Energy Policy 37 (2009) 91–101

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

On the contribution of labelled Certified Emission Reductions to sustainable development: A multi-criteria evaluation of CDM projects

Patrick Nussbaumer *

Institut de Ciències i Tecnologia Ambientales (ICTA), Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain

ARTICLE INFO

Article history:
Received 21 January 2008
Accepted 31 July 2008
Available online 19 September 2008

Keywords:
Clean Development Mechanism
Multi-criteria evaluation
Sustainable development

ABSTRACT

The Clean Development Mechanism (CDM) has a twofold objective, to offset greenhouse gas emissions and to contribute to sustainable development in the host country. The contribution to the latter objective seems marginal in most CDM activities. Also, CDM activities are unevenly spread among developing countries. In response to these concerns, initiatives with the objective of promoting CDM projects with broad local sustainable development dividends have been launched, such as the Gold Standard and the Community Development Carbon Fund. The Gold Standard label rewards best-practice CDM projects while the Community Development Carbon Fund focuses on promoting CDM activities in underprivileged communities. Using a multi-criteria method, the potential contribution to local sustainable development of those CDM projects with particular attributes is compared with ordinary ones. This evaluation suggests that labelled CDM activities tend to slightly outperform comparable projects, although not unequivocally.

1. Introduction

The Kyoto Protocol creates a legally binding set of obligations for industrialised countries and obliges those countries to reduce their emissions of greenhouse gases (GHG) to an average of 5% below their 1990 levels over the commitment period 2008–2012 (UNFCCC, 1997, p. 3). Three flexible mechanisms, Emission Trading, the Clean Development Mechanism (CDM), and Joint Implementation, aim at reducing the costs of meeting emission targets by allowing for geographical and temporal flexibility (Dutschke and Michaelowa, 1998).

The CDM is the outcome of lengthy and delicate international negotiations. It represents a compromise between the aspirations of developing countries for development on the one hand and the desire for industrialised countries to meet their emission target in an economically efficient manner on the other. The CDM has two objectives, to offset GHG emissions produced in developed countries, and to promote sustainable development in developing countries, as stated in the article 12 of the Kyoto Protocol (UNFCCC, 1997, p. 11).

The CDM was originally seen as of particular interest for developing countries. Indeed, the fear of environmental measures hampering development would vanish if climate and development policies could converge. However, the question of whether climate and development objectives are compatible or in contradiction is open to debate (see e.g. Michaelowa and Michaelowa, 2007).

The effective contribution of CDM projects to sustainable development is being questioned, giving rise to a series of measures, which aim at promoting CDM activities with broader sustainable development dividends. Attempts to evaluate the contribution of CDM projects to sustainable development exist (see e.g. Olhoff et al., undated; Olsen and Fenhann, 2008; Sutter and Parreño, 2007; Policy and Operations Evaluation Department, 2008). This paper contributes to this debate by comparing CDM activities with particular attributes to ordinary ones. It does so by applying a multi-criteria methodology in order to evaluate how labelled projects perform with respect to sustainability criteria in comparison to similar non-labelled projects.

In Section 2, the current status of the CDM portfolio is portrayed and its challenges briefly discussed. Section 3 introduces initiatives promoting CDM activities delivering broad sustainable development dividends. The methodology applied in the framework of this research is depicted in Section 4. The projects evaluated are presented in Section 5. The evaluation, analysis and discussion feature Section 6, and the conclusions are presented in Section 7.

2. The current CDM portfolio and its challenges

According to the literature (e.g. Boyd et al., 2007; Cosbey et al., 2005; Olsen, 2007; Pearson, 2007; Schneider, 2007; Sterk, 2008;

* Tel.: +43 2236 222 327.
E-mail addresses: patrick.nussbaumer@gmx.net, patrick.nussbaumer@uab.es (P. Nussbaumer).

0301-4215/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.enpol.2008.07.033

Sutter and Parreño, 2007), a number of CDM projects, including some already approved, are under-performing in terms of contribution to local sustainable development criteria.

They represent, for instance, end-of-pipe adjustments of industrial processes to capture gases with a very high greenhouse effect. These kinds of projects are not an issue as such, in the sense that they effectively contribute to a reduction of GHG released to the atmosphere. However, they are accompanied by very meagre benefits in terms of local sustainable development (Schneider, 2007; Policy and Operations Evaluation Department, 2008). It is argued that such projects represent almost no technological transfer, induce only low capital investment, promote almost no additional employment and their contribution to social sustainable development is meagre or nil. The relatively high potential of delivering Certified Emission Reductions (CER) from those end-of-pipe fix types of projects, together with their low costs, could trigger negative effects on the emerging market of emission credits, driving down prices by saturating the market (Olsen, 2007). This claim is, however, yet to be empirically demonstrated (Cosbey et al., 2006). Other projects recognised with higher local sustainable development profits, like renewable energy projects for instance, could nevertheless be strongly undermined (Sterk and Wittneben, 2005). Other authors (Estrada et al., 2008; Sterk, 2008) argue, however, that the contribution of offset mechanisms to sustainable development is more related to their design than to the typology.

The CDM procedure does not formally define sustainability criteria, in contrast to the other objective of the CDM, GHG offset, whose operationalisation and implementation are clearly defined and monitored. The assessment of the contribution to sustainable development of the projects is a sovereign matter of the host country. [...] *it is to the host Party's prerogative to confirm whether a clean development mechanism project activity assists it in achieving sustainable development*, [...] (UNFCCC, 2002, Decision 17/CP.7). By not clearly defining the sustainable development criteria required for the CDM, the United Nations Framework Convention on Climate Change (UNFCCC) allows, rightly so, for the host country of a CDM project to adjust those criteria according to national development priorities. On a less optimistic view, much uncertainty arises from the lack of consistency between the requirements of host countries.

Although sustainable development attributes are politically desired, they are not explicitly incorporated in the core structure of the CDM (Boyd et al., 2007). That is, beside the approval stage by the host country authorities, there are no formal requirements to fulfil in terms of contribution to sustainable development, and therefore also not *ex-post* verification.

The factors that would lead to the acceptance or the refusal of the projects are thus strongly dependent on national values, and could eventually suffer from the influence of strong stakeholders (Olsen, 2007). The decision for acceptance could be influenced by other factors, such as incentive for foreign investments, hence undermining social and environmental aspects and therefore weakening the potential positive influence on local sustainable development sought by the CDM.

The risk of having different host countries competing in order to attract CDM by easing the minimum criteria is real and could lead to what is the sometimes called the 'Race to the Bottom' (Sutter, 2003; Pearson, 2007). The potential host country has to define a policy balancing the short-term benefits of foreign investments and the long-term dividends of sustainable development.

There is a threat for the market in itself not to be able to yield sufficient projects with high sustainable development values (Olsen, 2007; Sutter and Parreño, 2007), and thus for the portfolio to be mainly driven by the economic attractiveness of the potential projects (Schneider, 2007). Indeed, a few projects with low local positive effects but high CERs, could weaken the opportunity for a greater overall sustainable development outcome (Burian, 2006).

Let us consider the following illustrative example. One project capturing a gas (hydrofluorocarbon, HFC) with a very high global warming potential alone will deliver about as many CERs as nearly 200 biomass energy projects together.[1] Therefore, in the market-based mechanism in which the CDMs evolve, one single project with low local sustainable development benefits can rival a multitude of other projects and their combined recognised broad sustainable development dividends.

The unequal distribution of CDM projects throughout developing countries is another source of concern (for data on project distribution, see Boyd et al., 2007; Fenhann, 2008; UNDP, 2006). Indeed, the great majority of CDM projects seem to target developing countries with strong economies, such as China, India, and Brazil in particular, those countries being the ones where a large amount of the Foreign Direct Investment already flows to (Ellis et al., 2004).

According to Ellis et al. (2004), the impoverished countries that are unable to attract foreign investments also do not seem to be in a position of generating interest in CDM project investments. Some of the poorest countries lack the institutional capacity required to become potential host countries (Kim, 2003). From a development policy point of view, some countries located in sub-Saharan and Southern Asian regions seem to have the greatest need for foreign investment. The CDM, in its current form, has generated little activity in those regions thus far.

Another concern from critics in developing countries is that the market is likely to promote the most economic options, the sometimes so-called low-hanging fruits (Cosbey et al., 2005). Assuming that, at a later stage, developing countries will also have to comply with some form of defined emission caps, those countries would only have more costly options available in order to do so (Rose et al., 1999; Muller, 2007). This may represent a paradoxical and contra-productive effect from a development assistance viewpoint. This claim is, however, refuted by Germain et al. (2007).

3. Initiatives addressing the CDM shortcomings

In response to the perception that mainstream CDM projects might underperform in terms of sustainable development, some institutions proposed to overcome those shortcomings by encouraging activities which are accompanied by broad and substantial contribution to sustainable development in host countries. In this regard, labelling appears to be a promising complement to enhance projects with specific features (Muller, 2008). Also, special funds target projects with specific characteristics, such as broad sustainability benefits or activities located in underprivileged countries.

In the current framework, a monetary value is only attributed to one of the two objectives of the CDM, namely the reduction of GHG. Premium markets seem to be an attractive option for giving a value to the second objective, which is to promote sustainable development (Schneider, 2007). Indeed, the quality of the projects is likely to have an influence on the price of the Certified Emission Reductions delivered.

Sutter (2003) and Muller (2008) review sustainability labels and indicators. Relevant to this research are the Gold Standard

[1] Project for HFC23 Decomposition at Changshu 3F Zhonghao New Chemical Materials Co. Ltd. (10,437 $ktCO_2$/yr), 199 biomass energy projects registered (10,976 $ktCO_2$/yr in total), own compilation of data from Fenhann (2008), status as of 1 April 2008.

label and Community Development Carbon Fund, since those two initiatives aim at promoting sustainable development dividends at local level and do feature registered CDM projects. Other promising initiatives are the recently launched MDG Carbon Facility and the CCB Standards. There is, however, no CDM project from those initiatives at registration stage as yet.[2]

3.1. Gold Standard

The Gold Standard[3] proposes a methodology to develop high-quality emission reduction projects with high environmental integrity and secured local social, environmental and economic benefits (Schlup, 2005). First initiated by the World Wide Fund for Nature (WWF), the Gold Standard is owned and managed by an international coalition of non-governmental organisations. This innovative approach intends to provide project developers with a tool that allows for ensuring the delivery of credible projects with real benefits for the host country (Gold Standard, 2003).

Under the framework of the CDM, the Gold Standard is an add-on methodology, which aspires to foster broad sustainable development dividends at local level. This non-profit organisation's initiative seeks to develop a label that represents the best-practice benchmark for the CDM. It does this by proposing a rigorous assessment framework which is directly compatible with the CDM project cycle. It use is free of charge. The objectives of the Gold Standard are: (1) ensuring the offset of the GHG by assessing the additionality in a conservative manner, (2) promoting low-carbon energy systems, and (3) supporting sustainable development in the host countries. The concept is based on the assumption that, left to the market forces, the CDM does not significantly contribute to sustainable development.

In order to ensure the sustainable development benefits of the project activities, the evaluation of the Gold Standard includes three interdependent elements, namely a sustainability matrix, an Environmental Impact Assessment (EIA), and a stakeholder consultation (Gold Standard, 2003). The sustainability matrix allows for a simple participatory assessment of the project's contribution to sustainable development. An EIA is performed either when the host country's regulations require it or when environmental pre-screening or initial stakeholder consultations demonstrate that the impacts are likely to be significant. The participatory approach represents a crucial feature in ensuring that the local sustainability benefits are real. As well, the involvement of the stakeholders reduces the risk of oppositions and delays in a later stage of the project, an argument that is often brought forward to project developers.

It is argued that the Gold Standard addresses four loopholes of the CDM (Langrock and Sterk, 2003; Sterk and Langrock, 2003). First, it limits the scope to certain types of projects, namely renewable energy and energy efficiency, because specific project activities are assumed to have a higher risk of climatic, environmental or social impacts. Second, as many NGOs dispute the validity of the demonstration of additionality for several projects already approved, the Gold Standard proposes a conservative approach in this regard. Third, the importance of the stakeholder participation is recognised. Fourth, the contribution to real sustainable development dividends is reinforced. On the down side, it is also argued that if CERs from Gold Standard projects become notably more costly than ordinary ones, it may be difficult to find buyers.

To date (April 2008), only 6 registered CDM projects received the Gold Standard certification. They are located in China, Honduras, India, and South Africa. More projects applying the Gold Standard methodology find themselves in an advance stage, but are currently held back by financial and institutional difficulties. Although this niche market might stay marginal, there seems to be strong interest in acquiring premium Gold Standard CER (GTZ, 2005).

3.2. Community Development Carbon Fund

Another initiative, the World Bank's Community Development Carbon Fund (CDCF),[4] targets small-scale projects located in underprivileged environments. It aims to foster broad sustainable development benefits while seeking to reduce the unequal distribution of projects.

Small-scale CDM projects seem to entail a relatively high contribution to sustainable development at community level. However, because of the transaction costs, small-scale projects are likely to be rejected by the market if not benefiting from external support (WB, undated). The CDCF offers project developers premium prices for projects that deliver demonstrable community benefits (Bishop, 2007).

The fund is designed with the goal of purchasing emission reductions from CDM projects, which give the opportunity to communities in developing and least-developed countries to benefit from new investments in clean technologies. The CDCF aims at encouraging sustainable development while promoting a more even distribution of the benefits throughout countries as well as within the host countries. Also noteworthy, although going beyond the scope of this study, the CDCF implements capacity building measures in order to reduce investment risks, as well as to facilitate project development and replication (WB, undated) through its program CDCFplus.

The CDCF screening ensures that the project is located in a developing country, which is part of the UNFCCC, that no more than 10% of the Fund's assets contribute to projects in the same country, that a minimum of 25% of the Fund is dedicated to projects in least-developed countries or in other countries if these projects provide demonstrable benefits to the poorer communities of those countries, and finally, that the projects comply with the small-scale definition stated in the Marrakesh Accords (WB, undated).

At the date of writing (April 2008), about two dozen projects were at validation stage, with 10 being already registered. The projects are located in Latin America (Argentina, Honduras and Peru), Africa (Kenya, Nigeria), Asia (China, India and Nepal), and Eastern Europe (Moldova).

4. Methodology

The approach exposed hereafter allows for a discussion on the potential benefits of those initiatives that aim at addressing the CDM shortcomings in terms of sustainable development contribution. This analysis claims in no way to provide an absolute evaluation of each projects contribution to sustainable development as such. Rather, it allows for a consistent comparison between projects benefiting from those initiatives, and others that do not. Also, this analysis being *ex-ante*, what is actually evaluated is the potential contribution to sustainable development (Cosbey

[2] Based on personal communication, 1 June 2008 (CCB Standards), 23 April 2008 (MDG Carbon Facility).

[3] For more detailed information on the Gold Standard, see: http://www.cdmgoldstandard.org/index.php, viewed 11 December 2007.

[4] For more detailed information on the Community Development Carbon Fund, see http://carbonfinance.org/Router.cfm?Page=CDCF&FID=9709&ItemID=9709, viewed 11 December 2007.

et al., 2006), rather than the contribution itself, which can only be evaluated *ex-post*.[5]

Sustainable development is multi-dimensional in its very nature. Hence, the evaluation of a project's influence on sustainable development requires the examination of several aspects. Therefore, a multi-criteria approach appears to be ideally suited to such analysis.

Also, there is no common unit of measurement in regards to sustainable development assessment with which a criterion, for example the number of jobs created or lost, can be evaluated against another, e.g. the impact on natural resources. However, this does not imply incomparability, but rather that the comparison across the values is weak and can only, or should preferably, be performed without the use of a single type of measure. Multi-criteria evaluation proposes methodological tools that allows for dealing with the incommensurability of values (Martínez-Alier et al., 1998).

Multi-criteria assessment (MCA) techniques help to deal with complexity (Afgan and Carvalho, 2001) by establishing preferences between alternatives to serve a predefined objective. In practice, it is unlikely for any given option, or project, to perform superior in every single criteria. MCA is designed to establish preferences between options for which measurable independent criteria have been defined. The approach does not solve all the issues related to multi-aspects evaluation and nor does it reduce the uncertainty linked to such assessment. Nevertheless, it assists in structuring the problem (Cavallaro, 2005) and allows for a clear and transparent appraisal and therefore has a clear advantage over informal judgments.

The assessment of a project's contribution to sustainable development would require context-specific criteria, as well as a context-specific definition of sustainable development. However, for the purpose of this study, the same approach and the same set of criteria is used for the evaluation of all the projects in order to allow for a comparison amongst them. This evaluation therefore only allows for partially capturing the potential impacts in terms of local sustainable development.

Elements of the method used are inspired by existing work. Sutter (2003) suggests a method, the so-called Multi-Attributive Assessment of CDM (MATA-CDM), which itself reposes on the Multi-Attributive Utility Theory (MAUT) framework, that is tailorcut for the evaluation of CDM projects. The MATA-CDM methodology, which includes a proposed set of criteria, assists in making explicit the contribution to the different aspects of sustainable development of each studied CDM project thus allowing for a comparison between projects.

The MATA-CDM method implies the design of a utility function for each criterion. The basic principle for the design of the utility functions is that the maximum utility (1) represents the benchmark best-practice. A utility of zero characterises a neutral state where the influence of the project compared with the reference or baseline in negligible. A negative utility signifies a negative impact of the project for that particular criterion.

The way the evaluation is executed here differs from the proposed original MATA-CDM methodology for various reasons. Firstly, the goal of this analysis is not to establish a ranking between projects but rather to compare and discuss the contribution of initiatives aimed at promoting broad sustainable development dividends from CDM projects in relative terms. Therefore, the aggregation to a single final utility is not necessary. The ultimate objective reposes on a comparison of the sustainable development dividends profiles. In this context, the functions for each criterion are to be understood as a means of scaling the criteria, resulting in scores for each criterion.

Secondly, the assumption of complete compensability is intrinsic to ordinal utility theory, which can be seen as a drawback from certain viewpoints. A bad performance in one criterion is compensated by a better performance in others. This particularity raises the issue of value trade-offs. MAUT models incorporate ratios which define the performance in one criterion that is compensated by another. In MAUT, such trade-offs are implicitly established when designing the individual utility functions. A potential technical incommensurability (Giampietro et al., 2006) of the indicators might exist. Indeed, the aggregation would imply that it is possible to value the criteria against another, that is, being able to transparently define how much environmental degradation is acceptable if a certain number of jobs are created for instance, and this for every single criterion against every other. This is thus another argument speaking in favour of not aggregating the scores. The stringency of the MATA-CDM was questioned by stakeholders during case studies application because of the issue of trade-off between different criteria (Heuberger et al., 2007). Furthermore, the elimination of that final stage allows for visualising the potential compensative effects (bad performance in one criterion being compensated by good performance in others) hidden in the original approach.

Thirdly, unlike the original methodology, the present study does not claim to assess the contribution of CDM projects to sustainable development as such. Rather it proposes a framework for comparing projects in order to discuss a specific aspect: the effectiveness of initiatives aimed at fostering local sustainable development dividends.

Fourthly, in the MATA-CDM, the weighting of the criteria aims at expressing the relative importance of each criterion (Sutter, 2003). Indeed, one criterion could be assumed as more relevant than another in relative terms. However, weightings represent a controversial, and well debated, issue in the framework of multi-criteria assessments. If assigned by an individual, weightings can seem arbitrary and value-driven. On the other hand, weightings derived from participatory processes would be ideal, but difficult to meaningfully implement. A consensus over the set of criteria to be evaluated might be possible under certain conditions. However, in the case of assigning relative importance to criteria, such a consensus is difficult to envisage if a broad range of stakeholders, with possibly conflicting objectives, are represented in the process. If divergences emerge, an aggregation of the values from different stakeholders, like a mean value for instance, might produce an outcome that does not reflect the reality and which masks the heterogeneity of the stakeholder representation. Also and most importantly, some authors (Munda, 2008; Munda and Nardo, 2005) argue that in a compensatory framework such as the MAUT, using weights to embody intensity of importance represents a theoretical inconsistency. In the case of linear compensatory aggregation models, weights depend on the scale of the criteria and are to be understood as trade-offs, or judgments about compensability and not as importance factors. The issue of weights is yet another argument speaking against aggregating the score of the criteria (see also discussion on aggregation in Sharpe, 2004).

Fifthly, in this paper, the results of the evaluation are represented in amoeba graphs, which are not an instance of the MATA-CDM, for each project type sub-group, allowing to visualise the representation of the sustainability profile of the projects evaluated.

Nonetheless, an advantage of the MATA-CDM, and MAUT methods in general, lies in the fact that the methodology is relatively simple to apply and does not require advanced knowledge in multi-criteria techniques. Therefore, its possible

[5] For an example of methodology to validate and certify sustainable development dividends from CDM, see Social Carbon: http://www.ecologica.org.br/mudancas_social.html, viewed 14 December 2007.

Table 1
Overview of sustainable development criteria

Criteria	Abbreviation
Social	
Stakeholder participation	SOC1
Improved service availability	SOC2
Equal distribution	SOC3
Capacity development	SOC4
Environmental	
Fossil energy resources	ENV1
Air quality	ENV2
Water quality	ENV3
Land resource	ENV4
Economic	
Regional economy	ECO1
Microeconomic efficiency	ECO2
Employment generation	ECO3
Sustainable technology transfer	ECO4

application is wide and not limited to the academic sphere. Also, the MATA-CDM methodology is field-proven. Indeed, this method already demonstrated its potential in several case studies (Sutter and Parreño, 2007; Heuberger et al., 2007). Moreover, the method is used in practice. The Uruguayan Designated National Authority (DNA), for example, applies the MATA-CDM for the evaluation of CDM projects in order to decide on whether they sufficiently contribute to sustainable development and thus give their approval or not (Sutter, 2003; Heuberger et al., 2007).

For the purpose of this evaluation, the sustainable development criteria used draw from Sutter (2003), with the exception of the criteria Equal Distribution of Project Returns, which is based on Sutter and Parreño (2007) due to its more appropriate operationability based on available project information. The criteria are organised according to the traditional classification of the three pillars of sustainable development. The criteria are listed in Table 1, and a more detailed description can be found in Sutter (2003).

It is acknowledged that the choice of the criteria is somewhat arbitrary and reposes on value judgment. However, the set of criteria suggested is based on the experience from existing studies applying the multi-criteria methodology (Sutter, 2003; Sutter and Parreño, 2007). Moreover, internationally acknowledged sustainability evaluation methods, such as the one suggested by South-SouthNorth (2003) and the Gold Standard itself, feature similar sets of criteria (for an overview of the literature, see Olsen, 2007). The set of criteria needs to represent a balanced compromise between representativeness and operationality. The scoring functions for the respective criteria are specified in Appendix A. The scoring functions are used for making the representation of the sustainable development profiles of the different projects possible in amoeba graphs.

The data necessary for the evaluation of the projects are derived from the respective Project Design Document (PDD) and associated documents. The PDD is the official document used throughout the process in the UNFCCC framework. The limitation to one source may seem restrictive. However, this approach presents many advantages. Firstly, the PDD is a public document available on the Internet and thus easily accessible. Secondly, the document and its content, unlike unofficial project documents, can be assumed as being fairly reliable. Indeed, the PDD represents the official document submitted to the authoritative body of the CDM, the Executive Board, for approbation of the project. Before this, the PDD has to be reviewed and approved by a so-called Designated Operational Entity, a body accredited by the UNFCCC, to ensure its concordance with the requirements. Furthermore, the procedure requires that the document be subjected to public comments as well as to take into consideration those comments. Thirdly, the form being standardised, it contains relatively homogenous data. However, information in regard to sustainable development in the PDD is sparse or vague in some cases. Where possible, data from other studies (Cosbey et al., 2006; Sutter, 2003; Sutter and Parreño, 2007) are used as cross-check. Fourthly, data from PPDs is easily available to the non-specialised community and is a reference for determining from which CDM activities to purchase Certified Emission Reductions for instance.

5. Projects evaluated

In order to evaluate the relative potential performance in terms of contribution to local sustainable development of Gold Standard and CDCF projects, they are compared with ordinary CDM projects with similar features. A total of 39 CDM activities were evaluated. Table 2 provides an overview of the projects evaluated, mentioning some of their main attributes as well as whether they are a Gold Standard or CDCF activity.

In order to limit the number of projects, and thus keep to a manageable amount of data, the CDM pipeline (Fenhann, 2008; status as of 1 April 2008) is filtered according to several criteria. Only registered projects are considered. All Gold Standard and CDCF CDM projects are selected. They are compared with non-labelled projects of similar type. The selection criteria of the CDM pipeline are, in the following sequence: type, sub-type, and methodology. In the case where the filtering results in a large number of projects, an additional criterion of size ($ktCO_2/yr$) is used to selected CDM activities that are of similar size to the labelled project by choosing the two projects that are directly adjacent to the labelled one in the pipeline.

6. Evaluation and discussion

The results of the sustainable development evaluation are presented in amoeba graphs for each project sub-groups. As a guidance for reading the graphs, social development criteria are represented from 12 to 3 o'clock in the diagrams, environmental development from 4 to 7 o'clock, and economic development from 8 to 11 o'clock. CDCF projects are represented in red and Gold Standard in gold, while ordinary projects are in other colours.

For the biogas sub-group, Fig. 1 suggests that the sustainable development profile of the Bagepalli project, which is an ordinary CDM activity, outperforms the CDCF project at least for a few criteria, while the other project (Joint venture) seems to perform relatively well in terms of economic criteria, but less well in other indicators. Only one Biogas Nepal project is shown in the graph for clarity since both feature similar sustainable development profile.

As far as the industrial energy efficiency sub-group is concerned, the two CDCF projects' sustainable development profiles are more ample than their opponent's, notably in terms of environmental indicators (Fig. 2).

In regard to the landfill diagram (Fig. 3), all three projects match closely, with the exception of the one social criterion (improved service availability) for which the CDCF activity surpasses the other two projects.

The picture in regard to the biomass projects (Fig. 4) looks relatively balanced, with the Gold Standard outperforming the other two projects only in one criterion (improved service availability), and scoring slightly less in a couple of others.

Table 2
Overview of CDM projects evaluated

Ref.	Project name	Host country	Type	Sub-type	Methodology	Gold standard	CDCF
121	Bagepalli CDM biogas programme (5500 units of 2 m^3)	India	Biogas	Biogas power	AMS-I.C		
136	Biogas sector partnership Nepal (6500 units) activity-1	Nepal	Biogas	Biogas power	AMS-I.C		x
139	Biogas support program-Nepal (BSP-Nepal) activity-2	Nepal	Biogas	Biogas power	AMS-I.C		x
478	A joint venture project of cogeneration of electricity and hot water using natural gas and biogas produced from on-site wastewater biodigesters	Mexico	Biogas	Biogas power	AMS-I.C		
777	Energy efficiency improvement in electric arc furnace at Indian Seamless Metal Tube Limited (ISMT), Jejuri, Maharashtra	India	EE industry	Iron and steel	AMS-II.D		
582	India-Vertical Shaft Brick Kiln cluster project	India	EE industry	Building materials	AMS-II.D		x
847	Up-gradation of Gas Turbine 1 (GT 1) and Gas Turbine 2 (GT 2) at co-generation plant of Hazira Gas Processing Complex (HGPC) of Oil and Natural Gas Corporation Limited (ONGC)	India	EE industry	Petrochemicals	AMS-II.D		
685	Modification of clinker cooler for energy efficiency improvement in cement manufacturing at Binani cements	India	EE industry	Cement	AMS-II.D		
707	India-FaL-G Brick and blocks Project no. 1	India	EE industry	Building materials	AMS-II.D		x
1018	Fuel efficiency improvement in glass melting	India	EE Industry	Glass	AMS-II.D		
140	Olavarría landfill gas recovery project	Argentina	Landfill gas	Landfill flaring	ACM1		x
1219	Coronel landfill gas capture project	Chile	Landfill gas	Landfill flaring	ACM1		
1442	AESA Misiones (Proactiva Group) sanitary landfill gas capture and flaring project	Argentina	Landfill gas	Landfill flaring	ACM1		
546	SRGEL Non-conventional renewable sources biomass power project	India	Biomass energy	Agricultural residues: other kinds	AMS-I.D		
298	4.5 MW biomass (low-density crop residues)-based power generation unit of Malavalli Power Plant Pvt. Ltd.	India	Biomass energy	Agricultural residues: other kinds	AMS-I.D	x	
281	4.5 MW biomass (agricultural residue)-based power generation unit of M/s. Matrix Power Pvt. Ltd. (MPPL)	India	Biomass energy	Agricultural residues: other kinds	AMS-I.D		
492	Eecopalsa—biogas recovery and electricity generation from palm oil mill effluent ponds	Honduras	Biogas	Power	AMS-I.D.+AMS-III.H	x	
498	SIDPL methane extraction and power generation project	India	Biogas	Power	AMS-I.D.+AMS-III.H		
505	Methane recovery and power generation in a distillery plant	India	Biogas	Power	AMS-I.D.+AMS-III.H		
159	Moldova biomass heating in rural communities project no. 1	Moldova	EE households		AMS-I.C.+AMS-II.E.+AMS-III.B		x
160	Moldova biomass heating in rural communities (project design document no. 2)	Moldova	EE households		AMS-I.C.+AMS-II.E.+AMS-III.B		x
79	Kuyasa low-cost urban housing energy upgrade project, Khayelitsha	South Africa	EE households		AMS-I.C.+AMS-II.C.+AMS-II.E	x	
244	Aleo Manali 3 MW small hydroelectric project	India	Hydro	Run of river	AMS-I.D		
88	Santa Rosa (1.1 MW+1.5 MW+1.5 MW)	Peru	Hydro	Run of river	AMS-I.D		x
35	5 MW Dehar grid-connected SHP in Himachal Pradesh	India	Hydro	Run of river	AMS-I.D		
960	"2 × 5 MW Upper Khauli and Drinidhar small hydroelectric project for a grid system", Himachal Pradesh	India	Hydro	Run of river	AMS-I.D		
9	La Esperanza Hydroelectric 12.7 MW small-scale project	Honduras	Hydro	Run of river	AMS-I.D		x
81	"Los Algarrobos" small-scale hydroelectric project	Panama	Hydro	Run of river	AMS-I.D		
841	Yunnan Whitewaters hydropower development project	China	Hydro	New dam	ACM2		
904	Guangrun hydropower project in Hubei Province	China	Hydro	New dam	ACM2		x
996	Zhoubai Hydroelectric Project	China	Hydro	New dam	ACM2		
1244	The Wulabo 30 MW wind-farm project in Urumqi, Xinjiang of China	China	Wind		ACM2		
1318	Fujian Zhangpu Liuao 45 MW wind power project	China	Wind		ACM2	x	
1327	Inner Mongolia Zhuozi 40 MW wind power project	China	Wind		ACM2		
310	Bundled wind power project in Jaisalmer (Rajasthan in India) managed by Enercon (India) Ltd.	India	Wind		ACM2		
1269	Ningxia Yinyi 49.50 MW wind-farm project, China	China	Wind		ACM2	x	
483	Jilin Changling wind farm Phase I project	China	Wind		ACM2		
414	Solar steam for cooking and other applications	India	Solar	Solar cooking	AMS-I.C	x	
218	CDM solar cooker project Aceh 1	Indonesia	Solar	Solar cooking	AMS-I.C		

The biogas for electricity generation diagram (Fig. 5) presents a similar outcome. The sustainable development profiles of the three projects are closely matching, except for a few criteria for which the Gold Standard project seems to perform better.

Fig. 6 for the energy efficiency sub-group features both a Gold Standard and a CDCF projects. The Gold Standard activity outperforms the CDCF project in some criteria, and the opposite statement is valid for one criterion. Both projects feature a similar profile overall, with a slight advantage for the Gold Standard.

The two CDCF run of river hydro projects' profiles (Fig. 7) seem well distributed over the different criteria. Interestingly, the Upper Khauli project appears to outperform both CDCF activities in terms of sustainable development profile. Noteworthy is the misbalanced profile of the Dehar project.

The two Gold Standard activities seem to outperform the other wind projects (Fig. 8), but again not uniformly in all criteria.

As far as the hydro new dam sub-group is concerned, the CDCF project performs similarly overall to the non-label activities in Fig. 9.

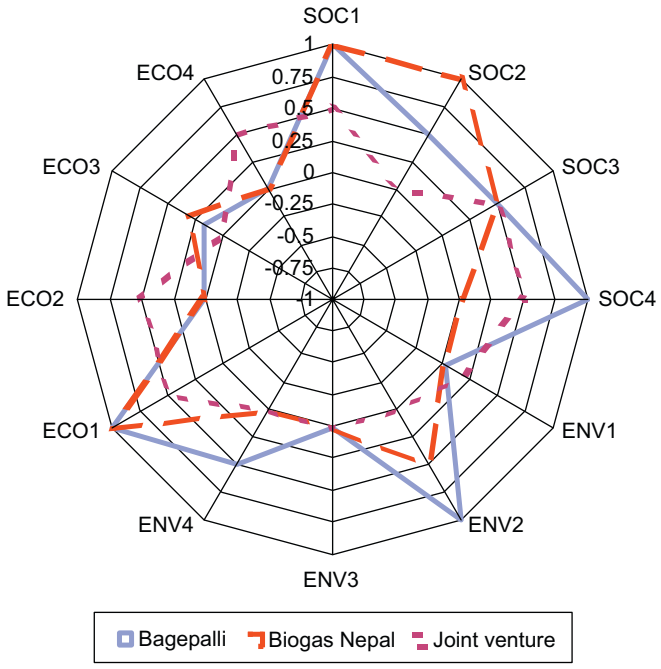

Fig. 1. Sustainable development profile of CDM projects, type: biogas thermal energy.

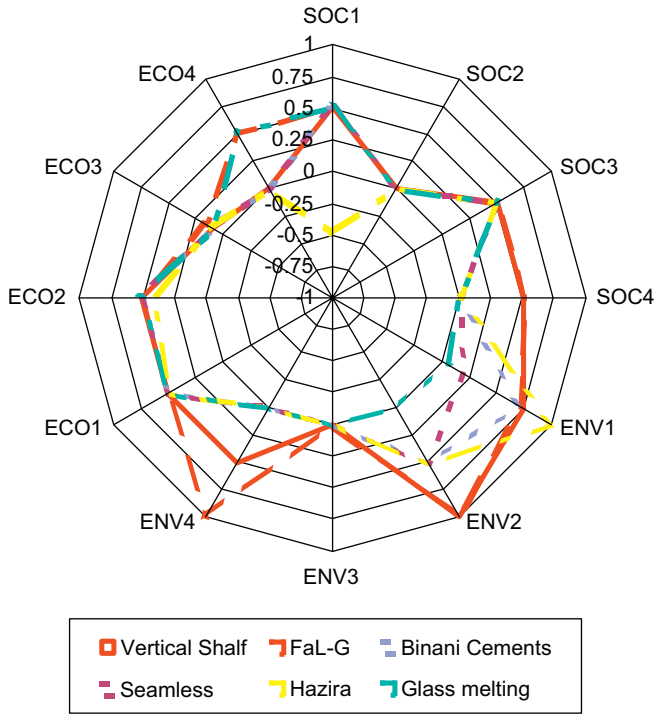

Fig. 2. Sustainable development profile of CDM projects, type: energy efficiency industry.

The Gold Standard solar project outdoes the non-labelled one in several criteria, whereas not in others in the solar sub-group (Fig. 10).

This section formalises the comparison between projects with and without special attributes. The scores of labelled projects in each criterion individually, in order to respect the incommensurability of the criteria, are compared with the average score of the respective sub-group projects in the same criterion. The results

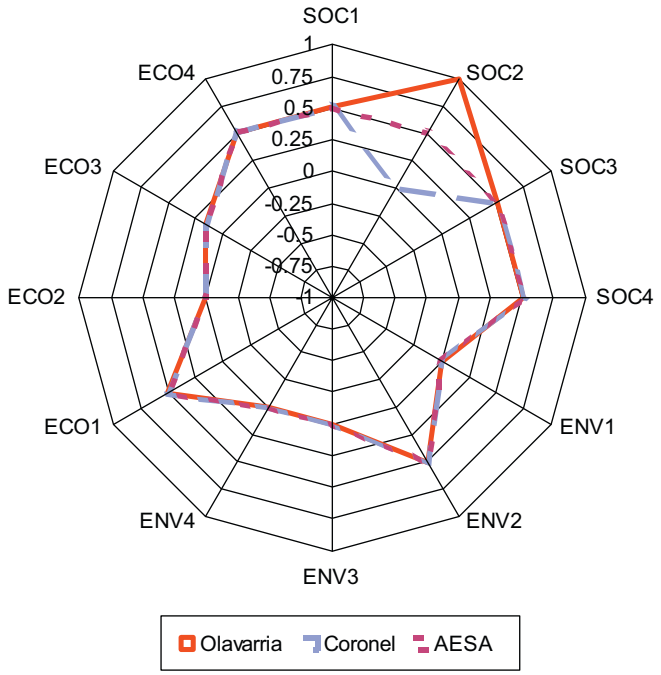

Fig. 3. Sustainable development profile of CDM projects, type: landfill.

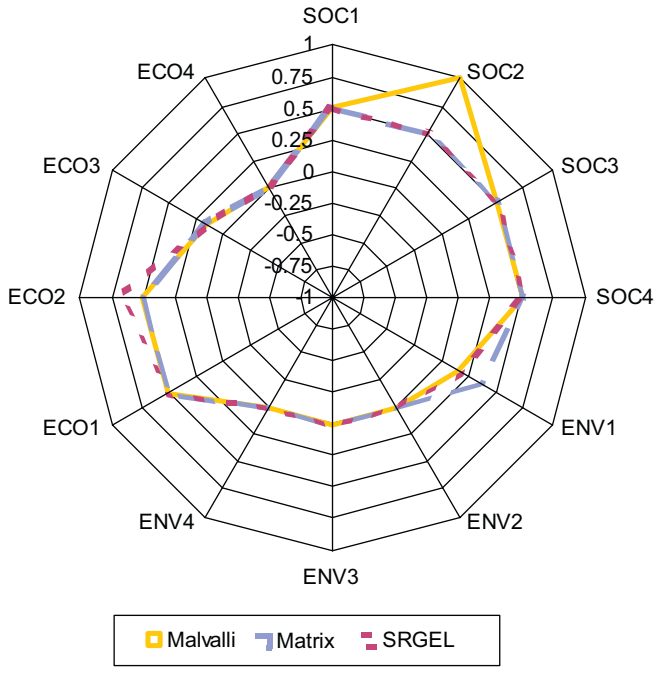

Fig. 4. Sustainable development profile of CDM projects, type: biomass agriculture.

are shown in Fig. 11. The sustainable development criteria are represented on the *x*-axis. The *y*-axis represents whether the labelled project outperforms (+, in green), equals (on the axis, in orange), or underperforms (−, in red) compared with the average. The size of the dots is proportional to the number of instances, considering all sub-groups together. For example, in regard to the criterion SOC1, the scores of Gold Standard projects equal the average of their respective sub-groups in many instances, outperform it one instance, and are never below the average.

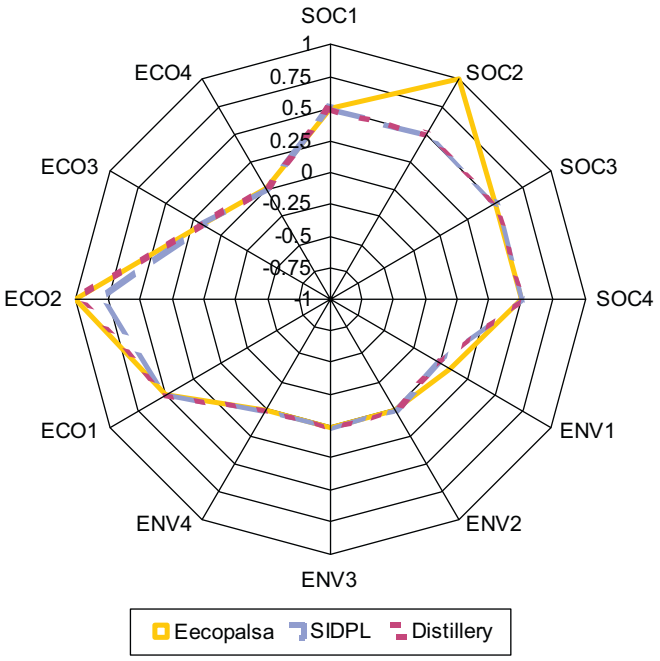

Fig. 5. Sustainable development profile of CDM projects, type: biogas electricity.

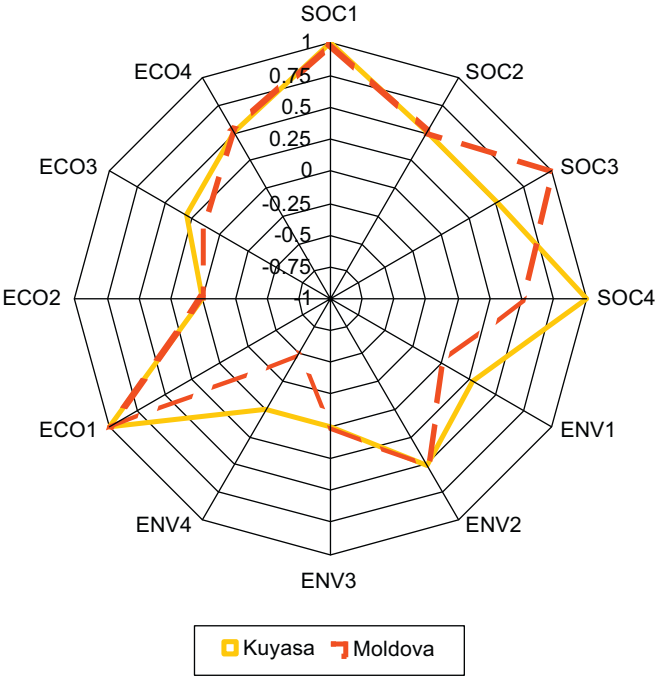

Fig. 6. Sustainable development profile of CDM projects, type: energy efficiency buildings.

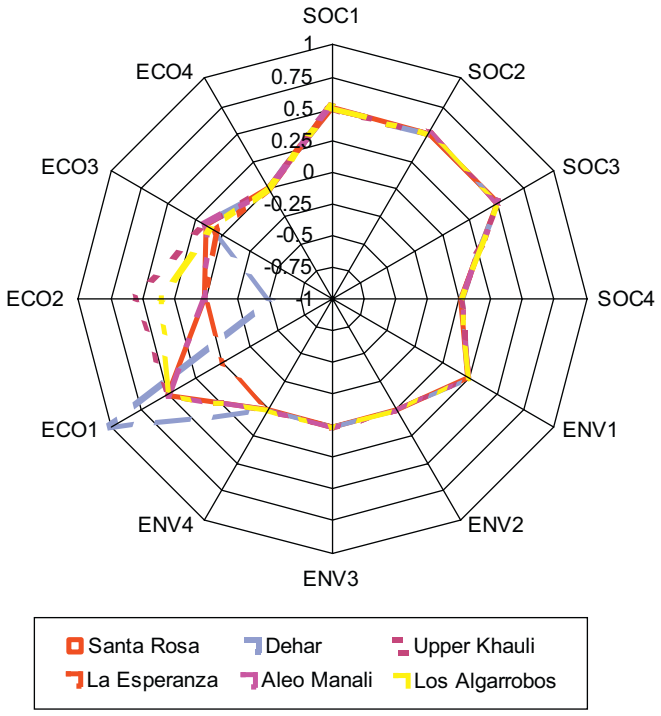

Fig. 7. Sustainable development profile of CDM projects, type: hydro run of river.

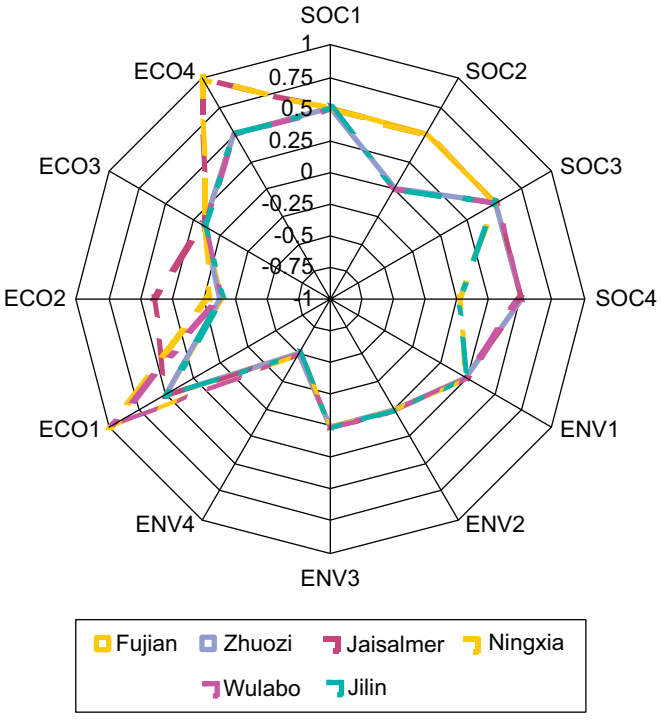

Fig. 8. Sustainable development profile of CDM projects, type: wind.

From Fig. 11, one can deduct that in most instances, labelled projects perform similarly to the average of their respective sub-groups. Both the Gold Standard and the CDCF feature a slightly better performance overall when compared with similar projects, the advantage being somewhat more marked for the Gold Standard.

Going into the details of the individual indicators, one can note a better contribution to criteria related to social sustainable development of labelled projects, and mixed results for the environmental criteria. In terms of economic indicators, the CDCF activities most often score under the average. This latter finding is not counter-intuitive since the CDCF aims at promoting activities that would otherwise be likely to be rejected by the market.

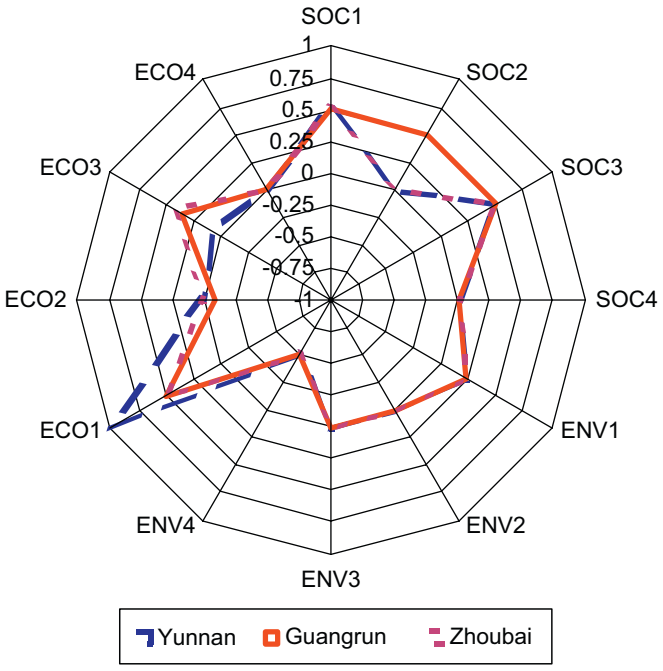

Fig. 9. Sustainable development profile of CDM projects, type: hydro new dam.

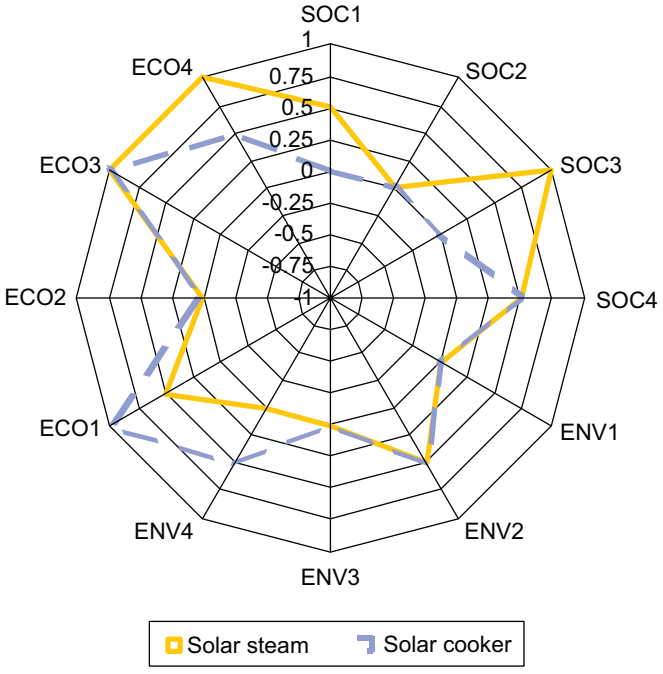

Fig. 10. Sustainable development profile of CDM projects, type: solar.

7. Conclusion

The CDM seems to have been very successful in contributing to the development of a global carbon market, allowing for temporal and spatial flexibility in achieving emission reduction targets. On the other hand, its role in assisting host countries in their effort to promote sustainable development is being questioned. According to critics, the contribution to sustainable development of several Clean Development Mechanism projects is disappointing. Several actions have taken place intending to remedy some of those shortcomings. The Gold Standard rewards best-practice CDM projects. The CDCF promotes CDM activities located in under-privileged communities. This analysis compares projects with special attributes with ordinary ones.

Since labelled Certified Emission Reductions are likely to be more costly than those delivered by ordinary CDM activities, it is legitimate to evaluate whether their contribution in terms of sustainable development differs from non-labelled projects. It is important to underline here, however, that the added-value of labelled projects might also be reflected in other issues. For example, the Gold Standard methodology features additional requirement in terms of additionality demonstration. Such effects go beyond the scope of this study and are thus not captured in this analysis, since it focuses exclusively on sustainable development attributes.

Multi-criteria seems particularly appropriate for evaluating the multi-dimensionality of sustainable development. The MATA-CDM provides a methodology that allows for a straightforward and consistent appraisal of the projects' contribution to sustainable development. The methodology applied in this research derives from the MATA-CDM and is adapted to the specific requirements of this evaluation, with a particular emphasis on the respect of the principle of incommensurability of the different indicators.

The evaluation carried out in this research suggests that, based on the sample of projects evaluated, the sustainable development profile of premium CDM projects tends to be comparable or slightly more ample than similar ordinary projects. Labelled projects do not, however, drastically out perform non-labelled ones. Also, the distinction between projects might very well be within the range of uncertainty intrinsic to such assessment. The contribution of labelled projects to social sustainable development tends to outdo comparable ordinary activities, whereas the contrary holds for economic criteria of sustainable development.

It must be noted that this evaluation compares CDM activities that are believed to be the most promising in terms of sustainable development contribution, such as renewable energy and energy efficiency projects for instance. Also, most projects evaluated are small-scale activities. Industrial end-of-the-pipe adjustments for instance, which are subject to fierce criticisms from the sustainable development contribution viewpoint, are not the focus of the Gold Standard or the CDCF, and thus do not appear in this analysis. There are reasons to believe that such projects would feature a significantly different sustainable development profile.

Considering that the CDM is at best carbon-neutral, its contribution to sustainable development is essential. Since the CDM is a market-based mechanism, it is likely to be driven by factors others than the contribution to sustainable development in the host country since those are not marketed. Means to differentiate the quality of the projects, such as labels, therefore provide valuable signals to investors, project developers, and potential certificate buyers, provided that such labels are credible.

Albeit the current shortcomings, a framework such as the CDM appears to have a great potential as an effective market instrument, including in the medium term (post-Kyoto). It is therefore of critical importance to ensure that both objectives, GHG emission reduction and contribution to sustainable development, effectively unfold their full potential. While the former objective is clearly regulated, clearer guidance in terms of making the assessment of the potential contribution to sustainable development, through a set of quantifiable indicators for instance, would be most useful. Guidelines in that regard could be integrated into the validation and verification processes.

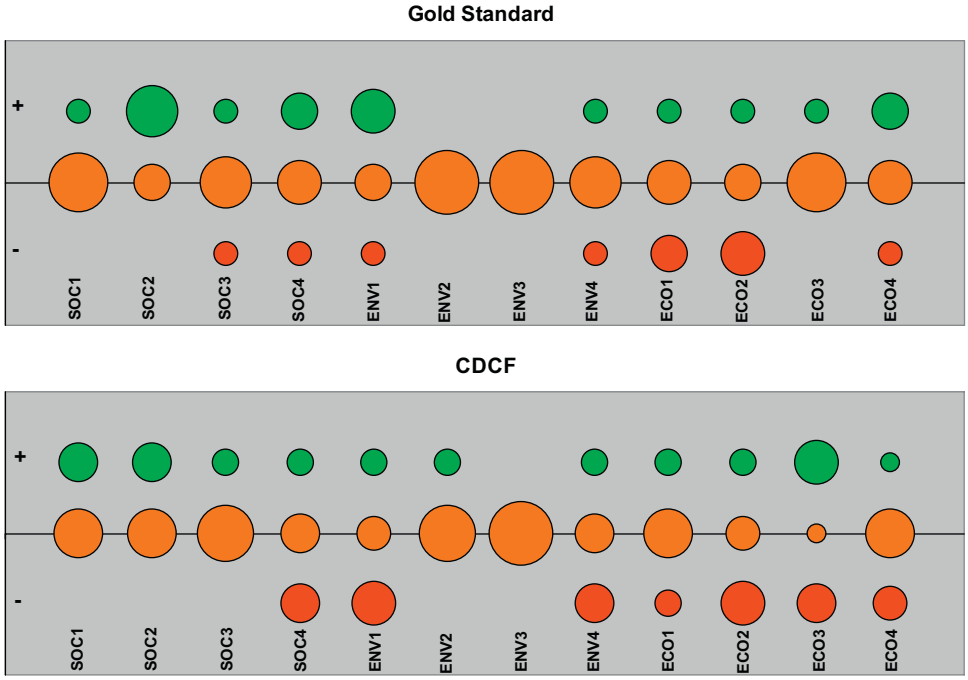

Fig. 11. Comparison of sustainable development contribution of Gold Standard CDM projects (top panel) and CDCF projects (bottom panel) with the average score of similar projects.

Acknowledgments

The author is grateful for the valuable comments on an earlier draft provided by two anonymous reviewers, colleagues at the International Institute for Applied Systems Analysis (IIASA), as well as for the support provided by the Institut de Ciències i Tecnologia Ambientales (ICTA) at the Autonomous University of Barcelona.

Appendix A. Supplementary materials

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.enpol.2008.07.033.

References

Afgan, N.H., Carvalho, M.G., 2001. Multi-criteria assessment of new and renewable energy power plants. Energy 27, 739–755.

Bishop, V., 2007. Improving price equity in CDM projects: strategies for maximizing carbon value. In: Hodes, G., Kamel, S. (Eds.), Equal Exchange: Determining a Fair Price for Carbon. United Nations Environmental Programme (UNEP), Capacity Development for the Clean Development Mechanism (CD4CDM). Available at 〈http://cd4cdm.org/Publications/Perspectives/FairPriceCarbon.pdf〉, last viewed 14 December 2007.

Boyd, E., Hultman, N.E., Roberts, T., Corbera, E., Ebeling, J., Liverman, D.M., Brown, K., Tippmann, R., Cole, J., Mann, P., Kaiser, M., Robbins, M., Bumpus, A., Shaw, A., Ferreira, E., Bozmoski, A., Villiers C., Avis, J., 2007. The clean development mechanism: an assessment of current practice and future approaches for policy. Tyndall Centre for Climate Change Research, Working Paper 114. Available at 〈http://www.tyndall.ac.uk/publications/working_papers/twp114.pdf〉, last viewed 12 December 2007.

Burian, M., 2006. The clean development mechanism, sustainable development and its assessment. Hamburg Institute of International Economics, Report 264. Available at 〈http://www.hwwa.de/Forschung/Publikationen/Report/2006/Report264.pdf〉, last viewed 15 December 2007.

Cavallaro, F., 2005. An integrated multi-criteria system to assess sustainable energy options: an application of the promethee method. International Energy Markets. Available at 〈http://www.feem.it/NR/rdonlyres/9E940C73-A958-4D9C-B5CC-48E940D89829/1448/2205.pdf〉, last viewed 12 December 2007.

Cosbey, A., Parry, J.-E., Browne, J., Dinesh Babu, Y., Bhandari, P., Drexhage, J., Murphy, D., 2005. Realizing the development dividend: making the CDM work for developing countries. International Institute for Sustainable Development (IISD), Phase 1 Report—Pre-publication Version, Manitoba, Canada.

Cosbey, A., Murphy, D., Drexhage, J., Balint, J., 2006. Making development work in the CDM. International institute for sustainable development (IISD), Phase 2 Report—Pre-publication Version, Manitoba, Canada.

Dutschke, M., Michaelowa, A., 1998. Creation and shraing of credits through the clean development mechanism under the Kyoto Protocol. HWWA Discussion Paper 62. Available at 〈http://opus.zbw-kiel.de/volltexte/2003/1070/pdf/62.pdf〉, last viewed 12 December 2007.

Ellis, J., Corfee-Morlot, J., Winkler, H., 2004. Taking Stock of the Progress under the Clean Development Mechanism (CDM). Organisation for Economic Co-operation and Development (OECD), Paris. Available at 〈http://www.oecd.org/dataoecd/58/58/32141417.pdf〉, last viewed 12 December 2007.

Estrada, M., Corbera, E., Brown, K., 2008. How do regulated and voluntary carbon-offset schemes compare? Tyndall Centre for Climate Change Research, Working Paper 116. Available at 〈http://www.tyndall.ac.uk/publications/working_papers/twp116.pdf〉, last viewed 26 July 2008.

Fenhann, J., 2008. CDM and JI pipeline overview. Status as of 1 April 2008, Capacity Development for CDM, United Nations Environment Programme (UNEP) Risø Centre, Roskilde, Denmark. Available at 〈http://cdmpipeline.org/〉, last viewed 10 April 2008.

Germain, M., Magnus, A., van Steenberghe, V., 2007. How to design and use the clean development mechanism under the Kyoto Protocol? A developing country perspective. Environmental and Resource Economics 38, 13–30.

Gesellschaft für Technische Zusammenarbeit (GTZ), 2005. Newsletter CDM Highlights 29. Available at 〈http://www.gtz.de/en/themen/umwelt-infrastruktur/umweltpolitik/14317.htm〉, last viewed 10 December 2007.

Giampietro, M., Mayumi, K., Munda, G., 2006. Integrated assessment and energy analysis: quality assurance in multi-criteria analysis of sustainability. Energy 31, 59–86.

Gold Standard, 2003. The Gold Standard–Background and Overview. Available at 〈http://assets.panda.org/downloads/thegoldstandardoverview.doc〉, last viewed 12 December 2007.

Heuberger, R., Brent, A., Santos, L., Sutter, Ch., Imboden, D., 2007. CDM projects under the Kyoto Protocol: a methodology for sustainability assessment—experiences from South Africa and Uruguay. Environment, Development and Sustainability 9, 33–48.

Kim, J.A., 2003. Sustainable development and the CDM: a South African case study. Tyndall Centre for Climate Change Research, Working Paper 42. Available at 〈http://www.tyndall.ac.uk/publications/working_papers/wp42.pdf〉, last viewed 12 December 2006.

Langrock, T., Sterk, W., 2003. Der Gold Standard für CDM und JI—Motivation und Wirkungsweise. Wuppertal Institut für Klima, JIKO Policy Paper 2/2003. Available at 〈http://www.wupperinst.org/uploads/tx_wibeitrag/gold-standard.pdf〉, last viewed 12 December 2007.

Martínez-Alier, J., Munda, G., O'Neill, J., 1998. Weak comparability of values as a foundation for ecological economics. Ecological Economics 26, 277–286.
Michaelowa, A., Michaelowa, K., 2007. Does climate policy promote development? Climatic Change 84, 1–4.
Muller, A., 2007. How to make the clean development mechanism sustainable—the potential of rent extraction. Energy Policy 35, 3203–3212.
Muller, A., 2008. Risk management in the Clean Development Mechanism (CDM)—the potential of sustainability labels. In: Hansjurgens, B., Antes, R. (Eds.), Economics and Management of Climate Change: Risks, Mitigation and Adaptation. Springer, New York, pp. 193–207.
Munda, G., 2008. Social Multi-Criteria Evaluation for a Sustainable Economy. Springler, Berlin.
Munda, G., Nardo, M., 2005. Constructing Consistent Composite Indicators: The Issue of Weights. 2005, Institute for the Protection and Security of the Children, European Commission, Luxembourg. Available at 〈http://crell.jrc.ec.europa.eu/Well-being/papers/Munda%20Nardo%20eurorepport1.pdf〉, last viewed 12 December 2007.
Olhoff, A., Markandya, A., Halsnaes, K., Taylor, T., undated. CDM. Sustainable development impacts. CD4CDM. United Nations Environment Programme. Available at 〈http://cd4cdm.org/Publications/CDM%20Sustainable%20Development%20Impacts.pdf〉, last viewed 12 July 2008.
Olsen, K.H., 2007. The clean development mechanism's contribution to sustainable development: a review of the literature. Climatic Change 84, 59–73.
Olsen, K.H., Fenhann, J., 2008. 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. Energy Policy 36, 2819–2830.
Pearson, B., 2007. Market failure, why the clean development mechanism won't promote clean development. Journal of Cleaner Production 15, 247–252.
Policy and Operations Evaluation Department, 2008. Clean and sustainable? An evaluation of the contribution of the clean development mechanism to sustainable development in host countries. Dutch Ministry of Foreign Affairs. Available at 〈http://www.minbuza.nl/binaries/en-pdf/iob-evaluatie/rapporten/39897_buza_iob310.pdf〉, last viewed 26 July 2008.
Rose, A., Bulte, E., Folmer, H., 1999. Long-run implications for developing countries of joint implementation of greenhouse gas mitigation. Environmental and Resource Economics 14, 19–31.
Sharpe, A., 2004. Literature review of framework for macro-indicators. Centre for the Study of Living Standards, Research Report 2004-03, Ottawa. Available at 〈http://ideas.repec.org/p/sls/resrep/0403.html〉, last viewed 10 December 2007.
Schlup, M., 2005. The Gold Standard: Linking the CDM to development and poverty reduction. Paper prepared for the Conference on Climate or Development? Hamburg Institute of International Economics (HWWI), 28–29 October 2005.
Schneider, L., 2007. Is the CDM fulfilling its environmental and sustainable development objectives? An evaluation of the CDM and options for improvements. Institute for Applied Ecology. Available at 〈http://www.oeko.de/oekodoc/622/2007-162-en.pdf〉, last viewed 10 December 2007.
SouthSouthNorth, 2003. The SouthSouthNorth sustainable development appraisal & ranking matrix tool. Available at 〈http://www.southsouthnorth.org/library.asp〉, viewed 12 December 2007.
Sterk, W., 2008. From clean development mechanism to sectoral crediting approaches—way forward or wrong turn? Wuppertal Institut für Klima, JIKO Policy Paper 1/2008. Available at 〈http://www.wupperinst.org/en/publications/entwd/uploads/tx_wibeitrag/CDM_sect_crediting.pdf〉, last viewed 26 July 2008.
Sterk, W., Langrock, T., 2003. Der Gold Standard–Kriterien für JI- und CDM-Projekte, Wuppertal Institut für Klima, JIKO Policy Paper 4/2003. Available at 〈http://www.wupperinst.org/uploads/tx_wibeitrag/gold-standard-kriterien.pdf〉, last viewed 19 January 2008.
Sterk, W., Wittneben, B., 2005. Addressing opportunities and challenges of a sectoral approach to the clean development mechanism. Wuppertal Institut für Klima, JIKO Policy Paper 1/2005. Available at 〈http://www.wupperinst.org/uploads/tx_wibeitrag/addressing-opportunities.pdf〉, last viewed 12 December 2007.
Sutter, Ch., 2003. Sustainability Check-Up for CDM Projects. Wissenschaftlicher Verlag, Berlin. Available at 〈http://www.up.ethz.ch/research/energy_climate/closed/cdm_assessment/Sutter_2003_Sustainability_Check-Up_for_CDM_Projects__e-book_.pdf〉, last viewed 12 December 2007.
Sutter, Ch., Parreño, J.C., 2007. Does the current Clean Development Mechanism (CDM) deliver its sustainable development claim? An analysis of officially registered CDM projects. Climatic change 84, 75–90.
United Nations Development Programme (UNDP), 2006. The clean development mechanism: an assessment of progress. Available at 〈http://www.energyandenvironment.undp.org/undp/indexAction.cfm?module=Library&action=GetFile&DocumentAttachmentID=1859〉, last viewed 15 December 2007.
United Nations Framework Convention on Climate Change (UNFCCC), 1997. Kyoto Protocol to the United Nations framework convention on climate change. Available at 〈http://unfccc.int/essential_background/kyoto_protocol/background/items/1351.php〉, last viewed 29 November 2007.
United Nations Framework Convention on Climate Change (UNFCCC), 2002. Report on the Conference of the Parties on its Seventh Session, Marrakesh, 29 October–10 November 2001. Conference of the Parties, Volume II, FCCC/CP/2001/13/Add.2. Available at 〈http://cdm.unfccc.int/Reference/COPMOP/decisions_17_CP.7.pdf〉, last viewed 29 November 2007.
World Bank (WB), undated. Community Development Carbon Fund. The World Bank, Washington, DC. Available at 〈http://carbonfinance.org/docs/CarbonFundweb.pdf〉, last viewed, 10 December 2007.