading globally (India and China) and others have just started or are in the process of institution building (Thailand, the Philippines and Indonesia). *Africa* expects and receives little CDM investment but partly due to capacity development support, a substantial number of countries (18) have established DNAs (Wittneben, 2005). In the *Middle East* few countries have yet established DNAs (Morocco, Egypt and Tunisia) but since the entering into force of the Protocol more countries have decided to reap the benefits of the emerging carbon market and are now beginning to establish CDM offices. *Southern-Eastern Europe and Countries in Transition* is the region furthest behind in CDM institutional development. Only a few countries in this region have designated DNA contact points and only one of them is operational with fully-fledged SD criteria and approval procedures (Findsen and Olshanskaya, 2006). Annex-I countries that have ratified the Kyoto Protocol are also required to establish DNAs in order to participate in the CDM. Before registering a CDM project a LoA is needed from the host country. Until a LoA from the buyer country is issued, the project is unilateral. When a LoA from the buyer country is signed, the project is considered bilateral.

2.2. Sustainable development criteria and processes for approval of CDM projects

Analysis of the practices of DNAs with regard to their functions, institutional and legal set-up do exist overall (Michaelowa, 2003, Jung, 2006), for Africa (Winkler et al., 2005, Wittneben, 2005) and Latin America (Figueres, 2004, Figueres, 2002). However, focusing on practices for sustainability assessment and approval processes and including all regions, the information is more scattered and only a few sources exist from the ‘grey literature’ (Pitayataratorn, 2006). The following assessment draws on data available on the internet describing the operation of selected DNAs in addition to existing studies. The assessment looks at examples of DNA practices in the two largest host countries - in terms of the number of projects in the validation pipeline - in Asia and Latin America as well as the largest DNAs in Africa, the Middle East and Europe. Table 1 provides an overview for comparison of SD criteria, other project eligibility criteria, documentation required and approval processes between regions and countries.

INSERT TABLE 1 HERE

The most commonly used approach to the establishment of SD criteria among the seven selected host countries is the checklist approach. However, the definition of criteria differs from one country to the other. India, South Africa and Morocco define each their domestic SD criteria along three or four dimensions of sustainable development. Brazil and Mexico also use a checklist of sustainability criteria but based on existing policies as the qualitative threshold CDM projects at least must meet. China on the other hand uses a different approach that discriminates between CDM projects based on project types. The reason to favour project types in the priority area is that these are seen to support domestic environmental and energy policies. Chemical gas-based CDM projects, such as N_2O, HFC and PFC reductions with few inherent SD contributions, are negatively discriminated by high taxes. Levies are pooled in a Clean Development Fund with the aim of supporting sustainable development in other ways.

The use of other eligibility criteria for approval of CDM projects varies significantly between countries. India and South Africa make no other requirements to approve CDM projects, whereas China is protective of its right to emit GHGs and do not allow foreign investors a majority share of CER revenues. In between are Brazil and Mexico with various additional requirements e.g. for the annual monitoring of the production of CERs produced. At international level the Designated Operational Entities (DOEs) are required to validate and verify that GHG reductions are ‘real and measurable’ and the information is publicly available on the UNFCCC website. Therefore it seems superfluous to demand this information also at national level. Differences in the use of other eligibility criteria in addition to different institutional frameworks between countries and regions are part of competition strategies between countries to attract investments (Jung, 2006).

In all seven countries the PDD is the basis for sustainability screening before issuing a LoA. India also requires project proponents to make a presentation of the proposed CDM project and most other countries offer a voluntary pre-screening based on Project Idea Notes (PINs) or Project Concept Notes (PCNs). With regard to approval processes most countries promise speedy decision processes between 1-2 months for a LoA and between 2-4 weeks for a Letter of Endorsement (LoE).

2.3. Weaknesses in the practices of DNAs for approval of CDM projects

No countries, however, require that the expected SD benefits - as described in the PDD - are monitored on an equal basis with GHG reductions to verify that they are 'real and measurable'. The Designated Operational Entities (DOEs) as part of their validation report include a checklist of questions on the proposed project's contribution to sustainable development. The means of validation is interviews with project stakeholders through contact information provided by the project developers. When the DOEs need to *verify* the project's GHG reductions, the contribution to sustainable development is not included in the assessment[2] and it is not a requirement at international level and neither at national level that sustainable development benefits are actually realized.

3. A taxonomy for assessment of sustainable development benefits from CDM projects

Towards the development of an international standard for measuring and monitoring all CDM projects' sustainability contribution, we propose a taxonomy of sustainable development benefits.

3.1. Shortcomings of existing methodologies

Existing methodologies for sustainability assessment can be divided into different approaches (Olhoff et al., 2004, Sutter, 2003) of which the most commonly used are checklists and multi-criteria assessments. For a review of the methodological literature see Olsen (2005).

3.1.1. Checklist approaches

In checklist approaches – as shown in Table 1 - the sustainability assessment is done qualitatively by people appointed in the institutional framework of the DNA. The approach is simple to use when the PDD is the basis of assessment and it is easily adaptable to host country priorities for sustainable development such as congruence with existing policies. The latter, however, has been strongly critiqued by Figueres (2004). In an assessment of DNAs in Latin America and the Carribean she argues that existing policies are typically not climate friendly and the lofty goal of achievement of sustainable development is minimized at the operational level. Furthermore, she critiques the CDM for falling short of assisting developing countries in achieving sustainable development. The narrow focus of checklist approaches on projects' compatibility with existing national environmental and development priorities – as opposed to developing new SD policies at sector and policy level - is insufficient to initiate 'sectoral transformation' towards the 'decarbonization of economies' (Figueres, 2004). She further argues that due to DNAs institutional weaknesses the goal of 'achievement of sustainable development' is most often operationalized

[2] Except when a DOE is asked to verify a project in fulfilment of the Gold Standard requirements for SD Standard, T. G. (2006) BASE, Basel, pp. 50.

with a narrow focus on individual projects rather than mainstreaming climate concerns into development policies.

3.1.2. Multi-criteria assessment approaches

The need to make a decision based on multiple factors and types of information is central to multi-criteria assessment approaches (Olhoff et al., 2004). Well known examples are the SouthSouthNorth Matrix tool (SouthSouthNorth 2004) and the Gold Standard, a label for high quality CDM projects in terms of sustainability contribution (Schlup, 2005). According to some methods qualitative and quantitative data can be combined and the relative significance of all the factors is weighed to arrive at a single measure for sustainability. The most elaborated approach is the Multi-Attribute Assessment methodology (MATA-CDM) developed by Sutter (2003) and adopted by Uruguay as the national definition of SD. Applying the MATA-CDM methodology to 16 registered CDM projects, Sutter and Parreño (2005) investigate, if the current CDM is delivering its sustainable development aim. For this purpose they choose three SD criteria and matching indicators: employment, equal distribution of CER returns and local air quality. Data for the analysis is obtained from PDDs, scientific literature and from a survey send to project developers. Based on the 16 registered projects the analysis concludes that the CDM is far away from delivering its sustainable development claim. The strength of these approaches is the participation by stakeholders to decide and/or weight the SD criteria used for the assessment. Weaknesses of the multi-criteria assessment approaches include that the requirements for data and participation by stakeholders are very demanding. Out of 16 surveys send out in the study by Sutter and Parreño only four of them were returned answered. Only a few SD criteria were chosen for assessment and no more than 16 CDM projects were actually analysed in spite of the need to know about all CDM projects' sustainability benefits. Hence, few host countries and few investors actually make use of the multi-criteria assessment methodologies.

3.1.3. Shortcomings

Existing methodologies at the project level are instrumental in providing analysis for decision making about individual CDM projects' sustainability contribution. However, it is well documented in the methodological literature that a highly competitive supply side of the CDM combined with the devolution of approval powers to the national DNAs causes what is known as a 'race to the bottom' (Kolshus et al., 2001, Sutter, 2003). Within the existing framework neither Annex-I countries nor non-Annex-I countries have direct incentives to enforce high sustainability standards (Sutter and Parreno, 2005). In the absence of an international sustainability standard competition to provide easy and speedy approval of CDM projects is therefore likely to persist creating a disincentive towards high sustainability standards.

3.2. Development of a taxonomy for sustainability assessment

In addition to existing methodologies we propose an international standard, i.e. a taxonomy for measuring and monitoring SD benefits. Defining sustainable development once and for all is an impossible task. The sustainable development benefits of CDM projects[3] can be – and are in host

[3] It can be argued that the development benefits of CDM projects are not sustainable in the sense of being long-lasting. Hence, it would be more correct to name them 'development benefits' rather than 'sustainable development benefits'. We agree with this critique to some extent. For example, employment benefits may be only short term and still they are included as SD benefits. However, we have chosen the term SD benefits, as this is the terminology used in the PDD (the view of the project participants on the project activities contribution to sustainable development). To take serious the

countries - defined and accounted for in numerous ways. For good reasons, therefore, no one, authoritative definition exists of how to divide it into criteria and indicators covering all aspects of sustainability. Whenever you try to define criteria you find that the categories overlap and you cannot divide the whole into parts without being imperfect.

3.2.1. The conceptual framework of the taxonomy
Knowing there will never be only one, 'right' way to define SD we suggest the conceptual framework shown in Figure 1 to describe the sustainable development benefits of CDM projects.

FIGURE 1 TO BE INSERTED HERE

The conceptual framework of the taxonomy has been developed bottom-up in the way that dimensions and criteria are based on *potential* SD impacts reported in the PDDs. The choice of dimensions and criteria is also inspired by existing methodologies and thus builds on to existing terminology for sustainability assessment (Sutter, 2003, Olhoff et al., 2004).

3.2.2. Defining and delimitating indicators for the taxonomy
Finding and choosing criteria and indicators of the taxonomy has been an iterative process over a period of four months alternating between reading, conduction of text analysis of the PDDs and developing and revising the taxonomy. The taxonomy is show in Table 2:

TABLE 2 TO BE INSERTED HERE

To avoid overlaps between the criteria due to the double counting of the same benefits, for instance that reduction of indoor smoke is both accounted as a health benefit and an air benefit, the following delimitations of each criteria are applied, see Table 3:

TABLE 3 TO BE INSERTED HERE

Even with these delimitations categorising and distinguishing between sustainable development benefits is tricky, as the SD criteria correlate. For example, economic benefits often bring along new employment opportunities and access to energy often facilitates growth and welfare improvements.

3.2.2. Aspects of sustainable development excluded from the taxonomy
As the basis of the analysis are the PDDs only positive contributions to SD can be measured as project developers rarely write anything negative about the proposed project. The absence of negative impacts of the project activity such as no impact on water, air or land is not counted as benefits unless it describes an improvement to the status quo. 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.

The taxonomy is developed to describe, how CDM projects *differ* with respect to their sustainable development contribution. This implies that common characteristics of all CDM projects (see Table 4) are *not included* in the taxonomy.

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critique would require a distinktion between benefits that are long lasting and benefits that are short term and this has not been possible based on information in the PDDs.

TABLE 4 TO BE INSERTED HERE

The exclusion of technological improvements including technology transfer and capacity development is unusual compared to existing methodologies and several host country definitions. We have excluded these aspects of sustainable development mainly due to the fact that we cannot think of any CDM projects that do not contribute to technological improvement. Also, it has not been possible to come up with good indicators based on the information given in the PDDs allowing us to distinguish between different types of technological improvement such as technology transfer versus dissemination of existing technology and upgrading. Development of local capacity to produce and manage a new technology, we thought would be an appropriate criterion; however, it has not been possible to answer with a 'Yes' or 'No' based on information given in the PDDs. Capacity development benefits broader than making the technology work are included in the criteria called 'learning'.

Inherent characteristics of projects as shown in Table 5 are also not included in the taxonomy.

TABLE 5 TO BE INSERTED HERE

The inherent characteristics are excluded from the taxonomy to avoid giving merit to tautological arguments in the PDDs, e.g. that energy projects contribute to SD because they produce energy or CO_2 reduction projects contributing to SD because they reduce the use of fossil fuels.

3.3. Application of the taxonomy for sustainability assessment

Besides the taxonomy analysis of the CDM's contribution to sustainable development requires access to adequate data and methods for qualitative and quantitative analysis.

3.3.1. Description of the data-set

The Project Design Document is chosen as the basis for sustainability assessment of CDM projects for several reasons:

- The PDDs represent the best coverage of all CDM projects at the design stage and in section A.2 of the template it is required to describe the project activity in terms of its purpose and contribution to sustainable development in maximum one page.
- Access to information is easy and free of cost. All the PDDs can be downloaded on the UNFCCC website (http://cdm.unfccc.int/Projects/Validation).
- Most important is the finding that all host countries use the PDD as the basis for their sustainability screening before issuing a LoA.

In spite of these advantages the quality of the data in the PDDs is not ideal. The description of sustainable development contributions reflects only *potential* benefits and not 'real and measured' SD impacts. Due to the absence of requirements for monitoring and verification of whether expected SD benefits are actually achieved, it is 'cheap' and of no negative consequence to be very optimistic in the project design document with regard to the project's sustainable development contribution.

3.3.2. Qualitative analysis of the PDDs

Text analysis of the PDDs is done using the taxonomy to 'code' the sustainable development benefits of each CDM project proposal. 'Coding' is the terminology used for attributing SD criteria to descriptions of CDM projects. The decision to make for each of the SD criteria in the taxonomy is a 'YES', if there is a positive contribution to SD or a 'NO', if there is no contribution to the criteria. If a positive contribution is found the text bite indicating this contribution is coded with the appropriate SD criteria. The software program Nvivo7 (QSRInternational, 2006), developed for qualitative text analysis, is used to store and handle the coding results, i.e. the text passages. Compared to other methodologies for sustainability assessment (Sutter, 2003, Olhoff et al., 2004) this methodology is qualitative and simpler in the sense that no values are attributed to indicate whether the SD benefit is 'high' or 'low'. With the use of Nvivo7, however, the coding process is transparent and it is possible to always back-track the coding-decisions made and access the text bites. This is useful for further qualitative analysis of e.g. what types of employment is generated, whether it is long term or short term, skilled or unskilled etc.

Text analysis, however, has an element of subjective judgement on how to attribute the SD criteria to each of the PDD's. Unfortunately, inter-subjective testing with a second analyst coding the same PDDs to check for deviant analytical results has not been possible due to lack of access to research assistance. Hence, coding at the project level is ambiguous in the sense that another analyst may come up with slightly different interpretations[4]. At an aggregated level, however, such grey-zones of exegesis ambiguity will be evened out over the coding of many projects.

3.3.3. Quantitative analysis

Out of the 744 CDM projects in the pipeline of 3 May 2006, 714 projects have been downloaded from the UNFCCC homepage, converted to plain text and imported into Nvivo7 for coding. A small number of the PDDs in the pipeline were charged with errors (30 PDDs = 4 % of 744) and could not be coded in Nvivo, as they were not available for download or could not be converted to text-format. Of the 714 projects imported into Nvivo7, a sample of 296 projects has been coded. Sampling has been done in order to save time, as the coding process is time consuming, i.e. approximately 40 projects can be coded in a day. However, only project types[5] containing more than 20 projects are sampled. For project types with less than 20 projects all the PDDs are coded. See Table 6 for an overview of how the sampling is done:

TABLE 6 TO BE INSERTED HERE

For the purpose of analysing all CDM projects in the pipeline, up-scaling is done for the large project categories using a scaling factor as shown in Table 6. Likewise, for analysis of the sustainability profiles of small scale versus large scale projects, unilateral versus multilateral projects and for host countries the following up-scaling factor are used. The coding results of all the sampled PDDs have been added to the UNEP Risø CDM pipeline (Fenhann, 2006)in the form of 'ticks' in each of the SD criteria. The pipeline uses an Excel spreadsheet notebook for storing a large quantity of information and this enables quantitative analysis of the coding results.

The quantitative analysis of coding results consists of counting and comparing the number of SD benefits at aggregated levels. In itself the number of SD benefits is not a measure of sustainability as the size of projects and the magnitudes of the benefits are not assessed. However,

[4] The possibility of automatic coding is explored. Automatic coding is based on ideas from artificial intelligence methods, where pattern recognition of selected keywords is used to indicate affiliation with SD criteria. Attempts so far show about 80% similarity with the manual coding results. However, it is still too early to know, if this is a viable and worthwhile way to go.

[5] The project types in Table 6 are those used in the UNEP Risø CDM Pipeline Fenhann, J. (2006), Vol. 2006 UNEP Risø Centre., see Table 7.

the number of SD benefits is a crude, proxy measure of *the maximum possible* sustainability contribution of CDM projects. There are 13 SD criteria in the taxonomy and hence 13 different types of benefits. The more SD benefits a project has, the higher is the *possible* maximum magnitude of SD impacts and vice versa. For example, if a project category has an average of five SD benefits per project it is likely (but not assessed quantitatively in this approach) that these give a higher contribution to SD than a project category with an average of only one or two SD benefits per project. However, a project with few SD benefits can have a higher impact than a project with many SD benefits, if the magnitudes of the few benefits are high and are seen to be important locally and nationally. More reliable findings of the analysis are the SD profiles of CDM projects showing how the SD benefits are distributed on the criteria and dimensions of sustainability.

3.4. The scope and limitations of the taxonomy

The innovativeness of the taxonomy is to assess the sustainability of CDM projects in a simple and qualitative way and present findings at aggregated levels rather than the project level. However, the strength of the taxonomy is also its weakness. While it is simple to use and not demanding in terms of requirements for data it is limited in scope to describe *how* CDM projects contribute to SD and not *how much*. Though coding is done at project level, findings are only presented at an *aggregated* level, e.g. for project types and categories and small scale versus large scale projects[6], as the interpretive approach is ambiguous and hence coding of the individual project can be contested.

Furthermore, the proxy measure of the possible maximum sustainability contribution assumes that all SD benefits are equally important and therefore have an equal weight. Unlike other approaches we do not pass judgements, for example, whether employment is a more important aspect of sustainable development than air quality or vice versa. At national and local levels the relative importance of different SD benefits is important and context specific depending on stakeholder perspectives (Kim, 2003). At the international level, however, introducing a standard weighing across countries and local contexts we find is not meaningful. Even if the weighing is done by 'experts' on CDM, we argue, that the weighing of criteria is only meaningful in a specific context and therefore, we choose not to weigh the SD benefits.

4. Findings of the sustainability assessment of CDM projects globally

With the strengths and limitations of the taxonomy in mind findings of the sustainability analysis of all CDM projects' show, what the SD benefits are, how the SD benefits of project types and categories differ as well as those of small-scale versus large-scale projects.

4.1. Sustainable development benefits of all CDM projects

The profile of sustainable development benefits of all CDM projects in the pipeline of 3 May 2006 are shown in Figure 2.

FIGURE 2 TO BE INSERTED HERE

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[6] Analysis of the SD profiles of countries and unilateral versus multilateral projects have also been made but the findings are not included in this article. This is partly due to the limitations on the length of the article and partly due to the focus on presenting and discussing the taxonomy as a new methodology rather than the full range of findings. SD profiles of methodologies can also be made but this has not yet been done.

Employment generation is the most likely impact of an average CDM project with more than two thirds of all projects (68%) contributing to this aspect of SD. Close to half of all CDM projects (46%) contribute to economic growth and slightly less (44%) to improved air quality. The distribution of SD benefits among the three dimensions is fairly even with the most benefits in the social dimension, then the economic[7] and the environmental. Only a few projects contribute to the dimension 'other benefits'.

4.2. Sustainable development profiles of project types and categories

4.2.1 Project types and categories
CDM projects can be categorised into project types and categories (Fenhann, 2006), see Table 7.

TABLE 7 TO BE INSERTED HERE

The significance of especially HFC and N_20 projects is shown in Table 7. In spite of the few number of HFC and N_2O projects; 2 % of all CDM projects, they contribute with 55% of the CERs per year. On the contrary, renewable energy projects are significant in numbers comprising 58% of all projects but less significant economically generating only 18% of the CERs annually.

4.2.2. Sustainable Development Profiles
A *profile* of sustainable development describes either the average number of SD benefits per project type (Figure 3) or the percentage of projects contributing to a SD benefit (Figure 2 & Figures 4-8).

FIGURE 3 TO BE INSERTED HERE

The SD profiles in Figure 3 are expressed as the number of SD benefits from a 100 projects in each project type. However, as the actual number of projects in each type – shown in brackets - varies with some types containing only one or two projects, the types with very few projects (1-4) are not easily compared. The figures for small project types dependent on a few projects and the SD profiles may change completely when a few more projects are developed. To be as inclusive of project types as possible, none are left out and this demands carefulness when reading Figure 3.

A ranking of project types has emerged from Figure 3 based on the proxy measure of the *maximum possible* sustainability contribution of project types. It supports the critique of HFC and N_2O projects having the least SD benefits; N_2O projects have in average only one benefit per project and HFC projects have 1.8 benefits per project. The ranking of project types shows several surprises. Renewable energy projects are often considered the types of projects with the highest sustainable development contributions (Pearson, 2004) and methane reduction projects are believed not to deliver much 'development dividend' (Cosbey et al., 2005). It is therefore surprising that cement projects are at the top of the ranking list and biomass energy projects in the renewable category is below average. More grounded, however, than the ranking of project types are the SD profiles of project types and categories.

4.2.3. Comparison of SD profiles of project categories and types
For an overview of the SD profiles of project categories see Figure 4 to 7.

[7] The economic dimension is characterised with only three SD criteria compared to four in the environmental and social dimensions. Therefore, the comparison of the number of SD benefits in each criterion is not a good measure for the quantitative sustainability contribution from CDM projects. However, it serves well as a relative measure for *how* project types differ in their SD contributions.

INSERT THE FIGURES 4 to 7 HERE

In comparison, *HFC and N_2O projects* have relatively many ‘other benefits’ with 50% of all the projects including a tax raised for sustainable development purposes or Corporate Social Responsibility (CSR) activities , which may to some extent compensate for the low number of SD benefits from the CDM project activity itself. Seven out of the 13 HFC projects globally are hosted by China, where a sustainability tax is introduced discriminatorily with a 65% tax on HFC projects, 30% on N_2O projects and only 2% on other project types. In the case of HFC projects in China there are even signs, the CDM is contributing to sector-transformation, as seven out nice existing plants eligible to generate emission credits are in the process of doing so (Baron and Ellis, 2006). *Energy efficiency projects*, also, generally have few SD benefits namely two per project. The distribution of benefits shows a light green profile, especially with a high contribution to improved air quality from 60% of all the projects. The project-activities are mainly in the industrial sector such as paper making, iron, cement and power production. Energy efficiency measures stem from technological improvements such as installation of new equipment to save energy. In 15% of the projects there are ‘other benefits’ to improve the otherwise low SD contribution of energy efficiency projects. *CH_4 reduction projects* - including agriculture, landfill gas, coal bed/mine, fugitive and cement projects - have the highest average number of SD benefits with 3.4 benefits per project. This is closely followed by the *renewable energy projects* – including biomass energy, hydro, wind, biogas, geothermal, solar and tidal projects – with an average of 3.2 benefits per project. Whereas the CH_4 reduction projects have a high green profile with many projects contributing with environmental benefits such as improved air and water quality, the renewable energy projects have a high socio-economic profile with relatively many projects contributing with employment, welfare, economic growth and energy benefits.

Looking more closely at the SD profiles of the different project types comprising the CH_4 reduction and renewable energy categories, some interesting characteristics are found (see Figure 3). Among the projects in the CH_4 reduction category, *cement projects* stand out with the highest number of average SD benefits; 3.7 benefits per project. The SD profile of cement projects is atypical in the way it has a high environmental profile with 82% of all the projects contributing to air and conservation benefits and only average or below average in social and economic benefits. The many environmental benefits are related to the project activity in cement production where fly as, a waste product usually dumped at landfills polluting air, land and water, is used to substitute limestone. Limestone is a finite natural resource and therefore the use of fly ash in the production of blended cement contributes to the conservation of natural resources. Also agriculture and landfill gas projects in the CH_4 reduction category have relatively many environmental benefits such as air, land and water benefits from improved animal waste management and decreased odour from better waste management at landfill sites. Agricultural projects have close to average socio-economic benefits including above average health benefits. Likewise, landfill gas projects have high health benefits related to the capturing and flaring of methane, which contributes to above average social benefits together with employment generation, learning benefits such as guided tours to the landfill, training of school teachers about environmental education and welfare benefits such as improved working conditions on site.

In the renewable energy category biomass energy projects – the largest project type - have surprisingly few SD benefits; 2.8 per project. The SD profile of biomass energy projects shows, the most benefits are socio-economic and many projects (26%) also contribute with other benefits. Often companies in the sugar cane industry especially from Brazil already run CSR programs including a wide range of social activities such as education, work safety and health care or environmental projects such as the planting of trees. In spite of numerous benefits mentioned as part of a CSR program they are only counted as one ‘other benefit’ according to the taxonomy and often it is not possible to distinguish what CSR activities are due to the CDM project as opposed to already ongoing. Wind and hydro projects contribute with an above average number of SD benefits, namely 3.5 benefits per project, only surpassed by cement projects among the larger project categories. This supports expectations that some renewable energy projects have a high possible contribution to SD. The social and economic benefits such as employment, welfare, growth and access to energy are the most significant and there are no other benefits. Biogas projects show a SD profile with many environmental benefits especially for land and conservation.

4.3. Sustainability benefits of small scale versus large scale CDM projects

Small scale projects are commonly assumed to deliver a higher ‘development dividend’ than large scale projects (Cosbey et al., 2005). This is based on assumptions that small-scale projects are often community-based and therefore generate more SD benefits. Special rules for fast tracking and otherwise promoting small-scale projects exist. However, yet it has not been investigated, if small-scale projects, generally, do deliver more SD benefits or not.

In Figure 8 the SD benefits of small scale and large CDM projects are shown based on the sustainability assessment of all CDM projects.

FIGURE 8 TO BE INSERTED HERE

The analysis shows, that small scale projects do deliver a slightly higher number of SD benefits than large scale projects with an average of 3.2 benefits per small scale project and 2.9 benefits per large scale project. As these numbers are based on qualitative measures, it is more informative to look at *how* the SD benefits differ between small scale and large scale projects. Small scale projects tend to deliver more economic and social benefits than large scale projects except for health benefits. Large scale projects, on the other hand, deliver more ‘other benefits’ and environmental benefits except for land and conservation benefits. Differences in the delivery of SD benefits is the most significant for economic benefits but generally, the variations in SD contribution within the category of small-scale projects and within the category of large scale projects – depending on project type and project design – are more significant than differences between small- and large scale projects, i.e. due to the *scale* of projects. Therefore we argue that small-scale projects cannot be assumed a-priory and generally to deliver more sustainable development benefits than large scale projects, as this is more *project* than scale dependent.

4.4. Summary of findings

The sustainability analysis of all CDM projects showed that the five most common benefits of CDM projects are employment generation, economic growth, a better quality of air, access to energy and welfare improvements.

The SD profiles of project categories and project types described by the distribution and number of SD benefits vary significantly. The analysis confirmed that few SD benefits are generated from HFC and N_2O projects and highlighted the existence of significant ‘other benefits’ from 50% of all the projects. Energy efficiency projects –especially in the industry sector – also have few SD benefits but with a high contribution to improved air quality from 60% of all projects. Surprisingly, renewable energy is not the category with the most SD benefits. Biomass projects contribute with relatively few SD benefits but a high number of ‘other benefits’ from 26% of all projects, whereas hydro and wind-projects contribute with many SD benefits that are mainly socio-economical such as employment, welfare, growth and access to energy. CH_4 reduction projects contribute with a slightly higher number of SD benefits than the renewable energy category and have a high environmental profile. In particular cement projects contribute with many SD benefits with 82% of all the projects contributing to better air quality and conservation.

Small-scale projects in average do deliver a slightly higher number of SD benefits with a higher socio-economic profile than large scale projects. Large scale projects, on the other hand, tend to deliver more air, water, health and other benefits. However, differences in SD contribution due to the *scale* of projects are less significant than differences due to other factors such as the project type and individual project designs.

5. Policy implications of the taxonomy for sustainability assessment

The findings of the analysis challenge general assumptions such as small-scale projects contributing more to SD than large scale projects and it raises questions if CDM projects with ‘other benefits’ - such as HFC, N_2O, EE industry, biomass and biogas projects - might be better than their reputation. In spite of the limitation of the qualitative approach to sustainability assessment, namely that conclusions cannot be made on how much individual projects contribute to SD, it does indicate the maximum possible SD contribution at aggregated levels. Together with the SD profiles describing what the SD benefits of project types are, the findings can inform national policy decisions for sustainable development along the lines of China’s approach to approval of CDM projects. This approach is based on national sustainability criteria for sectors and project types rather than sustainability assessments at the project level. For the purpose of providing information on how CDM projects contribute to SD at aggregated levels the findings can be made publicly available on a continuously updated website.

More important, however, than the exact findings of the sustainability assessment, is the potential of the taxonomy to address some of the weaknesses in the existing system of how DNAs approve CDM projects. Given standards for SD defined by the different host countries, the main weakness is the absence of an international standard and a mechanism to ensure that potential SD benefits are actually realized. The most important outcome of the research is the taxonomy, which provides a conceptual framework and qualitative indicators to assess how CDM projects contribute to SD. An option is to use the taxonomy as a template in the PDD to guide how project developers report on SD and to include the taxonomy in the manual for how DOEs validate and verify CDM projects. Against the indicators in the taxonomy we propose a qualitative verification check – a ‘Yes’ or ‘No’ – on whether or not the national standards for SD as described in the PDDs have been realized. Evidence, such as targets, estimates or activities for each sustainable development criteria must be provided by the project developers in order for the verifiers to check, if the SD benefits are real – even if they are not measurable. If project developers cannot provide sufficient evidence, the DOEs cannot verify that the SD benefits are real and hence the CDM project can not make claims to contribute to SD. The taxonomy can be supportive of DNAs to decide, what should be the consequences, if CDM projects at the stage of verification do not show signs of realizing its potential SD benefits. The strength of an international standard like the taxonomy is that all DNAs globally get the same opportunity for support.

6. Conclusion and perspectives

The article has addressed the issue of the CDM's poor performance with regard to achievement of sustainable development in developing countries by proposing and illustrating a taxonomy as an international standard for sustainability assessment of all CDM projects. Findings of applying the taxonomy contribute with new knowledge on how CDM projects contribute to sustainable development. CH_4 reduction projects are found to have a high environmental profile and contrary to expectations they have a higher average number of SD benefits than renewable energy projects, which have a high socio-economic profile. Small-scale projects in average contribute a slightly higher number of SD benefits than large-scale projects and have a high socio-economic profile whereas large-scale project contribute with relatively more air, water, health and other benefits. The innovativeness of the taxonomy is to assess the sustainability of CDM projects in a simple, qualitative way and present findings at aggregated levels rather than the project level. However, it remains an open question, whether it is methodologically possible and politically desirable to introduce an international measure for the quantitative, absolute sustainability impact at project level. The most important policy implication of the taxonomy is its contribution towards a new verification protocol to ensure that potential SD benefits of CDM projects are actually realized.

In relation to ongoing parallel discussions on a programmatic approach to increase the scope and SD contribution of the CDM by focusing on sector wide policies and standards, the taxonomy is complementary. Though it uses the individual CDM project as its unit of analysis, there is a wide scope for analysis at aggregated levels. This can be used to monitor if projects using the programmatic approach can accumulate the wanted SD benefits to fulfil the vision of sector transformation towards sustainable development.

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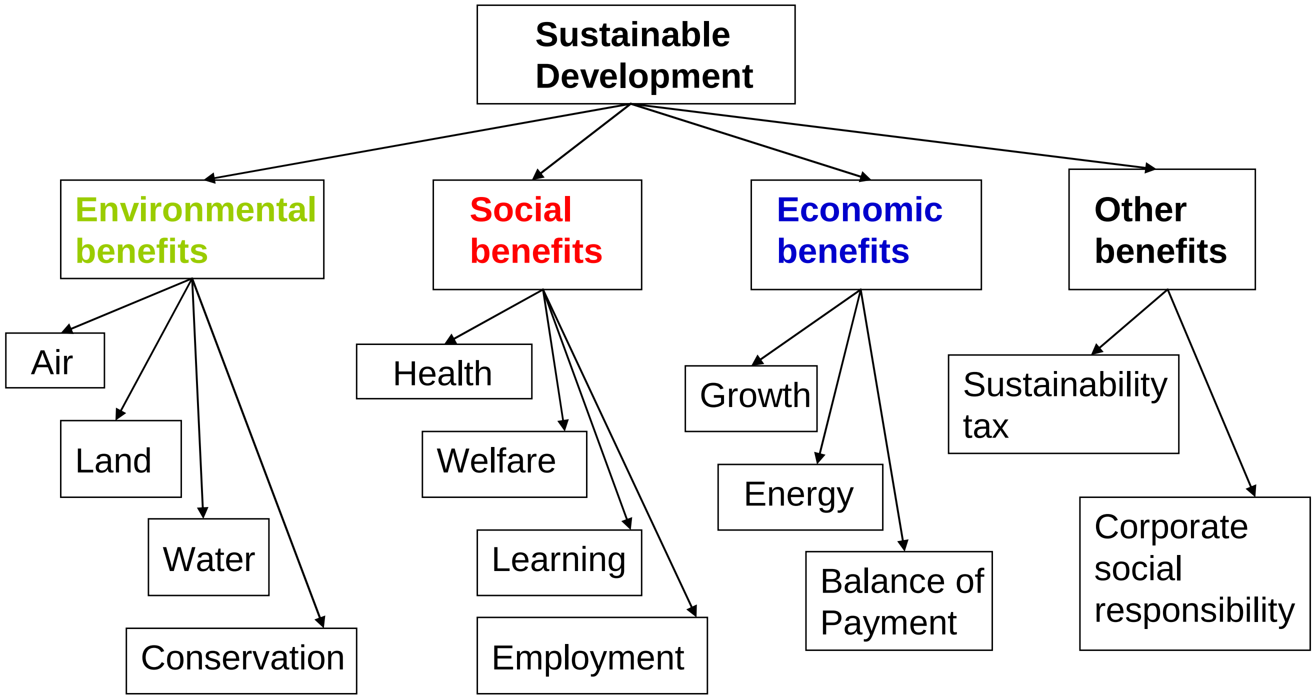


Fig. 1. Conceptual framework for a taxonomy of sustainable development benefits

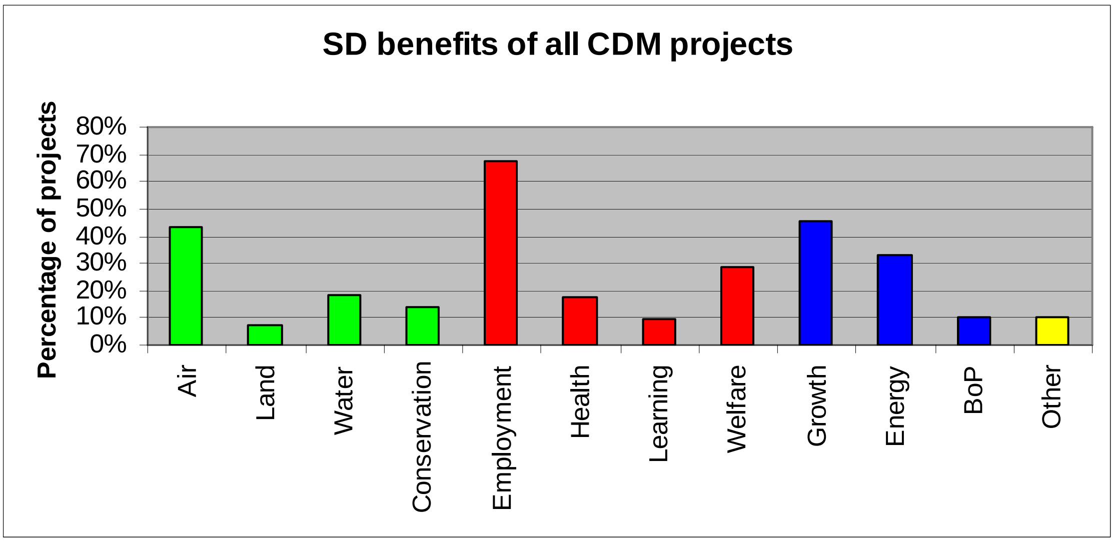
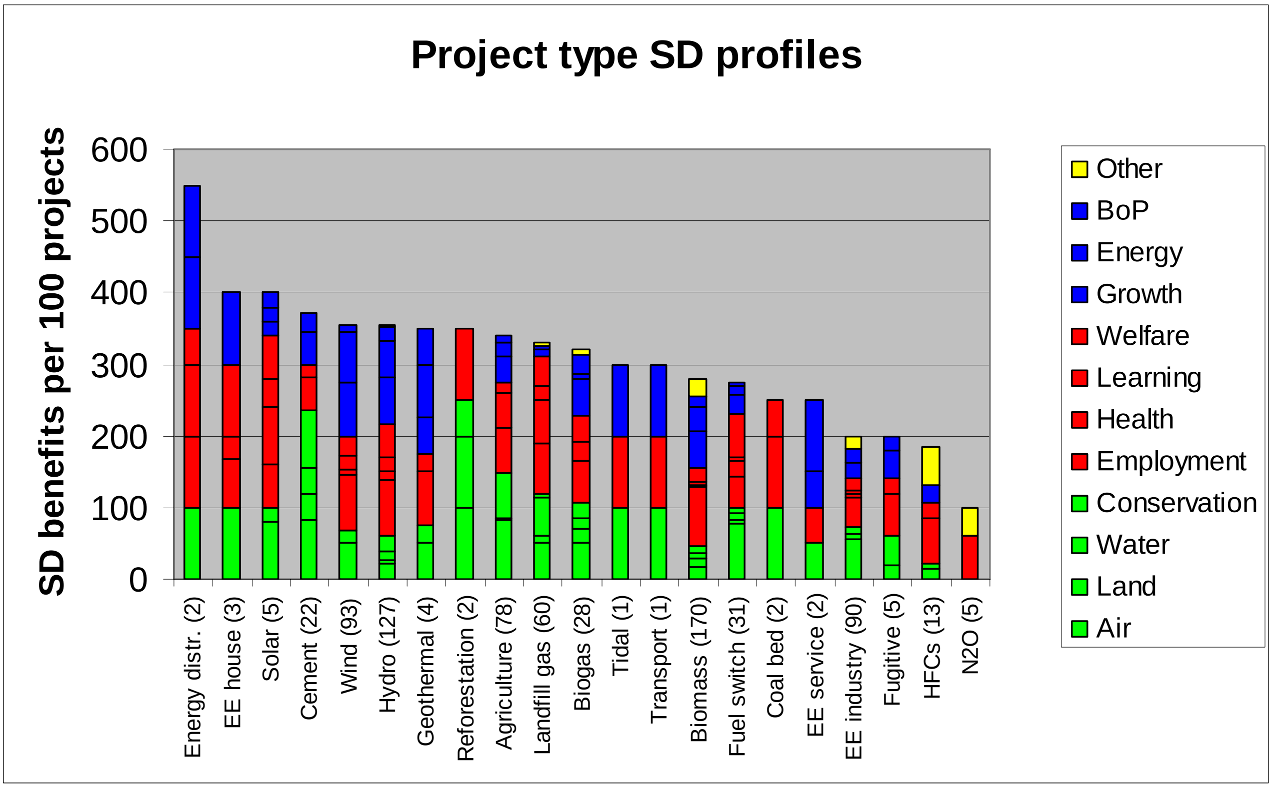


Fig. 2. Sustainable development benefits of all CDM projects

Fig. 3. SD profiles of project types



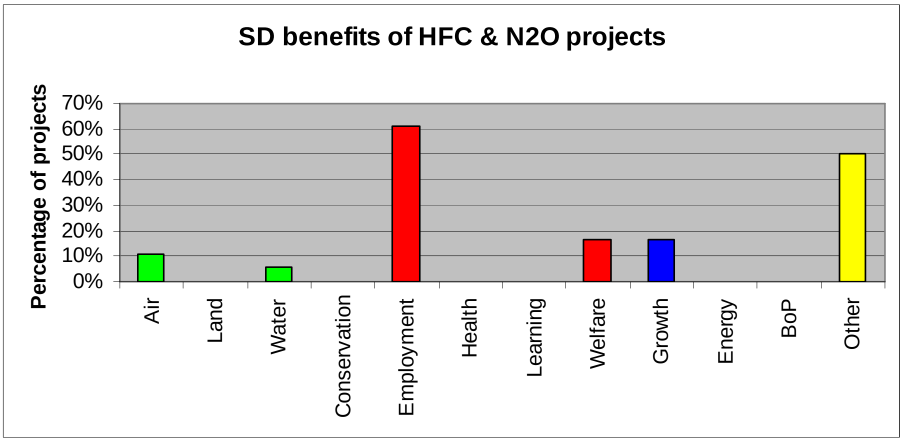


Fig. 4. SD benefits of HFC & N2O projects

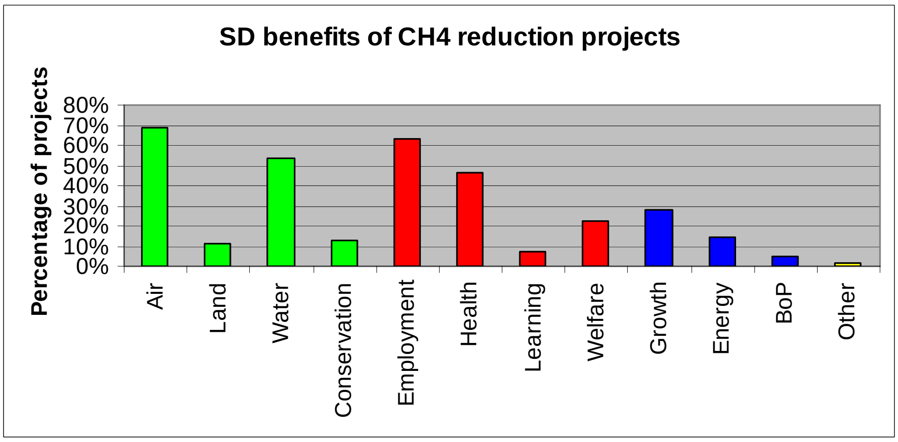


Fig. 5. SD benefits of CH4 reduction projects

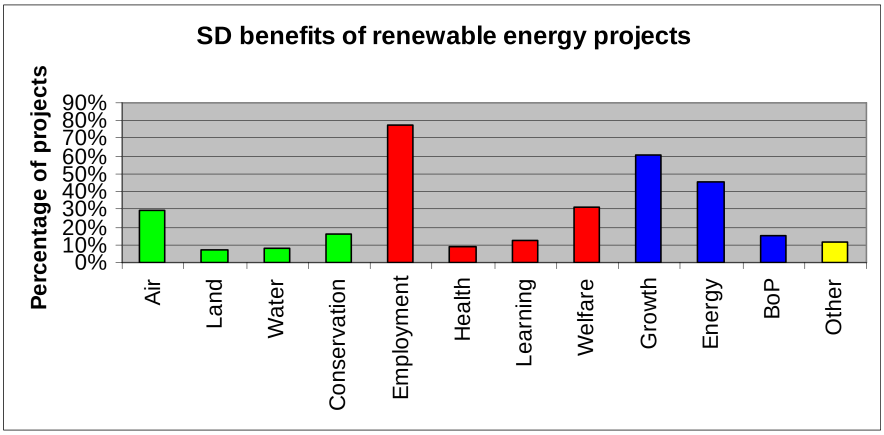


Fig. 6. SD benefits of renewable energy projects

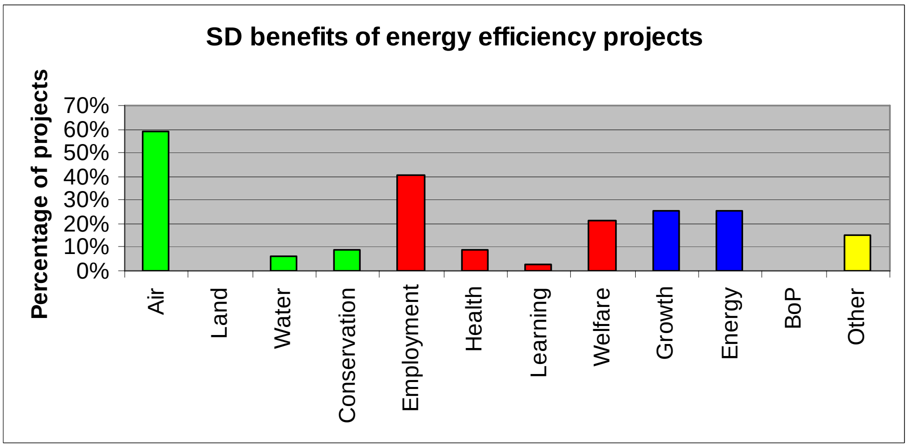


Fig. 7. SD benefits of energy efficiency projects

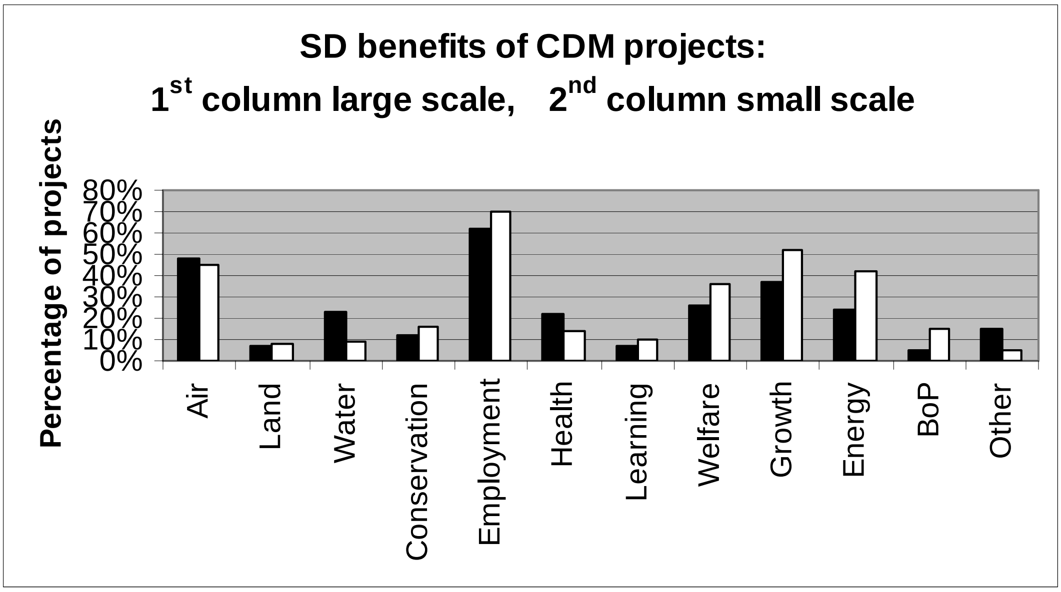


Fig. 8. SD benefits of small scale and large scale CDM projects

Table 1
Sustainable development criteria and processes for approval of CDM projects

	India	China	Brazil	Mexico	South Africa	Morocco	Moldova
SD criteria	Checklist for: -social -economic -environmental -technological 'well-being'	Discrimination by project type: - priority areas: EE, RE, CH4 -gas-based approach: 2% tax on CERs from priority areas, 30% for N2O and 65% for HFCs and PFCs	Checklist for congruence with existing SD policies	Checklist for congruence with existing SD policies	Checklist for: -economic -social -environmental development	Checklist for: -social -economic -environmental -technological development	Not available on internet
Other eligibility criteria	None	-at least 51% Chinese ownership of enterprises -CER sales belong to the Chinese Government and project developers -revenue sharing by other entities forbidden	-submission of validation report in Portuguese before LoA is given -documentation for stakeholder consultation -commitment to report on the CERs produced	-documentation of the legal and physical existence of the requesting Party -commitment to report on the CERs produced annually	None	-conform with Morocco's laws and policies, particularly an EIA	Not available on internet
Documentation required	PDD + presentation: LoA	PIN: LoE PDD: LoA	PDD: LoA	PIN: LoE PDD: LoA	PIN: LoE PDD: LoA	PIN: LoE PDD: LoA	PIN: LoE PDD: LoA
Approval process	-DNA is a single window clearance for LoA -max 60 days	-DNA issues LoE -DNA + Expert review + National CDM Board -> LoA -max. 60 days	-DNA is a single window clearance for LoA -max. 60 days	-DNA incl. consultation with ministries + audit -> LoA - max. 30 days	-DNA issues LoE within 30 days -DNA + public consultation for 30 days + Advisory Committee -> LoA - max. 45 days	-DNA issues LoE within 2 weeks -DNA is a single window clearance for LoA - max. 4 weeks	Not available on internet

Table 2
Taxonomy for assessment of sustainable development benefits of CDM projects

Dimension	**Criteria**	**Indicators**
Environmental benefits	*Air*	Improving air quality by reducing air pollutants such as SOx, NOx, suspended particulate matter (SPM), Non Methane Volatile Organic Compounds (NMVOCs), dust, fly ash and odour
	Land	Avoid soil pollution including avoided waste disposal and improvement of the soil through the production and use of e.g. compost, manure nutrient and other fertilizers
	Water	Improved water quality through e.g. wastewater management, water savings, safe and reliable water distribution, purification/sterilization and cleaning of water
	Conservation	Protection and management of resources (such as minerals, plants, animals and biodiversity but excluding waste) and landscapes (such as forests and river basins)
Social benefits	*Employment*	Creation of new jobs and employment opportunities including income generation
	Health	Reduction of health risks such as diseases and accidents or improvement of health conditions through activities such as construction of a hospital, running a health care centre, preservation of food, reducing health damaging air pollutants and indoor smoke
	Learning	Facilitation of education, dissemination of information, research and increased awareness related to e.g. waste management, renewable energy resources and climate change through construction of a school, running of educational programs, site visits and tours
	Welfare	Improvement of local living and working conditions including safety, community or rural upliftment, reduced traffic congestion, poverty alleviation and income redistribution through e.g. increased municipal tax revenues
Economic benefits	*Growth*	Support for economic development and stability through initiation of e.g. new industrial activities, investments, establishment and maintenance of infrastructure, enhancing productivity, reduction of costs, setting an example for other industries and creation of business opportunities
	Energy	Improved access, availability and quality of electricity and heating services such as coverage and reliability
	Balance of Payments (BoP)	Reduction in the use of foreign exchange through a reduction of imported fossil fuels in order to increase national economic independence
Other benefits	*Sustainability tax*	Collection of a sustainability tax for support of sustainable development activities
	Corporate Social Responsibility (CSR)	Support for ongoing corporate social responsibility activities that are indirect or derived benefits of the CDM project activity

Table 3
Delimitation of the SD criteria

SD criteria	Descriptions of benefits *not* included in each criteria
Air	Reductions in GHGs are not included as this defines all CDM project. Avoided indoor smoke is counted as a health effect.
Land	Trees planted, reforestation and afforestation has to do with the biosphere and does not count under land impacts.
Water	Access to water such as hot water for the heating of buildings counts as a welfare impact.
Conservation	Tree-planting for the purpose of generating CERs is not counted as a conservation benefit as it defines all aforestation and reforestation projects
Employment	Indirect, informal or part time activities - such as waste collection - are included as employment benefits. Income generating activities at higher levels than the individual are considered a contribution to growth.
Health	Avoided accidents such as gas explosions or fires from landfills or mines are covered under improved safety conditions in the welfare criteria.
Learning	Capacity development and training needed to make the technology work is not included, as this is a requirement of all CDM projects (see above). Setting an example for replication and encouraging similar activities are considered economic growth benefits.
Welfare	Tax benefits used in support of economic development is accounted as an economic benefit. Tax benefits used for public service purposes are welfare benefits.
Growth	Income generating activities at individual level are considered an employment benefit. At company, sector, industry or country level income generation is considered a contribution to growth. Tax benefits are generally considered a contribution to welfare unless it is explicitly stated it is used in support of local economic activities.
Energy	Benefits of electrification especially in rural areas such as improved welfare, education, health or other aspects of SD are included under each criterion when they are explicitly mentioned.
BoP	Increased self-sufficiency, diversification and security of energy supply characterise all renewable energy projects and do not automatically lead to reductions in foreign exchange expenditure. Only if imported fossil fuels are replaced with renewable energy is there a positive contribution to the BoP.

Table 4
Common characteristics of all CDM projects

- Reduction in emissions of GHGs; CO_2, CH_4, HFCs, PFCs, N_2O or SF_6
- Generation of an income for project developers through the sale of CERs
- Technological improvement to meet the additionality requirement from a business-as-usual scenario
- Capacity development and training in order to make the technology work

Table 5
Inherent characteristics of projects

Project	Inherent characteristics
Energy projects	Involve the production of energy or energy efficiency measures. In a developing country context access to energy is an important contribution to sustainable development, but only if improved access, availability or the quality of electricity and heating services is explicitly mentioned in the PDD is it included in the taxonomy.
CO_2 reduction projects	Involve the replacement or reduction of the use of exhaustible fossil fuels which has inherent sustainable development benefits such as the conservation of natural resources like coal, natural gas and oil. The conservation of fossil fuels is excluded from conservation benefits in the taxonomy, as conservation of resources and landscapes must be additional to these inherent characteristics.
Renewable energy projects	Are characterised by self-sufficiency, diversification of supply and increased energy security locally or nationally. Only if the country does not have domestic supplies of fossil fuels does it impact positively on the balance of payments (BoP).
CH_4 reduction projects	From landfills and agriculture involve improved waste management practices in order to capture and use or flare the methane from the waste production.

Table 6
Sampling of projects coded and up-scaling factors

Upscaled	Total projects	Sampled	Scaling factor
Biomass energy	170	50	3,40
Hydro	127	39	3,26
Wind	93	37	2,51
EE industry	90	30	3,00
Agriculture	78	27	2,89
Landfill gas	60	20	3,00
Fossil fuel switch	31	23	1,35
Biogas	28	14	2,00
Cement	22	11	2,00
HFCs	13	13	1,00
Fugitive	5	5	1,00
N2O	5	5	1,00
Solar	5	5	1,00
Geothermal	4	4	1,00
EE households	3	3	1,00
Coal bed/mine methane	2	2	1,00
Energy distribution	2	2	1,00
EE service	2	2	1,00
Reforestation	2	2	1,00
Tidal	1	1	1,00
Transport	1	1	1,00
	744	296	

Table 7
Overview of project types and project categories

Type	CDM					
	number		CERs/yr (000)		Accumul. 2012 CERs (000)	
Biomass energy	170	23%	8543	6%	65831	7%
Hydro	127	17%	7440	5%	51493	5%
EE Industry	90	12%	7061	5%	54893	6%
Wind	93	13%	6686	5%	49311	5%
Agriculture	78	10%	5141	4%	36931	4%
Landfill gas	60	8%	16521	12%	115993	12%
Fossil fuel switch	31	4%	1439	1%	12469	1%
Biogas	28	4%	1411	1%	11426	1%
Cement	22	3%	2631	2%	23788	2%
HFCs	13	2%	59609	42%	392567	40%
Fugitive	5	1%	5030	4%	34386	4%
Solar	5	1%	56	0%	358	0%
Geothermal	4	1%	817	1%	5294	1%
EE Households	3	0%	42	0%	253	0%
N2O	5	1%	18716	13%	115032	12%
Energy distrib.	2	0%	209	0%	1509	0%
EE Service	2	0%	600	0%	4666	0%
Coal bed/mine methane	2	0%	15	0%	94	0%
Tidal	1	0%	315	0%	1104	0%
Transport	1	0%	7	0%	59	0%
Afforestation & Reforestation	2	0%	72	0%	619	0%
Total	744	100%	142362	100%	978076	100%
Project categories						
HFC & N2O reduction	18	2%	78325	55%	507599	52%
CH4 reduction (cement, coal mine/bed, agriculture, fugitive & landfill)	167	22%	29338	21%	211192	22%
Renewables (biomass, hydro, wind, biogas, geothermal, solar, tidal)	428	58%	25268	18%	184817	19%
Energy efficiency (EE ind., EE house., EE service, energy distrib. & transp	98	13%	7919	6%	61380	6%
Fuel switch	31	4%	1439	1%	12469	1%
Afforestation & Reforestation	2	0%	72	0%	619	0%

Source: The UNEP Risø CDM Pipeline (Fenhann, 2006).