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Assessing sustainability for CDM projects

A case study from Thailand

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Judgements and opinions expressed in this paper are those of the author and do not represent views of the cited company, or the endorsement of any approach described herein

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Abstract

The main characteristic of the *Clean Development Mechanism* (CDM) introduced by the Kyoto Protocol is its twofold objective, aimed at integrating the goal of reducing CO_2 emissions, on a local and global scale, with the promotion of sustainable development in developing countries. This work discusses how sustainability assessment at the project level remains a critical issue, as it is often regarded as a secondary issue by project developers focusing on a limited number of countries and technologies. Several methods on how to measure sustainable development in CDM projects have been illustrated in this paper, and the critical aspects of performing sustainability assessments have been discussed. Through the presentation of a case study from the cement industry in Thailand, the author concludes that the regulatory and institutional framework of the host countries is the factor that ultimately affects the actual implementation of CDM projects and their effective contribution to sustainable development.

Executive Summary

The *Clean Development Mechanism* (CDM), introduced in 1997 through the Kyoto Protocol to the *United Nations Framework Convention to Climate Change* (UNFCCC), has the goal of supporting the implementation of joint projects between developed and developing countries, with the double intent of reducing the emissions of green house gases and promoting sustainable development. At the international level, several assessing methods have been developed to evaluate the contribution of CDM projects to sustainable development. The interviews and surveys carried out have shown that detailed sustainability assessments are rarely performed in practice, and mainly rely on the discretionality of the single project developer. Sustainable development is regarded as a secondary issue in the actual implementation of CDM projects. Among the obstacles to the development of accurate sustainability assessments there are high transaction costs and the unclear regulatory frameworks/allocation of responsibilities often characterizing developing countries, which obstacles the collection of information by project proponents, and hampers the definition of clear requirements and guidelines by the concerned national authorities, further discouraging project developers. Moreover, the Marrakech Accords state that developing countries have the prerogative to decide which aspects and development criteria should be prioritised in each national context. The *Designated National Authorities* (DNA) often adopt wide, badly defined sustainable criteria to facilitate the inflow of new investments to their countries. Therefore, for the project developers there is little incentive to carefully assess sustainability-related issues.

At the international level, the recent trends show that the number of CDM projects in the pipeline is growing rapidly, and it is estimated that registered CDM projects will contribute to reduce CO_2 emissions by 1,200,000,000 tons by 2012. However, the geographic distribution of CDM projects is uneven, being concentrated on some countries and regions, while project activities mainly involve technologies characterized by low-CO_2 abatement costs. These trends do not result in line with the overall goal of the CDM framework, aiming at supporting a more even transfer of clean technologies and the spread of sustainable practices in developing countries.

Cement industry is responsible for 5% of the world's man-made CO_2 emissions, originating about 2 billion tons of CO_2/year. Approximately 70% of these emissions come from developing countries. Fuel combustion accounts for about 40% of the total emissions from cement manufacture. In 2002, ten international cement companies set out to help cement industry to play a stronger role in the enhancement of sustainable development, giving birth to the *Cement Sustainability Initiative* (CSI). The CDM offers now a framework for the adoption of initiatives and innovative projects in line with the goals pursed through the CSI, dealing with environmental issues while benefiting the social and economic spheres. Within the UNFCCC framework, in fact, several methodologies have been developed for CDM project in cement sector. The use of alternative fuels in cement manufacture is regulated by the consolidated methodology ACM0003. The use of biofuels in cement kilns might be considered by Italcementi Group, one of the global cement companies member of the CSI, for the development of a potential CDM project in Thailand. In developing countries with abundant biomass resources the use of agricultural waste replacing fossil fuels can contribute to reduce CO_2 emissions and to promote the efficient use of resources locally available, reducing national dependency on energy imports. Moreover, CDM projects can effectively contribute to enhance sustainable development through the creation of job opportunities and the provision of additional benefits for local communities. The crucial issue concerns the actual availability of biomass in order to avoid leakages, i.e. the switch to the use of fossil fuels by other users of biomass residues.

As a result of this work, its author believes that the actual development of CDM projects may result very complex in countries characterized by institutional and political unstability such as Thailand; the delays of the CDM implementation system and DNA in Thailand can limit the development of CDM projects and prevent the country from benefiting from their potential positive impact on it's sustainable development.

"The CDM opens a universe of possible cooperation for mitigation of climate change and development, aims which are not easy to conciliate. A great effort of imagination and compromise is required for successful implementation of the CDM."

Raùl A. Estrada Oyue

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Introduction

1.1 Problem definition

The Kyoto Protocol to the *United Nation Framework Convention on Climate Change* (UNFCCC), which sets a framework for intergovernmental efforts to deal with the issue of climate change, was introduced in 1997 with the purpose of strengthening the Convention. The Protocol introduced legally-binding targets for the reduction of greenhouse gas emissions from the Parties listed in Annex I to the Convention (this is the group of developed countries commonly referred to as "Annex I countries")[1]. The total cut in greenhouse-gas emissions for Annex I countries consists of a reduction by 5% from 1990 levels in the first commitment period, 2008-2012. Only Parties to the Convention that are also Parties to the Protocol (i.e. countries that have ratified it) are bound by the Protocol's commitments. 164 countries have ratified the Protocol so far.

The *Clean Development Mechanism* (CDM) is a project-based mechanism introduced under the Kyoto Protocol. Together with the *Join Implementation mechanism* (JI) (art.6), and the *Emission Trading scheme* (EM) (art.17), the CDM belongs to the so-called "flexibility mechanisms" of the Kyoto Protocol[2].

Article 12 of the Protocol states that the CDM has a double objective:

I. To assist non-Annex I countries "in achieving sustainable development and in contribute to the ultimate objective of the Convention";

II. To assist Annex I parties "in achieving compliance with their quantified emission limitation and reduction commitments".

Therefore, in general terms, the contribution of CDM to sustainable development consists in the provision of social and economic benefits to the host country, besides the environmental benefits consisting in the reduction of GHG emissions.

However, the concept of sustainability can hardly find a unique definition, as it "can comprise many different views and preferences, regardless of the fact that these views are often actually diametrically opposed"[3]. In practical terms, a standardized definition of 'sustainability', in its holistic connotation, can hardly be concretely applied in different contexts at the project level, since diverse conditions affect the relative contribution of a project to the sustainable development of each country.

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[1] The individual targets for Annex I Parties are listed in the Annex B to the Kyoto Protocol.

Source: United Nations (1997). *Kyoto Protocol to the UN Framework Convention on Climate Change,* art. 2.

[2] United Nations (1997). *Kyoto Protocol to the UN Framework Convention on Climate Change,* art.12.

[3] Sutter, Cristoph (2003). *Sustainability Check-Up for CDM projects, p.*26.

http://www.up.ethz.ch/research/energy_climate/closed/cdm_assessment/Sutter_2003_Sustainability_Check-Up_for_CDM_Projects__e-book_.pdf (2006, May 13).

During the meeting held in Bonn in 2001, the Conference of the Parties stated: "it is the host Party's prerogative to confirm whether a clean development mechanism project activity assists it in achieving sustainable development"[4]. This principle was subsequently confirmed in Marrakech during the seventh meeting of the *Conference of The Parties* (CoP7)[5]. This means that the host countries (non-Annex I) have the right to determine whether the CDM project activities[6] meet the sustainable development objectives set at the national level. The host countries can use guidelines, checklists and other approaches to address the choices of the potential investors.

Investors willing to develop CDM projects therefore necessarily need to carry out a sustainability assessment in order to guarantee consistency with the development objectives prioritized by the host country. The crucial issue is the application of a set of indicators through which the development benefits can be effectively measured at the project level. To develop right indicators experience in sustainable development assessment is needed. The difficulties associated to the application of different indicators need to be taken into account. For instance, some approaches imply the use of qualitative indicators, while other methods are based on a more quantitative analysis and numeric variables to express the key characteristics of the project activities. Therefore pros and cons of different methods shall be weighted in order to adopt a method that results suitable in the specific context where the activities are planned.

1.2 Objective of the study

First aim of this work is to assess how the Clean Development Mechanism, as defined within the Kyoto Protocol to the United Nations Conventions on Climate Change, addresses the issue of Sustainable Development. The main objective is to perform an analysis of the sustainability component of the CDM, which implies an assessment of how *Sustainable Development* (SD) is defined within the UNFCCC context, how it can be measured, and what methods have been developed for this purpose.

The author has tried to answer to the following research questions:

1. How is sustainable development defined within the Kyoto Framework?

   Sub-question addressed:

   - How did the concept of sustainable development change and gain relevance over time?

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[4] UNFCCC. Conference Of the Parties (COP), Decision 5/CP.6. *Implementation of the Buenos Aires Plan of Action.* http://unfccc.int/cop6_2/documents/dec5cp6uneditvers.pdf (2006, May 16)

[5] UNFCCC. Conference Of the Parties (COP), Decision 17/CP.7. *Modalities and procedures for a clean development mechanism as defined in Article 12 of the Kyoto Protocol.* http://unfccc.int/resource/docs/cop7/13a02.pdf (2006, May 16)

[6] The Conference of the Parties has defined a project activity as "a measure, operation or an action that aims at reducing greenhouse gases (GHG) emissions. The Kyoto Protocol and the CDM modalities and procedures use the term 'project activity' as opposed to 'project'. A project activity could be identical with or a component or aspect of a project undertaken or planned."
UNFCCC (20003). Executive Board, seventh meeting. *Annex 4 (Glossary of terms used in the CDM project design document)*, p.5. http://cdm.unfccc.int/EB/Meetings/#EB2001 (2006, April 15)

2. How can sustainable development be measured at the project level?

   Sub-questions addressed:

   – Which set of indicators, criteria and methods can be used to measure sustainability?

   – Is there consistency between the provisions of the Kyoto Protocol and the sustainability assessments developed in practice for registered CDM projects?

   – Which are the main difficulties associated to sustainability assessments?

Secondly, the author aimed to perform a sustainability assessment for an actual CDM project, and to discuss the difficulties in doing such analysis.

To achieve this double objective, three main steps have been followed, consisting of:

A. An investigation of CDM and its regulatory and institutional framework within the Kyoto Protocol and the *United Nation Framework Convention on Climate Change* (UNFCCC) - focused on the definition of Sustainable Development, its components and its evolution and application in the international arena.

B. An assessment of different indicators and methods that have been developed to ensure consistency between CDM projects and sustainable development objectives defined by the host countries. Aware of the great specificity of the different national contexts, and of the existence of different guidelines, priorities and practices in each host country, the aim of this assessment was not the identification of the 'best' approach for sustainability assessment of CDM projects; the aim was to present the main features of the assessment methods developed, and to understand which factors can influence the choice of a specific method.

C. A case study on a potential CDM project applied to the cement industry in Thailand, in order to assess if the project would result in line with the Thai goals for sustainable development. The possible difficulties and crucial aspects associated to the concrete sustainability assessment of a CDM project have been discussed.

1.3 Scope and Limitations

This work is focused on the sustainability component of the Clean Development Mechanism, its definition and concrete application at the project level. Therefore, the analysis of the CDM presented in the following chapters, as well as the case study discussed, are concentrated on sustainability-related aspects: the author has presented other key-issues connected to CDM implementation such as transaction costs, baseline definition and additionality, but did not aim to analysed them in details.

The case study presented has been developed with the support of Italcementi Group (referred to as the "Group" in this work), a global cement company that might be interested in developing a CDM project in Thailand. This could be the basis for the future development of a CDM project. The project would imply a partial switch from the use of fossil fuels to the use of rice husk, following the approved consolidated methodology ACM0003[7] developed within the UNFCCC framework, entitled "Emissions reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture"[8]. Other methodologies approved for the cement sector under the UNFCCC framework, such as energy efficiency improvements, waste heat recovery or increased blending in cement manufacture, are not discussed in details in this work.

A feasibility study for the development of the CDM project might be developed in the next future: consultants and local partners working with the Group shall then investigate the exact availability of alternative fuel in the area surrounding the production sites. Assumptions were used in this work for the description of possible future scenarios connected to the development of the potential CDM project. In case of data gaps or when detailed information was not available, assumptions were made and 'reasonable' values were used, based on historic trends and most-likely future developments.

Data from similar CDM projects were also used and adapted to the case study when the information available was not sufficient to proceed with the sustainability assessment. This has been the case for the calculation of the net CO_2 emission reductions from off-site fuel transportation[9].

Since some of the information provided by Italcementi Group are sensitive, the author has used approximations; however, the quantitative measures used and the assumptions made in this work had the purpose of simulating the CDM project in realistic terms.

The possibility to carry out interviews with members of the Thai Government has been limited by the ongoing Thai institutional crisis. Uncertainties exist about the future developments of the national institutional framework for CDM implementation, which limits the possibility to find precise information, mainly as a consequence of the fact that the definition of responsibilities and the allocation of roles and competences among Thai authorities is still pending.

The approach used in this work for the sustainability assessment of the CDM project under study is fundamentally qualitative in nature; this choice has been mainly driven by time constraints and by a lack of quantitative data .

1.4 Structure of the thesis

The following paragraphs explain how the work has been structured.

Chapter 2: Background and Regulatory framework. Analysis of how Sustainable Development is dealt with in the context of the Kyoto Protocol; overview of the crucial issues for CDM implementation.

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[7] This methodology represents the guide for the development of CDM projects based on the use of alternative fuels in cements kilns, which should lead to a net reduction in GHG emissions.

[8] UNFCCC, *Approved Baseline and Monitoring Methodologies*

http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html (2006, March 8)

[9] In this case data from a project developed by Lafarge Malaysia have been used, since the modalitry of transportation resulted similar in the two CDM projects considered.

Chapter 3: Sustainable development assessment. Overview of main methods developed for sustainability assessment, presentation of main features and characteristics. Discussion on practical issues related to sustainability assessment at the project level.

Chapter 4: Cement sector. Description of the main features of the cement industry and its environmental impacts. Overview of methodologies developed for the cement sector within the UNFCCC context

Ch.5: Background on CDM implementation in Thailand. Institutional context and sustainability issue in Thailand.

Ch.6: Description of an hypothetical CDM project

Ch.7: Analysis of the impacts of the CDM project on different social, environmental and social dimensions.

Chapter 8: Conclusions. Discussion on the main findings.

1.5 Methodology

The initial assessment of sustainability component of CDM has been based on literature review. The aim was to investigate the role of the Clean Development Mechanism in the promotion of sustainable development, from a regulatory point of view, as well as to gain an overview of the ongoing debate concerning the definition of sustainable development in relation to CDM.

The assessment of the different methods used for the sustainability assessment of CDM projects has been mainly based on available reports and academic papers. Interviews with researchers were conduced in order to gain a better understanding of strengths and weaknesses related to the methodologies for sustainability assessment. The two persons interviewed were also asked to express their view on the concrete application of sustainable development assessments for CDM projects.

During the research, the author of this work reviewed the PDDs of different CDM projects developed under the approved consolidated methodology ACM0003, in order to assess how the sustainability issue was addressed in each case by other project developers, and to understand which aspects were prioritised and which approaches were used for the sustainability assessment.

The author has conduced a survey on key environmental issues related to cement industry and, in particular, on the use of alternative fuels in cement kilns. A literature review, as well as information and data provided directly by members Italcementi Group, have been the major information source. Personal and telephone interviews were carried out to get detailed information on production process and major environmental aspects related to its phases.

Italcementi Group provided some reference data for the simulation of a CDM project baseline, as well as for the quantification of the parameters under analysis, in order to express the characteristics of the potential CDM project described. The assistance provided by members of Italcementi Group has been of key importance for the collection of reference data and information, as well as for the assessment of the major points that might result relevant for the development of a potential CDM project.

In case of missing data, values used in similar CDM projects were taken; the decision to adapt data coming from similar CDM projects was mainly due to time constraints and to the impossibility to obtain all the information needed for the present analysis.

An overview of the most significant aspects characterizing Thai economy and society has been fundamental to understand which aspects would result more relevant to ensure the sustainability of the CDM project under study, and therefore to identify the criteria that deserve major attention for the project development. The assessment of the Thai socio-economic system was initially based on a literature review. In order to gain a more complete picture, the author has independently carried out interviews with different stakeholders, including representatives from research centres, academics, members of international and national institutions, and private and public entities; the diversity of stakeholders involved has been indispensable to get a more complete overview of different perspectives, and an insight on local realities.

The assessment of sustainable development for the CDM project under study has been based on the sustainability criteria (tentative and provisory) provided by the Thai Government. Following the criteria listed, the author selected the ones that seemed more significant for the project concerned (choosing the parameters that would be affected by the CDM project implementation). The potential impact of the proposed CDM project on the criteria selected has been discussed on the basis of the information collected through the interviews conduced and the data compiled.

2 Clean Development Mechanism and Sustainable Development

As mentioned, the Clean Development Mechanism was established in 1997 through the Kyoto Protocol, which set the emission reduction targets that developed countries (the ones listed in Annex I to the UNFCCC) were to achieve during the first commitment period, 2008-2012. The goal of CDM was to support the implementation of joint projects between Annex I countries and developing countries (non-Annex I countries), which have no binding commitments to limit their *green house gases* (GHG) emissions[10]. Through CDM projects, industrialised countries can meet part of their emissions reduction obligations in a cost effective way, undertaking abatement projects in developing countries. Annex I countries can obtain the so-called *Certified Emission Reductions* (CERs), emission credits that can directly contribute to the achievement of their emission reduction targets or can be sold in the emission trading market. Since the emission credits are bankable, CERs can be accumulated from the year 2000, and can be used later during the first crediting period from 2008 to 2012.

The main characteristic of the CDM is its twofold objective, aimed at integrating the goal of environmental protection, on a local and global scale, with the goal of economic development in non-Annex I countries (art. 12 of the Kyoto Protocol). While developed countries can benefit from the CERs obtained through CDM projects, non-Annex I countries will attract additional capital flows and technology transfer.

Article 12.5 of the Kyoto Protocol specifies three requirements that need to be satisfied to make CDM projects eligible[11]:

- Voluntary participation and approval by the Parties involved;
- Production of real, measurable, long term mitigation benefits;
- Emission reductions additional to any that would occur in the absence of the project activity.

The requirement for the final approval and registration of the projects is that these long-term environmental benefits are integrated with the social and economic development goals of the host countries.

In 1987 the Bruntland Commission (World Commission on Environment and Development - WCED) brought the issue of *climate change* (CC) on the international political scene; in the report entitled 'Our common future' the Commission defined Sustainable Development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[12]. However, the debates on anthropogenic GHG

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[10] Toman, Michael, and Cazorla, Marina (1998). The Clean Development Mechanism: A Primer.

http://www.rff.org/Documents/RFF-CCIB-13.pdf (2006, April 29)

[11] United Nations (1997). *Kyoto Protocol to the UN Framework Convention on Climate Change.* Artivle 12.

[12] World Commission on Environment and Development (WCED)(1987). *Our common future.* Oxford: Oxford University Press, p. 43.

emissions and climate change, on one side, and economic development, on the other side, for a long time remained separated, as belonging to two distinct areas: the scientific field, and the social and human science, respectively. Olsen has pointed out that the real integration of these two dimensions has occurred only in recent years, and has been encouraged by the work of the *Intergovernmental Panel on Climate Change* (IPPC) and by the World Summit on Sustainable Development, which took place in Johannesburg in 2002, setting the focus on the linkages between the two issues[13]. The commitments adopted by the countries represented in Johannesburg also incorporated the results of past international conferences, such as the Millennium Summit (autumn 2000), at which the Millennium Development Goals were adopted, the WTO Ministerial Conference in Doha (2001) and the Financing for Development Conference in Monterrey (spring 2002)[14]. The view shared in these international conferences seems to rely on the definition of sustainable development as a process aimed to pursue concomitant improvements in the environmental and economic spheres. Nowadays, the key challenge for the CDM mechanism, as defined in the Kyoto Protocol and in the Marrakech Accords, is the fulfillment of this twin goal.

The major international organizations and institutions have stressed the existence of a plurality of issues underneath the concept of sustainable development. Among these, the World Bank has defined Sustainable Development as a multidimensional concept combining different perspectives[15]:

- Financial capital: sound macroeconomic planning and prudent fiscal management.

- Physical capital: infrastructure assets such as buildings, machines, roads, power plants, and ports.

- Human capital: good health and education to maintain labor markets.

- Social capital: people's skills and abilities as well as the institutions, relationships, and norms that shape the quality and quantity of a society's social interactions.

- Natural capital: natural resources, both commercial and non-commercial, and ecological services which provide the requirements for life, including food, water, energy, fibers, waste assimilation, climate stabilization, and other life-support services.

All these different aspects shall be simultaneously enhanced in order to promote sustainability in developing countries based on their development goals. In particular, the World Bank Sustainable Development Reference Guide describes developing countries' priorities with three major goals[16]:

[13] Olsen, K:H (2005), p.3.

[14] Netherlands Ministry of Housing, Spatial Planning, and the Environment. *Sustainable action, p. 3.*

http://www2.vrom.nl/pagina.html?id=9751 (2006, October 15)

[15] World Bank. *Sustainable Development in the 21st Century.*

www.worldbank.org (2006, Oct.15)

[16] World Bank (2005). *Sustainable Development Reference Guide, p.9.* World Bank publications.

- "Improvements in the quality of life affected by environmental conditions"; the Guide specifies that this includes improvements in "people's health, livelihood, and vulnerability".

- "Improvements in the quality of growth", through the support to "policy, regulatory, and institutional frameworks for sustainable environmental management, and by promoting sustainable private development";

- "Protection of the quality of the regional and global commons such as climate change, forests, water resources, and biodiversity".

A similar view has been adopted by the Dutch Government, promoter of a proactive strategy aimed at supporting sustainable development in non-Annex I countries through CDM project activities. The Netherlands is in fact the second European country (after Spain) involved in CDM and JI projects implementation in terms of investments. The Dutch government has specified that sustainable development implies a balance among three major domains[17]: the sociocultural domain (people), the ecological domain (planet), and the economic domain (profit). Host countries shall benefit from CDM activities through improvements achieved in these different domains. This plethora of objectives further stresses that 'sustainability' can hardly be synthesized through a single indicator. Moreover, the definition of sustainability is further complicated by the fact that development goals and priorities vary from country to country, and different aspects can be given higher or lower relative importance, depending on the specific national context under analysis. Therefore, sustainable development strategies effectively adopted in a developing country might not be suitable in a national context characterized by different needs and priorities. The ultimate success of development-oriented projects mainly relies on the ability of the project developers to identify the approach that results most suitable in the specific context where the activities are planned.

2.1 CDM institutional framework

Both international and national institutions are involved in the CDM design and functioning.

On the international level, the *Conference of the parties/Meeting of the parties* (COP/MOP) "shall have authority over and provide guidance to the clean development mechanism (CDM)"[18]. The COP/MOP is the key actor providing guidance and addressing the activity of the *Executive Board* (EB).

The Executive Board "shall supervise the CDM, under the authority and guidance of the COP/MOP, and be fully accountable to the COP/MOP"[19]. The Executive Board includes ten members from the Parties to the Kyoto Protocol. It accredits and designates the

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[17] Netherlands Ministry of Housing, Spatial Planning, and the Environment. *Sustainable action, p. 9.*

(2006, October 15)

[18] UNFCCC (2001). Draft decision -CMP.1 *Modalities and procedures for a clean development mechanism as defined in Article 12 of the Kyoto Protocol.*

http://cdm.unfccc.int/EB/rules/modproced.html#CEB (2006, April 16)

[19] UNFCCC (2001). *Draft decision -CMP.1.*

Operational Entities (OEs), and provides information on the operational requirements of the clean development mechanism; a typical task is the definition of the requirements for the clean development mechanism *project design document* (PDD). Therefore, the COP/MOP has established that the Operational Entities are accountable to the COP/MOP, through the Executive Board. The Operational Entities can be either domestic legal entities or international organizations. They validate proposed CDM project activities; verify emission reductions of registered projects and request the Executive Board to issue the Certified Emission Reductions. The OEs annually submit a report to the EB.

Both host and investor countries participating in the CDM have to designate a national authority, the so called *Designated National Authority (DNA),* responsible for the implementation and monitoring of CDM at the national level. The DNA is the institution responsible for the definition of criteria and guidelines containing the national development objectives for the host countries.

Figure 2-1 shows the CDM project cycle, the process for the design and evaluation of CDM projects.

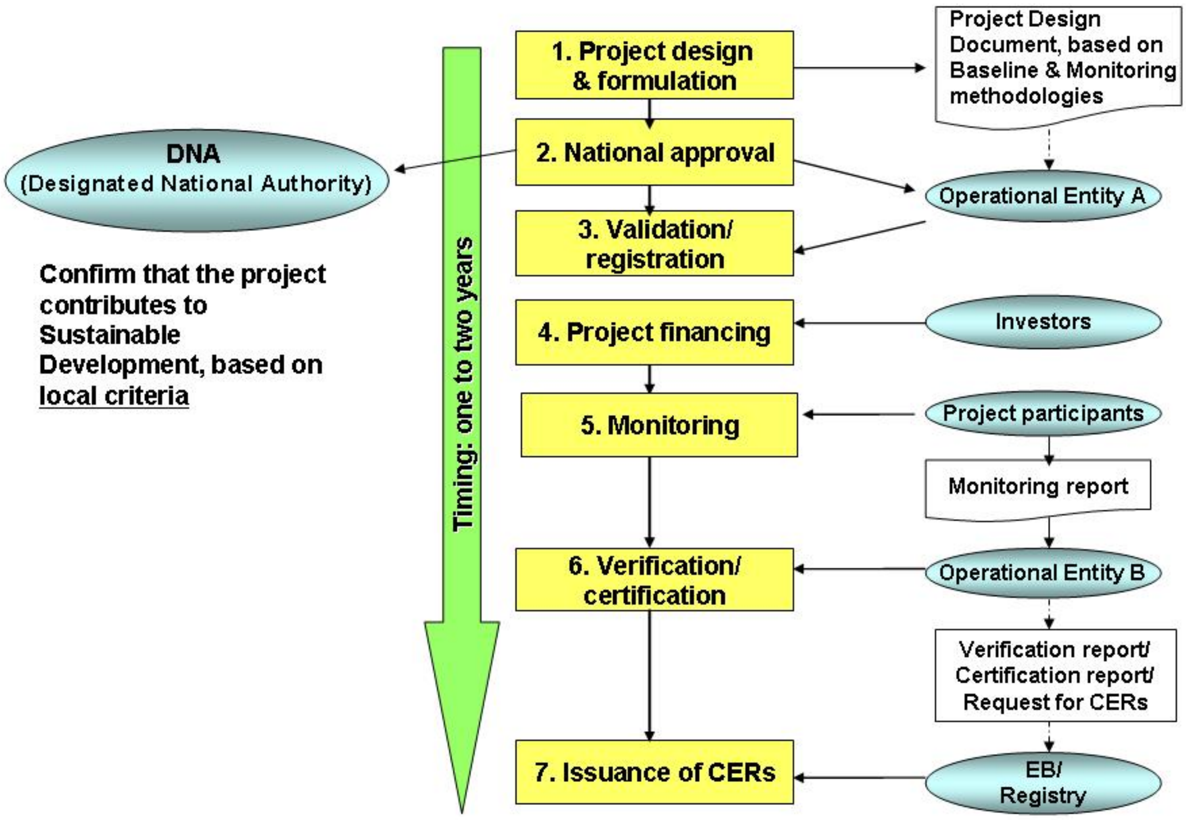

Figure 2-1 CDM structure[20].

The first step in the project cycle consists in the preparation of the PDD by the project proponents. The PDD defines the baseline scenario and needs to demonstrate the

[20] Source: Italcementi Group.

additionality of the project (see chapter 2.2 on this issue). Moreover, the PDD should contain a plan for monitoring the emission reductions. The baseline and the monitoring plan should be developed on the basis of the methodologies approved by the CDM Executive board (EB); alternatively, new methodologies can be suggested by the project proponents and have to be submitted for approval to the EB, prior to submission of the project activity for registration. A description of the project and an identification of project participants should be included in the PDD. The following phase of the cycle concerns the approval of the host country, upon verification that the project is consistent with the sustainable development goals defined at the national level. A designated operational entity (DOE) accredited by the EB then evaluates the project activity against all the necessary requirements of the CDM framework, in order validate it. If the validated project is accepted by the EB and there is no request for review, the project can be registered. The certified emission reductions can then be issued by the CDM Executive Board. A designated operational entity is responsible for monitoring the emission reductions over time, and certifies the reductions by written documentation.

Different models can be followed when developing CDM projects[21]:

- **Bilateral model**. In this case one or more Annex I investors participate in the development of the project. Activities like project selection and financing, as well as the sharing of CERs, are agreed upon by investors, developers and interested governments. Baumert et al. have observed that the bilateral model is the one that most resembles the direct model of *foreign direct investment* (FDI), and governments can try to develop bilateral CDM projects through aid programmes that already exist[22]. The bilateral model is very common for CDM projects development. Following this pattern, however, the development of CDM projects can result unevenly geographically distributed because the majority of FDI is currently concentrated in a limited number of developing countries.

  Providing the basis for a direct dialogue between Annex I countries and developing countries, the bilateral model seems to be particularly suitable for development of CDM projects that ensure the alignment of investors' activities with the host country's priorities since the initial phase of the project design. Moreover, the existence of relationships consolidated over time between host countries and Annex I countries through FDI practices might provide the basis for reciprocal trust, eventually speeding up the approval process for proposed CDM projects.

- **Multilateral model.** This scheme, often referred to as 'portfolio' or 'fund' approach, consists in the creation of a centralized fund used by different investors (Annex I countries) to finance CDM projects. This approach implies a clear separation between the project development and the investors, who can receive a share of the credits generated by the project, depending on their relative contribution to the fund. The multilateral model is considered as a valid approach for sharing the risks associated to project development;

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[21] United Nations Environment (UNEP) (2004*). CDM information and guidebook*, p.69.

http://cd4cdm.org/publications.htm (2006, May 20th)

[22] Baumert, A. Kevin., Kete, Nancy., and Figueres, Christiana (2000). *Designing the Clean Development Mechanism to meet the needs of a broad range of interests*. World Resources Institute publications, p.4.

- **Unilateral model.** Annex I countries are not involved in financing or developing CDM projects. In the unilateral model, in fact, non-Annex I countries can develop a fund autonomously and directly apply for the CERs, that can be later sold to Annex I countries or private actors interested in buying the credits. This model is considered as a good approach for encouraging a higher participation from developing countries that have difficulties at attracting bilateral or multilateral projects. On the other hand, however, it has been observed that not many developing countries have sufficient resources and capacity to develop CDM projects without the assistance of Annex I partners[23]. Several Indian CDM projects have been developed following the unilateral model.

These three models can also be combined in hybrid CDM models presenting a mix of different features; the choice of a specific approach mainly depends on national policies, investing decisions, and distribution of power among the partners involved.

2.2 Additionality and baseline definition

The environmental benefits associated to the implementation of the projects need to be measured against a baseline scenario identified during the project design phase. The baseline for a CDM project is defined as "the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases that would occur in the absence of the proposed project activity. A baseline shall cover emissions from all gases, sectors and source categories listed in Annex A (of the Kyoto Protocol) within the project boundary. A baseline shall be deemed to reasonably represent the anthropogenic emissions by sources that would occur in the absence of the proposed project activity"[24].The baseline can be measured expressed either in project output/t CO_2-eq. (such as MWh/ t CO_2-eq.) or t CO_2-eq[25].

As shown in Figure 2-3, the emission reductions realized by a CDM project can be expressed by the difference between the emissions in the baseline scenario and the emissions in the project scenario.

[23] Baumert et al. (2000), p.7.

[24] UNFCCC (20003). Executive Board, seventh meeting. *Annex 4 (Glossary of terms used in the CDM project design document)*, p.1.

[25] European Commission (2003). *Development of RES through the Kyoto Protocol Mechanisms – Special focus on the Clean Development Mechanism,* p.8.

http://www.opet-chp.net/download/wp6/epuntua_developmentofresthroughthekyotoprotocolmechanisms.pdf (2006, May 20)

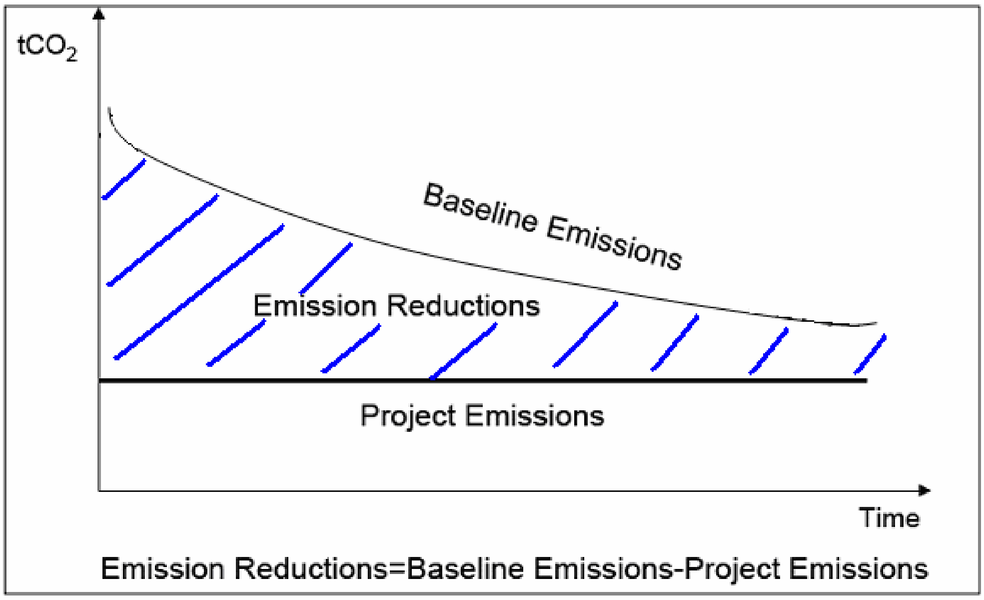

Figure 2-2 Baseline concept and emission reductions[26].

In order to define which sources of GHG emissions to include in the calculation of the project and the baseline emissions, a project boundary has to be established. During the seventh Conference of the Parties held in Marrakech in 2001, it was specified that the project boundary should encompass all anthropogenic emissions by sources of greenhouse gases under the control of the project participants that "are significant and reasonably attributable to the CDM project activity"[27].

Several alternative baseline scenarios, also defined as 'baseline candidates', could be chosen[28]. For each project activity, therefore, the project developers shall choose a baseline candidate and justify why that particular scenario has been selected as a basis for the calculation of the emission reductions arising from the CDM project.

The comparison between the baseline scenario and the project activity should provide evidence that the emission reductions obtained through the CDM project are 'additional'. The additionality requirement is aimed at guaranteeing that the mitigation of GHG emissions only occurs as a consequence of the CDM project: if projects representing the *business as usual* (BAU) case were awarded emission credits, in fact, the overall objective of the Kyoto Protocol would be hampered. However, the determination of additionality represents one of the major problems for the implementation of CDM projects. Several authors have stressed the difficulties related to the distinction of projects that are additional from projects that simply reflect the BAU scenario. Takeuchi has underlined that the Kyoto Protocol only offers a vague definition of additionality. In particular, it has been stressed that the lack of

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[26] European Commission (2003). *Development of RES through the Kyoto Protocol Mechanisms – Special focus on the Clean Development Mechanism.* http://www.opet-chp.net/download/wp6/epuntua_developmentofresthroughthekyotoprotocolmechanisms.pdf (2006, May 20)

[27] UNFCCC (2001). The Marrakesh Accords and the Marrakesh Declaration, art.52.

[28] World Business Council for Sustainable Development and World Resources Institute. *The Greenhouse Gas Protocol. The GHG Protocol for Project Accounting*, p.39. WRI publications.

clear guidelines on the evaluation of additonality can compromise the overall credibility of CDM[29].

In order to provide guidelines for the evaluation of additionality to project developers, the Executive Board agreed upon the so-called 'Tool for the demonstration and assessment of additionality', published in 2004, and recently reviewed through the 'Tool for the demonstration and assessment of additionality, version 2'[30]. The document indicates the steps that need to be undertaken for the demonstration of additionality in CDM projects. These steps include:

1. Identification of alternatives to the project activity.

2. Investment analysis, aimed at showing that the proposed project activity is not the most economically or financially attractive.

3. Barriers analysis. Barriers could be of technological or institutional nature, as well as barriers due to prevailing practice.

4. Common practice analysis. This analysis is aimed at assessing the diffusion of activities similar to the planned project activity.

5. Impact of registration of the proposed project activity as a CDM project activity.

In particular, from the Tool for Assessment of Additionality clearly emerges the concept of 'project additionality': the developers have also to demonstrate that the projects under analysis would be unlikely to occur without the CDM, as they would not result economically attractive. This is to ensure that the credits are only recognized to projects that would not have occurred 'anyway'. The concept of additionality therefore covers both an environmental and financial dimension.

In order to simplify the procedures for the identification of baselines and additional benefits related to projects implementation, simplified procedures have been developed by the EB for *small-scale* (SS) CDM projects[31].

2.3 Sustainability Component of CDM projects

In general terms, there seems to be a common agreement that sustainable development includes three dimensions: social, economic and environmental. Following the classification carried out by Olhoff et al., social criteria include issues like poverty, equity and quality of life; economic criteria include economic development of local communities, effects on the balance of payments and transfer of technology; environmental criteria include aspects such as reduction in GHG emissions, conservation of local resources, use of fossil fuels, and

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[29] Takeuchi Waldegren, Linn. *The Project Based Mechanisms of the Kyoto Protocol. Credible Instruments or Challenges to the Integrity of the Kyoto Protocol?* P.46. Report n.58. Lund University. Department of Technology and Society. Lund, Sweden.

[30] UNFCCC(2005). *Tool for the demonstration and assessment of additionality (version 02).*

[31] UNFCCC. *Methodologies for small scale CDM project activities.*

http://cdm.unfccc.int/methodologies/SSCmethodologies (2006, May 24) pressure on local environment[32]. Olhoff et al. have underlined that these criteria present significant overlaps with the national development goals pursued by developing countries: this means that the implementation of CDM projects have the potential to effectively contribute to the achievement of national targets through the integration of economic issues and climate considerations.

A screening procedure needs to be applied in order to guarantee the contribution of the project activities to sustainable development in the host country. This procedure implies three different screens covering the environmental, social and economic dimensions. The environmental screen is used to assess that the project generates long-term net environmental benefits. Social sustainability is reached when the project activities positively contributes to raise living standards at the national and local level. Economic sustainability is reached by projects that are economically viable and are able to provide economic benefits to the host country. The project then needs the final approval from the host country. Figure 2-3 shows the procedure including the screens for the sustainability assessment.

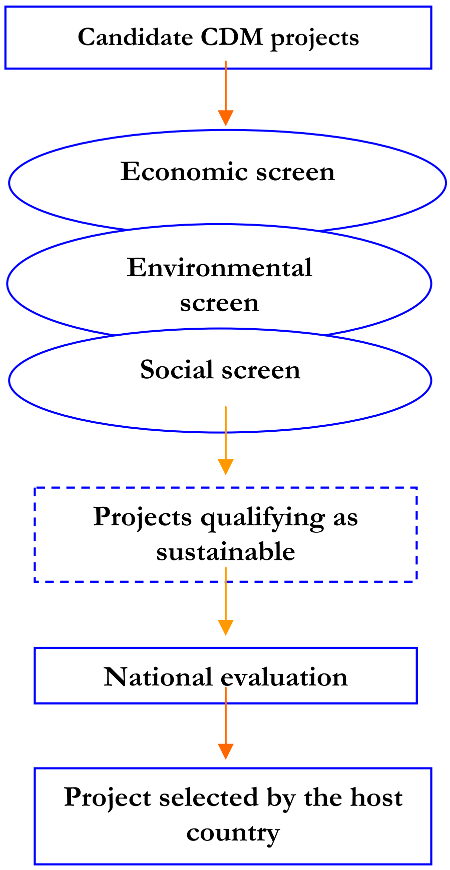

Figure 2-3 Project sustainability screening procedure[33].

[32] Olhoff, Anne., Markandya, Anil., Halsnaes, Kirsten., and Taylor, Tim (undated). *CDM Sustainable Development Impacts*. UNEP RISO Centre publications, p.18.

http://cd4cdm.org/Publications/CDM%20Sustainable%20Development%20Impacts.pdf (2006, May 24)

[33] The Energy and Resource Institute – TERI (2006). *The Clean Development Mechanism: issues and modalities*. http://static.teriin.org/climate/cdmissues.htm (2006, May 17)

As shown in the figure, the project developers need to assess the net contribution of their projects to sustainable development in the host country where they intend to operate. Since the Kyoto Protocol does not provide a definition of 'sustainable development', it is fundamental that the host country clearly develops its own sustainability guidelines and approval procedures. This is necessary in order to address the choice of the project developers when selecting specific approaches and parameters for the sustainability assessment. The success of CDM projects and their effective contribution to sustainable development in fact are greatly influenced by the institutional and policy instruments applied. In other words, the host country should create the right environment to encourage the interest of foreign investors and project developers.

Sterk and Wittneben have underlined that the concrete implementation of the mechanism is hampered by the fact that some non-Annex I countries have not yet established their Designated National Authorities and, even if they have, these often present a lack of staff or operating capacity, which results in a poor definition of approval procedures[34]. At the same time there is the risk that the lack of transparent approval procedures raises the degree of uncertainty associated to the evaluation and validation of the projects, making it more difficult for investors to receive clear indications for the development of their PDD.

Another problem concerning the definition of sustainability objectives, at the national level, arises from the potential competition among developing countries for the attraction of foreign investments, which eventually leads to the adoption of weak national standards and to the attraction of projects with low emission reduction costs. Some developing countries in fact voluntarily have established very wide, general guidelines, with the specific aim of attracting foreign capital, which has resulted in an actual weakening of sustainability criteria and in the attraction of projects that do not necessarily contribute to sustainable development. Some authors have referred to this phenomenon as the "race to the bottom"[35] associated to the definition of poor sustainability standards, and implying a potential trade-off between the achievement of environmental and economic benefits.

2.4 CDM implementation - crucial issues

In the ongoing debate on the factors affecting the spread of CDM projects in developing countries and their role in promoting sustainable development, three main issues are regarded as crucial ones.

A. The development of the projects is usually associated to high transaction costs, mainly concentrated in the project activity design, and in the validation, verification and certification phases. In countries where the institutional framework has not been defined yet, these costs can become prohibitive and hinder the entire project cycle. This is the case for many developing countries, which discourages the development of projects in some host countries in favor of countries with a safer investment climate.

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[34] Sterk, W., and Wittneben, B. (2005*). p.3.*

[35] Evander et al. (2004). P. 34; Olhoff et al.(undated), p.11.

B. The regulatory framework established within each host country ultimately affects the actual implementation of CDM projects. A project not only needs to satisfy the requirements of the Kyoto framework, but it also needs to meet the specific criteria existing in the host country.

C. Also as a consequence of institutional inefficiencies, the distribution of CDM project activities is highly uneven, being concentrated in a limited number of countries and covering especially technologies characterized by low CO_2-abatement costs. The immediate consequence of these dynamics is the increasing disparity in the geographic distribution of economic, social and environmental benefits deriving from CDM project activities. This disparity is clearly in contrast with the overall goal of the CDM framework, aiming at encouraging a more even spread of clean technologies and sustainable practices in developing countries.

   The necessity to support the spread of projects among a larger number of countries and technologies has been recently stressed in Bonn, in May 2006, during the twenty-fourth sessions of the *Subsidiary Body for Scientific and Technological Advice* (SBSTA) and the *Subsidiary Body for Implementation* (SBI) of the United Nations Framework Convention on Climate Change[36].

2.4.1 Transaction costs

Transaction costs can be classified into two main categories[37]:

1. Costs associated with the project preparation phase: these costs represent the risk capital, because it may not be recovered in case the project failed;

2. Costs associated with the project implementation phase, or operational costs.

The principal activities that are associated to transaction costs in CDM projects are illustrated in figure 2-4.

[36] UNFCCC. *Sessions of the Subsidiary Bodies, 17-26 May 2006, Bonn, Germany*.

http://unfccc.int/meetings/sb24/items/3648.php (2006, May 30)

[37] Climate Change Projects Office (CCPO), Department of Trade and Industry (undated). *Carbon transaction costs and carbon project viability*, p. 2.

http://www.dti.gov.uk/files/file21145.pdf (2006, June 15)

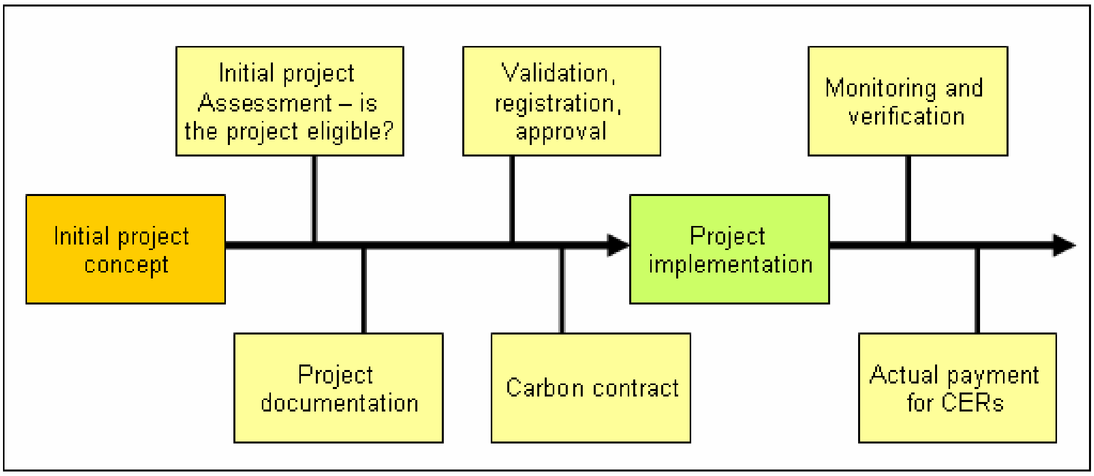

Figure 2-4 Transaction costs for CDM projects[38].

Michaelowa and Jotzo have shown how transaction costs make CDM projects more expensive (see Figure 2-5).

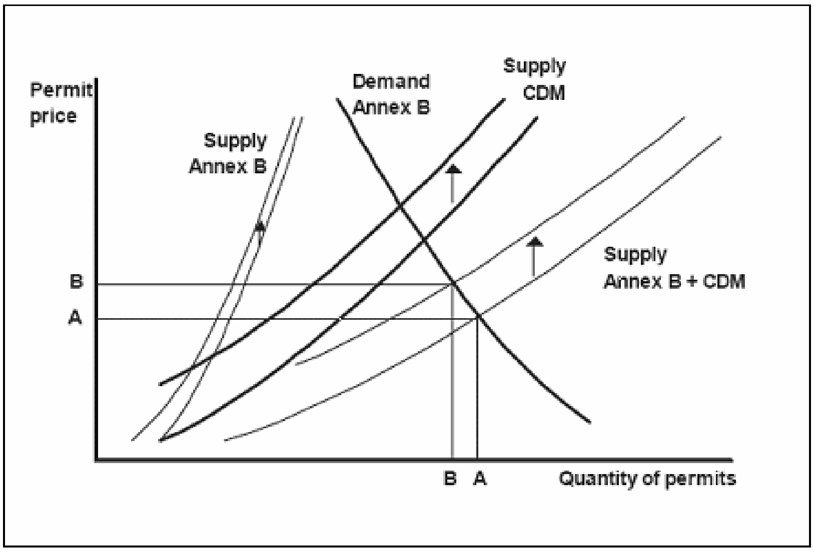

Figure 2-5 How transaction costs influence the use of the Kyoto Mechanisms[39].

The figure shows how transaction costs shift upward the supply curves of emission permits: this leads to a reduction of the quantity of permits traded and to an increase in the market price[40].

Michaelowa has underlined that transaction costs are strongly influenced by the institutional framework of the host country, which can affect the cost of negotiations and can limit cheap

[38] Climate Change Projects Office (CCPO), Department of Trade and Industry (undated). *Carbon transaction costs and carbon project viability, p.2.*
http://www.dti.gov.uk/files/file21145.pdf (2006, June 15)

[39] Michaelowa, Axel, and Jotzo, Frank (2003), p.512.

[40] Michaelowa, Axel, and Jotzo, Frank (2003), p.512.

http://www.hwwa.de/Forschung/Klimapolitik/docs/2005/Publ/Michaelowa_Jotzo_Transaction.pdf (2006, May 17) and easy access to information. Therefore, the costs will be higher in countries where the regulatory framework is inefficient. In developing countries, in particular, the collection and analysis of information result extremely complex, while administrative procedures are not clearly defined and are time-consuming

One of the main problems associated to transaction costs derives from the fact that a large part of the costs are fixed, so that smaller projects bear a higher cost per certified emission reduction. Small projects therefore result less attractive[41].

Table 2-1 presents indicative transaction costs for CDM project development, for large and small-scale projects.

Table 2-1 Transaction costs for CDM projects[42]

CDM Project Preparation Activities	Large-scale	Small-scale
Project assessment	€ 7,000 - 21,000	€ 4,000- 6,000
Completion of project documentation	€ 21,000 - 80,000	€ 9,000 - 18,500
Validation	€ 6,000 - 27,000	€ 5,000 - 8,000
Development of carbon credits sales agreement	€ 5,000 - 50,000	€ 2,000 - 7,000
Registration fee	€ 9,000 - 26,000	€ 4,000
Total	€ 48,000 - 205,000	€ 24,000 - 43,500

The development of a sustainability assessment may initially increase transaction costs, as a consequence of the collection, selection and analysis of data and information. This can further discourage project developers from performing a detailed assessment. Some authors have indicated this aspects as the "small-scale CDM dilemma": small-scale projects often have a high potential to contribute to sustainability, but this is combined with the inability to attract private CDM investments[43].

[41] According to the CDM regulatory framework, small scale CDM project activities are defined as follows:

- renewable energy projects with an installed capacity under 15MW;
- energy efficiency projects that reduce energy consumption by up to 15GWh per year;
- activities that reduce GHGs and emit less than 15,000 tonnes of CO_2 equivalent per year.

To reduce carbon transaction costs and their impact on smaller projects, the authorities managing climate change projects have introduced simplified PDDs and monitoring plans for small scale projects[41]. For instance, registration fees for small projects are determined by the amount of CERs generated, and project developers can use baselines and monitoring methodologies that have been already developed for other similar projects, therefore reducing the costs of preparing the PDD. Source: Michaelowa, Axel,, and Jotzo, Frank (2003). P.514.

[42] Climate Change Projects Office (CCPO), p.3.

[43] Sutter, Christoph (2001). *Small-Scale CDM Projects: Opportunities and Obstacles, p. 5.*
http://www.up.ethz.ch/publications/documents/Sutter_2001_Small-Scale_CDM_Vol1.pdf (2006, Oct. 14)

Well defined methods and experience in sustainable development assessment might reduce the overall transaction costs over time.

Several authors have discussed about bundling of projects as a possible way to obtain a better financial performance[44]. Project bundling consists in the grouping of several projects that present similar characteristics, so that part of the costs, including the financial risk, can be spread among different activities.

The development of unilateral projects might also represent a good way of cutting prohibitive transaction costs[45]. As seen in chapter 2.1, unilateral CDM projects are financed and implemented by the host country, with no foreign investments. The project owner sells CERs, independently produced, to interested entities in Annex-I countries, so that transaction costs linked to international investments are completely cut.

2.4.2 Institutional framework for CDM implementation

One of the major obstacles is the high complexity and incongruity that often characterize the legal system of developing countries. This is true especially in developing countries where the CDM framework and the related authorities are not established, mainly because of bureaucratic rigidity and administrative and organizational barriers.

Among the aspects that affect the investing climate there are[46]:

a) Foreign direct investment (FDI) laws. CDM projects can be affected by the FDI framework set up by a host country. For instance, some foreign investments require government approval or are limited by high taxation[47]. Therefore if investment laws are likely to limit or add costs to the CDM projects, foreign investors will not have incentives at developing new projects. Such restrictions should be limited and major consideration should be given to alternative ways for simplifying and encouraging the investments. Moreover, investments should be targeted at sectors that are in line with the host country's sustainable development goals.

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[44] Mundaca, Luis., and Rodhe, Hakan (2005). *CDM wind- energy projects: exploiting small capacity thresholds and low performances.* Climate Policy Journal 4, p.407.

Sutter, Christoph (2001). Small-Scale CDM Projects: Opportunities and Obstacles, p. 15.

Lawson, Karen., Li, Jia., and Kelly, Cathleen (2001). *Identifying Investment Opportunities for the Clean Development Mechanism (CDM) in Brazil's Industrial Sector, p.38.*
http://www.ccap.org/pdf/Brazil_final.pdf (2006, June 15)

[45] Sutter, Christoph (2001). *Small-Scale CDM Projects: Opportunities and Obstacles, p. 16.*.

[46] United Nations Environment Programme (UNEP), 2004. *Legal issues guidebook to the CDM*, p. 57.

http://www.uneptie.org/energy/publications/files/cdm_LEGAL_issues.htm (2006, July 2)

[47] For instance, whenever a foreign company wants to open a subsidiary in Brazil a formal authorization from the President of Brazil is necessary, while in Malaysia a foreign company willing to start a business needs to register with the Companies Commission of Malaysia and pay a registration fee.

Source: UNEP, 2004, p. 57.

b) Environmental laws. Host countries could try to integrate CDM environmental assessment with *environmental impact assessment* (EIA) processes commonly used within the country. A well-planned integration can reduce the costs of duplicating processes.

c) Property laws. Foreign investments can be characterized by restrictions on foreign ownership. In the case of CDM the Government of the host country –the Chinese Government is an example- can claim a share of the CERs generated from CDM projects implemented on their territory.

d) Securities and financial regulations. The trade of CERs in some jurisdictions belongs to a particular category of transactions, including financial derivatives, and actors operating in this field might need specific licenses in order to buy and sell the permits. Project developers willing to sell and buy CERs therefore need to take into account possible legal obligations before being involved in any transaction.

e) Tax regulations. The trade of CERs might be subjected to different forma of tax imposition, which could negatively affect the financial performance and therefore the attractiveness of some projects, discouraging potential investors.

Thailand is an example of a country where the institutional delays are limiting the effective implementation of CDM projects, since several PDDs have been submitted to the national authorities but no project has been registered. India is probably the best example of the opposite situation: the Indian DNA is strongly promoting CDM projects, attracting a growing number of foreign investors; this process has made India the country leading CDM market for number of registered projects.

2.4.3 Distribution of project activities

There are currently more than 1,000 projects in the pipeline; last year only around 140 activities were registered or requesting for registration. It is estimated that GHG emission reductions from registered CDM projects will generate 1,200,000,000 CERs prior to 2012[48]. Richard Kinley, acting head of the United Nations Climate Change Secretariat has stated "It is now evident that the Kyoto Protocol is making a significant contribution towards sustainable development in developing countries"[49].

The status of CDM projects is presented below.

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[48] UNFCCC. *CDM statistics*.

http://cdm.unfccc.int/Statistics (2006, August 23)

[49] UNFCCC, Press release. *Emission reductions from Kyoto Protocol's Clean Development Mechanism pass the one billion tonnes mark*. http://unfccc.int/files/press/news_room/press_releases_and_advisories/application/pdf/20060608_cdm_1_billion_tonnes-english.pdf (2006, June 9)

Table 2-2 Current status of CDM projects[50]

Projects	**Corresponding CERs**
Registered: 269	84,037,076 CERs/year
Requesting for registration: 63	6,328,108

However, on several occasions it has been stressed that the geographical distribution of CDM projects remains uneven[51].

Figure 2-6 shows the current regional distribution of registered CDM projects.

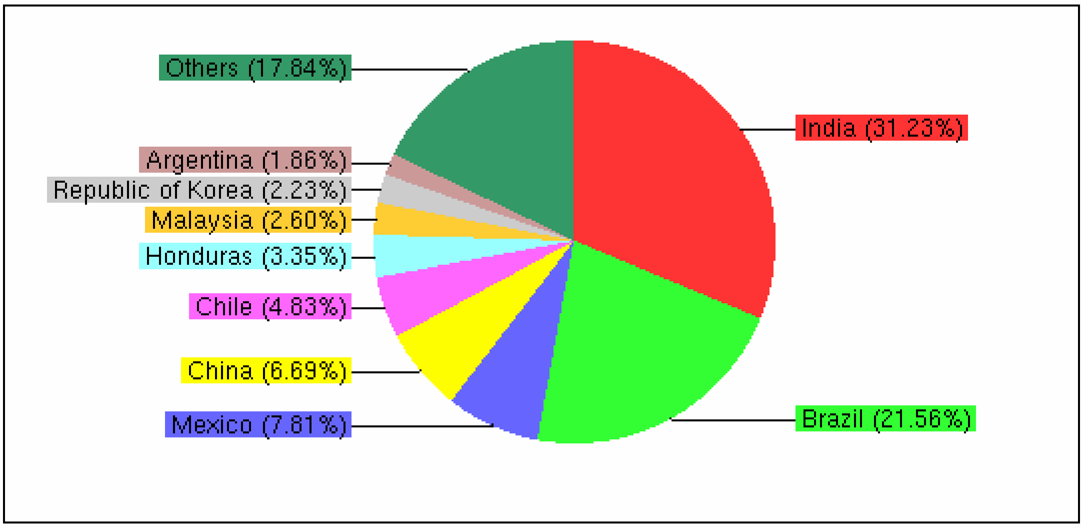

Figure 2-6 Registered project activities by host party[52].

As shown in the figure, the current trend is as follows:

- India and Brazil stand out as the countries that account for more than half of registered CDM projects: India is currently hosting more than 31% of CDM projects, and Brazil more than 21%;
- China is hosting almost 7% of registered projects;
- Africa and Middle East host a very small number of projects, even if there is a growing trend[53].

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[50] UNFCCC. *CDM statistics.* (2006, August 23).

[51] Ellis and Karousakis (2006). *The developing CDM markket: May 2006*, p.10.

OECD reports, COM/ENV/EPOC/IEA/SLT(2006)5.

[52] UNFCCC. *CDM statistics.* (2006, August 23).

The direct result of this uneven distribution is that developing countries are benefiting differently from the CDM implementation, as Annex I countries and foreign investors are mainly focusing on a limited number of countries. The issue of uneven distribution should be discussed in details during the twelfth Conference of the Parties (COP12) that will be hosted in Nairobi in November 2006.

Besides the uneven geographical distribution, one trend clearly associated to the implementation of CDM projects is the high share of expected CERs from projects characterized by low-cost emission reductions (like N_2O, mentioned above). CDM in fact was supposed to bring about sustainable development, in particular through the introduction of technologies etc, but it seems that there is a major focus on projects that generate high reductions in GHG emissions without necessarily having a significant positive impact on sustainable development, being more focused on end-of-pipe solutions.

It has been observed that there is a higher concentration of projects in the following categories:

- Renewable electricity projects, the most numerous in the CDM portfolio,

- F-gas and N_2O reduction projects in the industrial sector that are usually low-cost and large scale (generating up to 10 million credits/year);

- CH_4-reduction projects. This category includes very large proposed projects reducing emissions during coal or oil production, as well as LFG (landfill gases) projects.

Therefore, there is a preference for projects that present low emission-abatement costs and generate CERs cheaply[54]. Evander et al. have underlined that projects involving technology transfer, i.e. energy efficiency and renewable energy projects, usually have a higher initial cost, but they also benefit the host countries in the long term, significantly helping them to leapfrog to cleaner technologies[55]. Ellis and Karousakis, who in May 2006 discussed in Bonn about the high share of expected CERs generated by projects for HFC23-emission reductions, also stressed this issue[56].

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[53] Ellis and Karousakis (2006), p. 11.

[54] Sterk, Wolfgang, and Wittneben, Bettina (2005*). Addressing opportunities and challenges as a sectoral approach to the Clean Development Mechanism, p.4*.

http://www.wupperinst.org/download/JIKO-PP_2005-1.pdf (2006, May 16)

[55] Evander, Anna.., Neij, Lena., and Sieböck, Gregor (2004). The Clean Development Mechanism, CDM, for the development and diffusion of new energy technology. P. 46.

[56] Ellis and Karousakis (2006).

3 Assessing sustainability

Several approaches can be used to assess the sustainability of CDM projects. These approaches are used by the project developers to verify that the project activities are consistent with the priorities defined by the host country; this can imply the interaction among different subjects involved in the project development, who need to agree upon the choice of the key-parameters to consider.

According to Sutter, a good approach to assess sustainability should satisfy the following requirements[57]:

- Be adjustable in regards to preferences. This means that the approach chosen, the criteria selected and the result of the evaluation should be sensitive to decision makers' preferences;

- Provide relative measurements. The contribution of a project to sustainable development needs to be assessed in relation to the specific national context, as the sustainability component cannot be defined 'in se';

- Produce valid results. This aspect is defined as a method's ability 'to significantly differentiate among projects in a replicable way'. A key condition for this is the definition of a clear assessment procedure;

- Be comprehensive. Economic, social and environmental issues should be considered during the sustainability assessment; at the same time, time boundaries should be chosen to allow a long-term analysis.

The following table presents some indicators used in sustainability assessments.

Table 3-1 Example of major sustainability indicators for CDM projects[58]

SD criterion	Indicators	Measurement standard of indicator	
Economic		**Quantitative**	**Qualitative**
Cost effectiveness	Net costs		
Growth	Income generation		
Employment	Employment	N. of man-year created or lost	
Investments	Activity in energy sector, industry, agriculture etc.	Foreign exchange requirements ($ and share of investment)	
Sectoral development	Technology access	Physical measures (like energy demand and supply);	

[57] Sutter , C.(2003), p. 30.

[58] Olhoff, Anne., Markandya, Anil., Halsnaes, Kirsten., and Taylor, Tim (undated). *CDM Sustainable Development Impacts, p.40.* UNEP RISO Centre publications.

		economic measures, energy efficiency and affordability	
Technological change	Innovation learning	N. of technologies; price of technologies and maintenance;	
Environmental		**Quantitative**	**Qualitative**
Climate change	GHG emissions	GHG emissions	
Air pollution	Local air pollution, particulates. Environmental health benefits	Emissions of SO2, NOx, particulates. Monetary value of environmental health benefits	
Water	Rivers, lakes, irrigation, drinking water	Emissions in physical units; damages in physical and monetary units	
Soil	Exposure to pollutants	Emissions in physical units; damages in physical and monetary units	
Waste	Exposure to pollutants	Emissions in physical units; damages in physical and monetary units	
Exhaustible resources	Fossil fuels	Physical units	
Biodiversity	Specific species	Number, monetary values	
Social		**Quantitative**	**Qualitative**
Legal framework	Regulation, property rights		Outline of major rules and property rights.
Governance	Implementation of international agreements, enforcement	Costs of administrating and enforcing. Number of infringements and sanctions.	Characteristics of formal and informal authorities.
Equity	Distribution of costs and benefits	Economic costs and benefits related to stakeholders, income segments, gender, geographic area etc.	Mapping local stakeholders and their participation. Gender aspects.
Poverty alleviation	Income or capabilities created for poor people.	Decrease in number of people below poverty limits; generation of income.	Characteristic of poverty in terms of limited capabilities: food, education, heath, and limited freedom of choice.
Education	Decrease in the n. of people below poverty limit; raise in income; provision of energy services. Literacy rates, primary and secondary education. Training.	Literacy rates, enrolment rates, changes in the years of training.	
Health	Life expectancy; infant mortality; major diseases; malnutrition.	Epidemics, nutrition, energy for clinics.	

Four major methods for the sustainability assessment of CDM projects can be identified[59]:

1. **Guidelines**. The guidelines describe the aspects that should be considered in a project in order to ensure its contribution to sustainable development. They are usually designed normatively in the host country by an authority designated for the development of CDM. They are usually based on a holistic approach addressing social, economic and environmental issues. Guidelines provide wide, general principles, which give a high degree of discretionarily to the project developers. Specific procedures for the sustainability assessment are not defined.

2. **Checklists**. Specific questions are formulated and predefined answers are used to assess the compatibility of the project with a specific set of criteria. Checklists are used to assess the impact of the project activities on selected issues. Straightforward questions and closed-answers are used to examine the projects: during this process, the different projects are 'filtered' and only the ones that positively satisfy the entire pre-defined requirements can pass the test. The reductive approach used in the checklist method is easily replicable and based on a clear procedure, defined ex ante, therefore this method is considered as having a high validity. Olhoff et al. have stressed the fact that this method has the advantage of being extremely transparent, even if weights can be needed to guarantee the compliance of the activities with the national sustainable development objectives[60].

3. **Negotiated targets**. The negotiated targets are based on the interaction between local stakeholders and the projects proponents, in order to define which additional benefits the projects should bring to the communities. However, Sutter has underlined that the benefits do not necessarily need to be related to the main project activity, as they can simply result from collateral activities that are not part of the CDM project design. Therefore this method does not imply a real sustainability assessment of CDM projects, and cam only be used to generate additional benefits in line with the local communities' indications.

4. **Multi-criteria methods**. Several sustainability criteria are defined and the projects are assessed with regard to each of them. Each criterion is described through a set of selected indicators. The criteria can be weighted according to their relative importance, and then aggregated to express the overall utility of the project. Thresholds can be defined and projects activities that obtain scores higher than thresholds are considered as eligible.

Sutter has pointed out that, among the different alternatives, the multi-criteria approach is the one that can better satisfy the four requirements previously mentioned. In particular, the multi criteria approach can be better adjusted to individual preferences because the criteria can be selected differently from case to case; moreover, in several cases the specific indicators used can be weighted according to the preferences of the evaluators, on the basis of their relative importance in each specific context.

Different multi-criteria methods are presented in the next section.

[59] Sutter , C.(2003), p. 34.

[60] Olhoff et al. (undated), p. 49.

3.1 Multi-criteria methods

Evander et al. have presented a review of the major multi-criteria methods developed by different authors[61]. A similar classification has been presented by Sutter[62]. The methods presented include:

1. **The Analytical Hierarchical Process (AHP).** This method was developed in the '70s and has been used to evaluate several CDM projects in India. Evander et al. have described the process followed for the sustainability assessment. The projects were divided into four major sectors (conventional power generation; renewable power generation; renewables for agriculture; cement, steel and iron manufacture) and were evaluated against nine different criteria that were weighted on the basis of researchers' and government officials' indication. For instance, in assessing weights they were asked a series of questions, in order to assess the importance of the selected, and on the basis of the answers obtained weights were applied to rank the criteria[63]. This finally allowed a ranking of the projects within each of the four sectors. Evander underlines that when this method was applied to the Indian projects neither measurable indicators nor transparent definitions were presented: in these cases the final ranking obtained through AHP results extremely subjective and lacking of transparency. Moreover, if a separate ranking is developed within each sector, projects belonging to different sectors cannot be compared.

2. **Factor AG for small-scale CDM projects**. Factor Consulting and Management AG used this method in a study on opportunities and obstacles of 16 small-scale CDM projects implemented in India[64]. Quantitative criteria covering social, environmental and economic aspects were used, and the performance of the projects could be assessed against each single criterion. Since the indicators are of quantitative nature, it is possible to compare them for different projects. However, Sutter has underlined that the indicators used in Factor AG assessment, all quantitative, are not normalized and therefore cannot be aggregated into a final score. Moreover, no weighting is included in the procedure, which means that the process cannot be easily adapted to the preferences of the decision makers.

3. **SouthSouthNorth (SSN) sustainable development tool.** This method has been proposed by the non-profit NGO SSN, based in South Africa, and also active in Brazil, Bangladesh and Indonesia[65]. It includes eligibility screens, sustainable indicators and feasibility indicators[66]. It is only used for energy projects[67]. The screens

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[61] Evander et al. (2004), p. 36.

[62] Sutter , C.(2003), p.38.

[63] Olhoff et al (undated), p. 51.

[64] Sutter (2003), p. 40.

[65] Burian, Martin (2006). *Development Mechanism, Sustainable Development, and its Assessment.* HWWA Report 264, Hamburg Institute of International Economics, p.67.

[66] Sutter (2003), p. 39.

[67] SouthSouthNorth. *The SouthSouthNorth Sustainable Development Appraisal and Ranking Matrix Tool.*

http://www.southsouthnorth.org/library.asp (2006, May 24) are initially used to decide upon the eligibility of a project. The CDM projects are compared to a baseline using a set of selected indicators. The score for each indicator ranges between –3 and +3, while 0 indicates that the project does not bring changes to the baseline. All the sustainable development indicators must be positive to make a project eligible. A final score for the project is calculated by adding all the partial scores. Different projects can then be compared. In SSN tool the various indicators are not explicitly weighted: it is implicitly assumed that they all have the same relevance. Therefore the evaluation of the project does not depend on a scale of preferences indicated by the decision makers, and cannot be adjusted in different context. This method is currently used for the sustainability assessment of several CDM projects in Africa and Asia[68].

4. **Gold Standard Sustainable Development Assessment.** This method has been developed by WWF, and implies the fulfillment of three major requirements[69]:

    - En environmental impact assessment (EIA) must be conducted to show the compatibility of the project with legal standards set by the host country and with minimum standards set by WWF;

    - Public participation must be ensured;

    - Predefined indicators are used in order to express three major components of sustainable development: social sustainability, economic and technological development, and local/regional/global environmental sustainability[70]. The range of the indicators used varies between –2 and +2. If any of the indicators scores –2, then the project is not eligible.

    The methodology and the indicators for the project assessment are based on SouthSouthNorth's sustainable development tool. The Gold Standard carbon credits are designed to develop sustainability assessments beyond the environmental standards demanded by the DNAs.

    By July 6th, 2006, one GS project has been registered and about twenty are under development[71].

5. **Anagnostopoulus et al.** This method uses sustainability criteria and indicators for CDM projects screening, reflecting the environmental, social, economic and technological dimensions. The authors suggest ten sustainability criteria measured through nineteen indicators. Each indicator is used to measure the impact of the CDM project, in percentiles, against a baseline. The method implies the use of both quantitative and qualitative criteria that are normalized and aggregated. The same weight is conferred to the criteria.

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[68] SouthSouthNorth. *The SouthSouthNorth Sustainable Development Appraisal and Ranking Matrix Tool.*

http://www.southsouthnorth.org/library.asp (2006, May 24)

[69] Sutter, C. (2003), p. 44.

[70] Evander et al. (2004), p.38.

[71] Schlup, Michael (2006, July 12). Telephone interview.

6. **MATA-CDM.** This method is based on the *Multi-Attribute Utility Theory* (MAUT). The main characteristic of MAUT is that it is suitable for dealing with a plurality of objectives and decision makers at the same time during the sustainability assessment of CDM projects[72]. Both qualitative and quantitative data can be used to measure different components and dimensions of a project, and finally can be integrated to express an overall score of the projects through a utility function. Moreover, the feature that makes the Multi-Attribute Utility Theory useful in several contexts is that this approach does not imply a comparison of different projects against each other, but generates an assessment of the attractiveness of a project in absolute terms. Burian has stressed the fact that this is the only method that reflects what has been defined as 'constitutive plurality'[73], because it takes into account the existence of multiple objectives and decision makers, as well as the fact that the judgments are subjective and depend on the decision makers involved in the sustainability assessment. However, Olhoff et al. have observed that, since the criteria and indicators –as well as the weights- vary from case to case, and are based on subjective evaluations, problems about transparency and comparability of the indicators can arise[74]. Other experts have observed that the MATA-CDM is extremely quantitative in nature and tends to express in numbers aspects that can hardly be quantified, like social parameters; at the same time, it has been observed that a significant degree of subjectivity is inevitably used to attribute numeric values to the different aspects considered[75].

3.2 Practical issues for evaluating sustainability in CDM projects

The previous chapters have highlighted that the key challenge for CDM projects developers is the necessity to design projects able to integrate the development objectives of the host country with GHG emission reductions, in order to fulfill the twin goal of the CDM.

In general terms, the project developer needs to choose a method that can be adjusted to the local preferences while producing results that are valid and based on a comprehensive analysis. The difficulty in the choice of the assessment method at the project level arises from the fact the sustainability criteria vary from country to country; the guidelines, criteria and priorities set at the national level need to be analysed carefully by the project developer, so that it is possible to identify the methodology that is more suitable for taking into account the parameters relevant in the host country. This is of crucial importance also because the choice of the assessment method can significantly affect the final outcome of the sustainability assessment.

Among the different methods reviewed, the multi-criteria methods seem to be the most suitable in a context where multiple stakeholders need to be involved. These methods in fact have demonstrated to be easily adjustable to different preferences, depending on the specific context where CDM projects are implemented, because the selection of criteria and

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[72] Sutter, C. (2003), p.76.

[73] Burian, M. (2006), p.75.

[74] Olhoff et al (undated), p. 51.

[75] Schlup, M (2006, July 12).

indicators reflects the priorities of the decision makers. Moreover, while taking into account the high specificity of each national environment, these methods provide the basis for comprehensive assessments through the use of both quantitative and qualitative indicators.

However, the choice of a specific multi-criteria method is influenced by a plurality of factors characterizing the context where the project activities are planned. For instance, some methods are more appropriate when there is a portfolio of different projects that need to be evaluated and ranked against each other[76], while methods like MATA-CDM can be used as stand-alone tools for the evaluation of a single project. Some tools imply a large number of indicators and detailed information, which can result problematic when the level of detail in the indicators is higher than the level of detail in the project data available.

Methods focused on the economic and environmental-technical dimensions usually require the analysis and the synthesis of quantitative information, while methods that are aimed at including the social dimension rely on both quantitative and qualitative measures and can be better for a more comprehensive assessment. On the other hand, however, the use of qualitative indicators is usually associated to a higher degree of subjectivity in the evaluation process, as even more discretionality is left to the evaluator; this can create problems in terms of measurability as well as comparability of different projects in different locations and over time.

The number of stakeholders involved in the project implementation is another key variable that needs to be taken into account when selecting the criteria and, possibly, their weight. Stakeholders' involvement and public participation are key issues that should be included and discussed since the *project idea note* (PIN) of CDM projects. In some multi-criteria methods, for instance, the weighting process of the different indicators is based on the opinion of the local stakeholders. The MATA-CDM approach offers an example of how stakeholders' indications can be used to establish the relative importance of different criteria and sub-criteria.

A project developer might also obtain useful indications on sustainability assessment methods from other actors that have developed projects in the same geographic area or using similar technologies in other geographic areas.

The key variable that ultimately affects the choice of the assessment method, however, is the guide provided directly by the national and local authorities; for instance, the DNA of the host country can address the project developer's choice suggesting the assessing methods that are commonly used in the country with regard to a specific sector or to a project category. In particular, since the DNAs have to secure that CDM projects actually fulfil sustainable development national requirements, they can be important actors addressing the choice of sustainability assessment methods. The involvement of different stakeholders from the public and private sector therefore is of key importance, in the first place, for the choice of the sustainability-assessment method and, later on, for the concrete evaluation of the CDM project on the basis of the criteria, indicators and weights selected.

[76] For instance, Olhoff et al.have pointed out that cost-benefit analysis is usually appropriate for large scale projects and for the assessment of social costs and benefits of a portfolio of different projects. Source: Olhoff et al. (undated), p. 53.

3.3 Experience in sustainability assessments

The project design documents (PDD) of different projects promoting the use of alternative fuels (including both registered projects and projects requesting for registration) have been analyzed by the author of this work, in order to gain a better understanding of how sustainable development has been addressed. From this analysis it is possible to conclude that the sustainability component of the proposed CDM activities is actually regarded as a secondary issue[77]. A detailed assessment of sustainability component of CDM projects in fact is rarely carried out.

In general, the PDD analyzed include only a brief section (if any) dedicated to the project impact on sustainable development development, and aspects like job creation and benefits to local communities are discussed in broad terms. No quantitative analysis is usually presented in the discussion, and no estimation of social and economic benefits through the choice of specific indicators is carried out. The DOE responsible for the validation, on the other hand, simply has to verify that the PDD fulfils the requirements provided by the DNA. Since these requirements are often expressed in a "soft language", the project developers themselves usually treat the sustainable development components of their projects in an approximate way[78].

According to Christoph Sutter, the author of MATA-CDM method for sustainability assessment, "In most projects, sustainability is treated in very generic and weak terms. Same applies for host country requirements… A few exemptions might be found among some Gold Standard"[79]. A detailed sustainable development assessment is carried out for less than 5% of the CDM projects[80]. Sutter has pointed out that in some CDM projects the sustainability assessment is not even mentioned in the written documentation and, even when this is done, it does not necessarily mean that the sustainability component has actually been carefully evaluated.

According to Sutter, two main points explain why the sustainability component in practice is not as important as it could seem in the provisions of Kyoto Protocol:

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[77] UNFCCC.

Project 0339: Emission reduction through partial substitution of fossil fuel with alternative fuels like agricultural by-products, tyres and municipal solid waste (MSW) in the manufacturing of Portland cement at Grasim Industries Limited-Cement division South (GIL-CDS), Tamilnadu, India.
http://cdm.unfccc.int/Projects/DB/DNV-CUK1142971280.51/view.html (2006, July 20)

Project 0302: Partial replacement of fossil fuel by biomass as an alternative fuel, for Pyro-Processing in cement plant of Shree Cements Limited at Beawar in Rajasthan, India.
http://cdm.unfccc.int/Projects/DB/SGS-UKL1141827837.06/view.html (2006, July 20)

Project 0247: Replacement of Fossil Fuel by Palm Kernel Shell Biomass in the production of Portland Cement.
http://cdm.unfccc.int/Projects/DB/DNV-CUK1137498953.91/view.html (2006, July 19)

Project 0493: Indocement Alternative fuel project. Online]
http://cdm.unfccc.int/Projects/DB/DNV-CUK1152056370.16/view.html (2006, August 22)

[78] Sutter, Chrsitoph (2006, August 3).

[79] Sutter, Chrsitoph (2006, August 3).

[80] Sutter, Chrsitoph (2006, August 3).

1. The Kyoto Protocol was pushed mainly by Annex I countries, and the sustainability issue was discussed and formally included in the Protocol as a prominent component as a result of a compromise between developed and developing countries: the sustainable development issue was addressed mainly to make the Protocol more attractive for non-annex I countries.

2. With the Marrakesh Accords it was specified that the evaluation of sustainability component of the CDM projects was exclusive responsibility of the host countries, recognizing that each country has the right to decide which aspects should be prioritized in a specific national context. Therefore, this is not an issue that can be enforced or discussed at the international level any more, as the formal authority and the decision power remains at the national level.

Given these conditions, the main incentive for carrying out a detailed sustainability assessment for the project developer is the benefit in terms of image.

The interview to Michael Schlup, director of the Gold Standard (promoted by the *World Wilde Fund*, WWF), has highlighted the same problem stressed by Sutter. Schlup has stressed that, during the project cycle, the only step where sustainable development is really taken into account is the DNA's assessment. Therefore, given the broad guidelines often developed by the DNAs, the concrete application of detailed assessment methods, based on a precise set of qualitative and quantitative indicators, remains limited to few cases, and mainly relies on the approach chosen by the single project developer[81]. As previously discussed, the main reason underneath the adoption of weak criteria by the DNAs is probably the tendency, common among host countries, to prioritize the attraction of foreign capital; the introduction of complex guidelines is often seen as a way to discourage potential investors. On the other hand, the project developers have an obvious interest at facing weaker standards because low requirements simplify the implementation of CDM projects and the subsequent issue of CERs; the introduction of broad indications ad guidelines by the DNA allow for high discretionality of the project developers and minimize their efforts and the number of variables that need to be taken into account during the project conception and implementation.

[81] Schlup, M (2006, July 12).

4 Cement sector

Cement industry produces about 1.5 billion tons of cement a year, with an estimated annual turnover of $87 billion, which has grown by nearly 4 percent a year over the past decade[82]. Overall, cement sector is responsible for approximately 5% (about 2 billion tons CO_2 in 2005) of man-made CO_2 emissions and 3% of global CO_2 emissions[83]. Out of these CO_2 emissions, about 1.4 billion tons (70% of the CO_2 emissions in the cement industry) were produced in developing countries.

Issues like release of carbon dioxide during the manufacturing processes, intensive consumption of energy and non-renewable resources, and impacts from cement dust, represent major concerns for the cement industry. Technological innovation, coupled with initiatives for rational use of natural resources and management of environmental aspects, represent the basis for a proactive approach towards sustainable development within the cement industry.

4.1 Production process – an overview

The production of cement can be divided into three main stages: (1) the extraction of raw materials, (2) clinker production and (3) cement grinding and distribution. In the first stage primary raw materials such as lime stone, mark and clay/ shale are extracted from quarries that are generally located close to the cement plant. Around 1,600 kg of raw material is needed to produce 1000kg of cement. Corrective materials such as bauxite, iron ore or sand are added to adapt the chemical composition of the raw mix to the requirements of the process and product specifications. Often by-products, so called “secondary raw materials” from other industries are used to replace a portion of the natural raw materials in the raw mix. In the cement plant the raw material mix is homogenized, and then partitioned, ground, dried and blended in the raw mill. It is possible to divide the kiln systems according to their water use into dry, semi-dry and wet kilns. In all processes the kiln feed is first dried and then calcinated by the dissociation of CO_2 from the Ca CO_3 in the feed material. The difference is that in semi dry process the water content is 10-12% and in the wet kiln process 28-43%[84]. There has been a recent trend from wet process to semi-dry and dry processes as a way to increase energy efficiency. The prepared raw material or “kiln feed” is then fed to the kiln for preheating, calcination and clinkerisation. In the pre-heater the raw materials are heated to 900 ºC in a counter-flow heat exchange. This is when the decarbonation/calcination takes place.

In the kiln the material is heated to 1450 ºC in a rotary kiln[85] after which the clinker is rapidly cooled to ensure the desired mineralogy. The inclination and the rotation of the kiln allow for a material transport that achieves the thermal conversion processes required. Heat recovered

[82] WBCSD (2005). *Cement Sustainability Initiative. Progress Report.*

http://www.wbcsd.org/web/publications/csi.pdf (2006, June 2)

[83] WBCSD (2005).

[84] Cembureau (2000). *Best Available Techniques for the Cement,* p.41.

http://www.cembureau.be (2005, November 18)

[85] The kilns systems commonly applied are rotary kilns that may have either “suspension preheaters” or “precalciners”.

from the kiln can be recycled in the process to reduce fuel requirements. It is common to store the clinker on site, after which it is ground with gypsum and supplementary cementitious materials and mineral additives to be ready for distribution. Figure 4-1 and 4-2 show the production process and the rotary kiln.

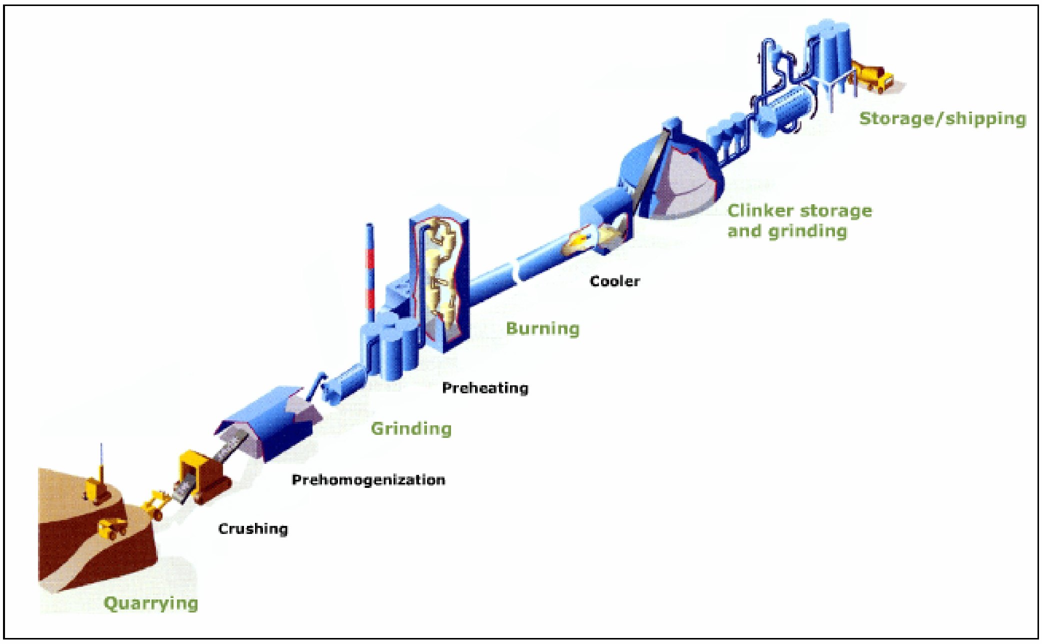

Figure 4-1 Production process. Cement production and aspects related to sustainable development [86].

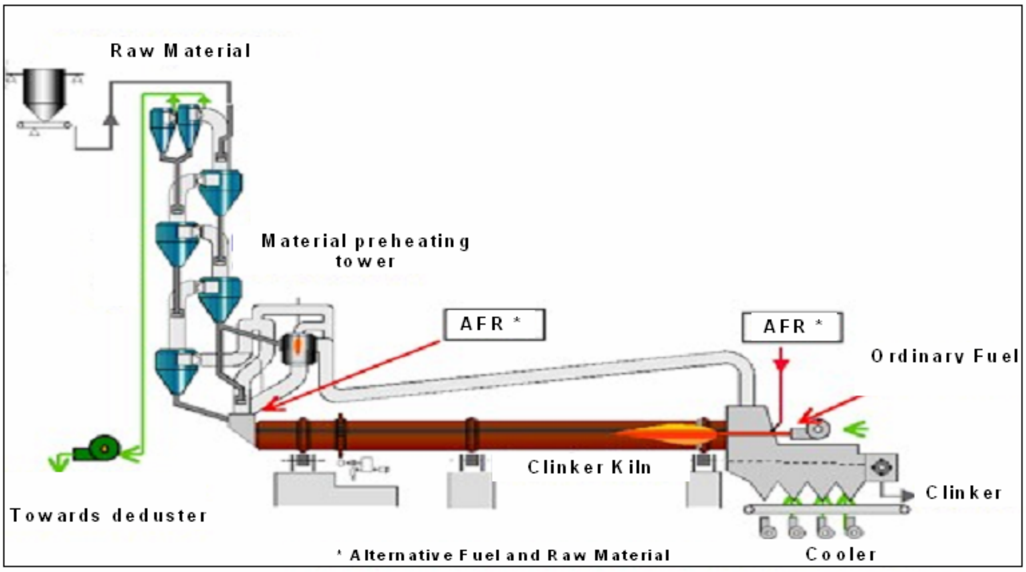

Figure 4-2 The cement kiln[87].

[86] Italcementi Group. *Cement production and aspects related to sustainable development.*

http://www.italcementigroup.com/svilupposostenibile/inglese/index.htm# (2006, June 20)

GHG emissions from cement manufacturing depend on the fuel mix, energy consumption, state of technologies and site-specific variables. There are two main sources of direct CO_2 emissions in cement manufacture:

- CO_2 from calcinations' and pyro-processing, released through the kiln stack. This is generally the major source of GHG in manufacture process, accounting for 50% of the total CO_2 emissions. During the generation of cement from limestone and other constituents, in fact, the following reaction takes place:

$$CaCO3 + heat \rightarrow CaO + CO_2$$

- CO_2 from fuels for the operation of kilns, which require high temperature, usually above 2,000°C, and large quantities of fuels. This stage is highly energy-intensive: depending on the raw materials and on the characteristics of the production process, a cement plant consumes fuel at an average rate between 3,200 and 5,500 MJ/t of clinker[88].

Figure 4-3 shows man-made GHG emissions classified per major sources.

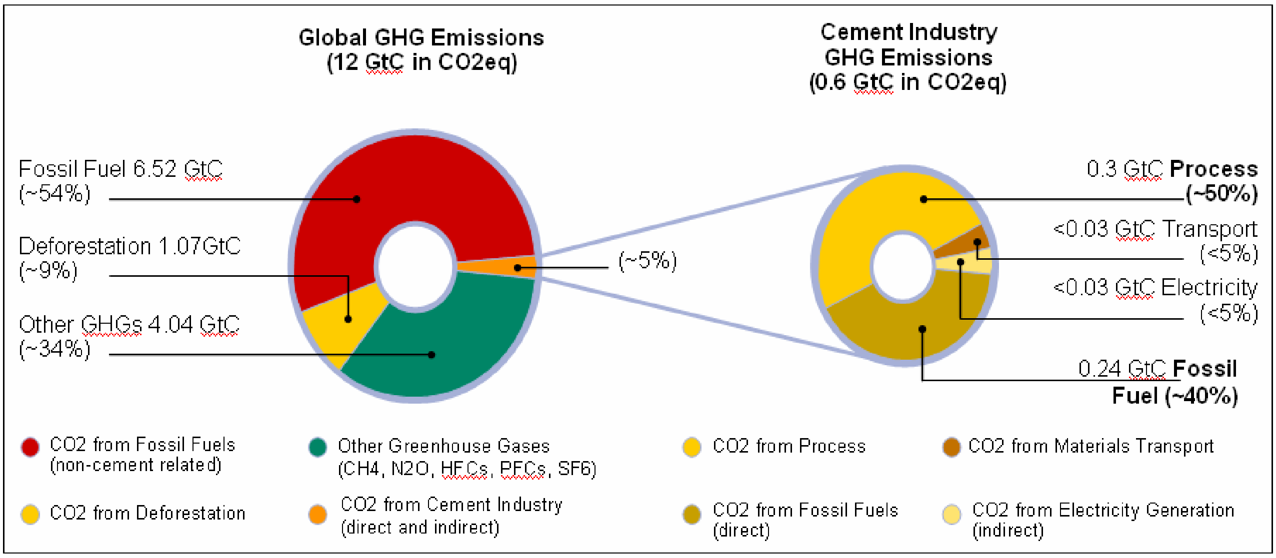

Figure 4-3 GHG emissions by sources.

Direct and indirect emissions from cement industry account for about 5% of total anthropogenic CO_2eq emissions; as said, about 50% of these emissions are process-related, and approximately 40% derive from fuel combustion.

4.2 Cement sector - the sustainability issue

The plurality of environmental aspects related to cement manufacture provides a rationale for the adoption of comprehensive initiatives addressing the climate-change issue, involving at

[87] Italcementi Group.

[88] WBCSD and WRI (2005). *The GHG Protocol for project accounting*, p. 86.

the same time the social and economic dimension. In the year 2,000 a large segment of the global cement industry embarked on a systematic effort to improve its environmental and social impacts, launching the *Cement Sustainability Initiative* (CSI), assisted by the WBCSD. The initiative involved ten large cement corporations, accounting for more than one third of global cement production; they were: Lafarge, (France), Holcim (Switzerland), Cemex (Mexico), Heidelberg (Germany), Italcementi (Italy), Cimpor (Portugal), RMC (UK), Siam Cement (Thailand), Taiheyo Cement (Japan), and Votorantim (Brazil). CSI was aimed to address sustainability issue in cement sector, based on a common commitment for the reduction of cement industry's ecological footprint and for the enhancement of its social contribution.

The ten corporations together constituted the so-called Working Group Cement (with the WBCSD Secretariat as programme manager and coordinator) that in 2002 launched an Agenda for Action, including specific commitments for future company activities and mechanisms for further stakeholder engagement. The Agenda was a response to the report 'Toward a sustainable cement industry' of the Battelle Memorial Institute, a US-based not-for-profit consulting firm that conducted an independent research concerning cement sector and sustainability challenges.

The CSI is based on the triple-bottom-line approach (see figure 4-4) aimed at integrating economic, environmental and social dimensions, and is focused on six key issues[89]:

- climate protection;
- fuels and raw materials;
- employees health and safety;
- emissions reduction;
- local impacts;
- reporting and communications.

In the Agenda for Action the corporations stated: "We have chosen to adopt an agenda for sustainable development for three reasons: to prepare ourselves for a more sustainable future; to meet expectations of stakeholders; and to individually identify and capitalize on new market opportunities" [90]. The engagement in the sustainability challenge therefore is also regarded as a way to create new business opportunities and to gain competitive advantages through investments in intangible assets and the adoption of first-mover strategies.

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[89] WBCSD (2002). *Cement Sustainability Initiative. Our Agenda for action.*

http://www.wbcsd.org/web/publications/cement-action-plan.pdf (2006, June 1st)

[90] WBCSD (2002), p.6.

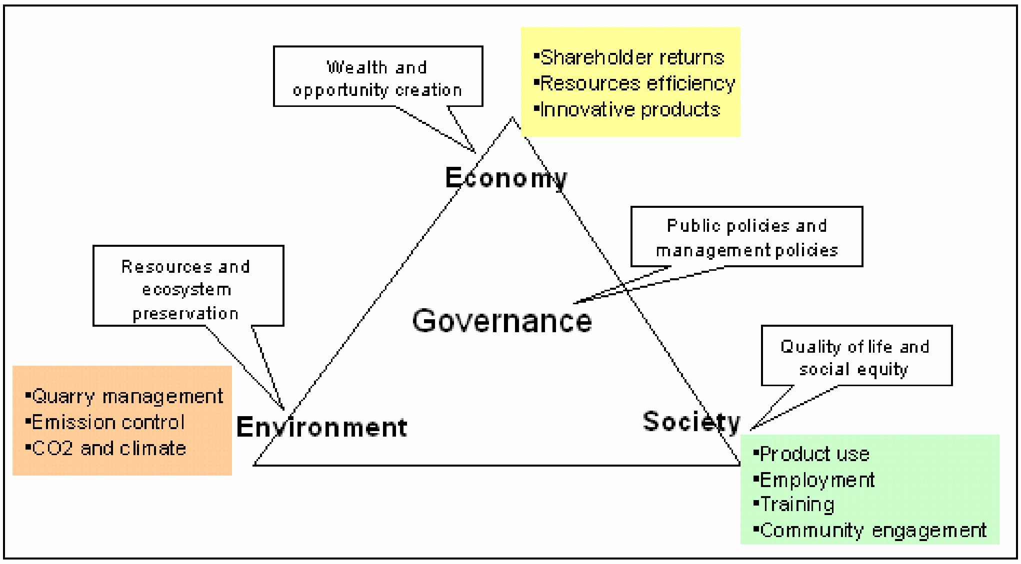

Figure 4-4 Sustainability dimensions[91].

Since about 70% of CO_2 emissions from cement sector are produced in developing countries and the production in these areas is expected to increase, it is of prior importance to intervene through measures aimed to limit the negative environmental impacts of the industry. CDM provides the institutional and operative framework for tackling the major issues that the cement sector faces nowadays in developing countries, being an overarching mechanism for the integration of the 'triple bottom line' components.

4.3 Methodologies for CDM application to the cement industry

As of August 22nd, 2006, eleven CDM projects have been registered in cement sector, most of which have been developed in India. Additionally, four projects have requested for registration, and five are undergoing the validation process[92]. However, the scenario is evolving quickly, and new PDD projects are being submitted to the different DNAs of non-Annex I countries for the national approval.

Different typologies of projects are possible for CDM activities in cement industry. The projects should be developed following the methodologies approved by the EB, within the UNFCCC framework.

Under the framework provided by the UNFCCC for cement sector, it is possible to implement projects that imply both direct reductions in CO_2 emissions, and indirect reductions[93]:

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[91] Nordqvist, Joakim., Boyd, Christopher., and Klee, Howad (2002). *Three bic Cs: Climate, Cement and China. Green Management International, issue 39,* p.73.

[92] UNFCCC. *CDM statistics.* (2006, August 22).

[93] UNFCCC. *Approved Baseline and Monitoring Methodologies*

http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html (2006, July 10)

a) Projects achieving direct emission reductions. In this case there are emission reductions from sources owned or leased by the project developer. Therefore these reductions usually occur 'in loco'. For the cement industry, the following activities account for direct reductions:

   – Reduction of clinker/cement factor through increased blended cement (e.g. using fly ashes or limestone) or finer grinding. The specific methodology applied is the ACM0005*,* entitled 'Consolidated Baseline Methodology for Increasing the Blend in Cement Production';

   – Substitution of raw material in cement processing. The methodology applied here is the new methodology AM0033 (previously classified as NM0123-rev), approved by the Executive Board at the 25th meeting, held in July 2006. The methodology is entitled "Use of non-carbonated calcium sources in the raw mix for cement processing". Following this methodology, a part of the raw material usually used for clinker production (limestone and clay) is replaced by non-carbonated calcium sources;

   – Use of alternative fuels such as biomass or waste as fuel substitute. The project activities are developed following the methodology ACM0003 'Emissions reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture'.

b) Projects achieving indirect emission reductions. This category includes projects that imply reductions from emission sources not directly owned or leased by the project developer, but occurring as an indirect result of his activities. The following project activity accounts for indirect CO2 emission reductions:

   – Heat recovery (e.g. from pre-heater, grate cooler) for the production of electricity. The emission reductions in this case occur at the power plant where electricity is usually generated: as a consequence of the project activity, less electricity is generated from conventional sources and fewer emissions occur with respect to the business-as-usual situation. The methodology AM0024, entitled 'Baseline methodology for greenhouse gas reductions through waste heat recovery and utilization for power generation at cement plants", is applied in this case.

However, other methodologies not specifically developed for the cement sector, such as the production of grid-connected electricity or the achievement of energy savings through installation revamping (e.g. mills, fans), can be applied to the cement industry to obtain CERs. The approved consolidated methodology ACM0004, already applied in a cement plant in Rajasthan, provides a guide for the use waste heat-recovery technology in different industrial processes.

4.4 The rationale for alternative fuels in cement manufacture

Traditionally, cement industry uses various fossil fuels to operate the kilns, including pet coke and coal, fuel oil and natural gas – especially in developing countries. The following table shows the average fuel mix and kiln types in different countries.

Table 4-1 Kiln types and fuel shares in the world[94]

Table 4 Types of kiln by installed capacity and fuel shares used in different regions (Humphreys and Mahasenan, 2002; Tilley, 2003*)

Region	Sub-region	Kiln type, %				Fuel shares, %				
		Dry	Semi-dry /wet	Wet	Vertical	Coal	Oil	Gas	Heavy fuel oil	Alternative fuels/wastes
North America	USA	65	2	33	0	58	2	13	0	26
	Canada	71	6	23	0	52	6	22	4	15
Western Europe		58	23	13	6	48	4	2	4	42
Asia/Pacific	Japan	100	0	0	0	94	1	0	<1	3
	Australia*	80	1	19	0	60	0	34	<1	5
	China	5	0	2	93	94	6	<1	0	0
	SE Asia	80	9	10	1	82	9	8	0	1
	Rep. of Korea	93	0	7	0	87	11	0	0	2
	India	50	9	25	16	96	1	1	0	2
Eastern Europe	FSU	12	3	78	7	7	1	68	24	<1
	Other	54	7	39	0	52	34	14	0	<1
Latin & South America		67	9	23	1	20	36	24	8	12
Rest of world	Africa	66	9	24	0	29	36	29	2	5
	Middle East	82	3	15	0	0	52	30	14	4

* 2002 data

In recent years higher attention has been given to the use of alternative fuels in cement production. There is a great environmental value and potential for CO_2 cuts in using certain wastes as alternative fuels and materials in cement manufacture; most of the times this is regarded as a way for valorizing and eliminating waste that would otherwise be incinerated or landfilled.

Particular relevance is now given to the use of biomass and municipal solid waste as fuels. Agricultural waste, waste oil, tyres, fractions of solid waste and sewage sludge have been increasingly used in cement kilns. In most developing countries, for instance, there is abundant agricultural waste that is used inefficiently or is not used at all.

As seen, the use of biomass as an alternative to the use of traditional fossil fuels in cement production is regulated by the methodologies approved within the UNFCCC framework for the development of CDM projects. In particular, project activities implying the use of alternative fuels can be implemented following the methodology ACM0003. Table 4-2 presents a classification of the main alternative fuels.

[94] Smith, Irene (2003). *Co-utilisation of coals and other fuels in cement kilns,* p.56. International Energy Agency Coal Research (IEACCC) publication series.
http://www.caer.uky.edu/iea/ieaccc.shtml (2005, December 3)

Table 4-2 Main alternative fuels in cement manufacture[95]

Alternative fuel	Examples
Gaseous	Coke oven gases, pyrolysis gas, landfill gas
Liquid	Low chlorine spent solvents, lubricating as vegetable oils and fats, distillation residues, hydraulic oils, insulating oils
Pulverized, granulated or fine crushed solid	Ground waste wood, sawdust, dried sewage sludge, granulated plastics, animal flours, agricultural residues, residues from food production, fine crushed tyres
Coarse crushed solid alternative fuels	Crushed tyres, rubber/plastics waste, waste wood, reagglomerated organic matter
Lump	Whole tyres, plastic bales, material in bags and drums

The next chapter presents the main features of this methodology, used as the reference methodology for the simulation of CDM project activities in Italcementi's plants in Thailand.

4.5 ACM0003: Emissions reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture

The methodology ACM0003, revised in May 2006, has been developed on the basis of two cases of partial substitution of fossil fuels in cement manufacture in Malaysia and Indonesia.

The methodology is restricted to CO_2 emission reductions from fuel combustion (therefore the decarbonisation of raw material is not included), and it is exclusively applicable to project activities that imply the substitution of fossil fuels with wastes and biomass residues. The methodology specifies that "*Biomass residues* means biomass by-products, residues and waste streams form agriculture, forestry and related industries and the non-fossilized and biodegradable organic fractions of industrial and municipal waste. *Biomass* means non-fossilized and biodegradable organic material originating from plants, animals and micro-organisms… Biomass also includes gases and liquids recovered from the decomposition of non-fossilized and biodegradable organic material" [96].

The ACM0003 is applicable "if the alternative fuels available for the projects are at least 1.5 times the amount required to meet the consumption of all users consuming the alternative fuels". This requirement is aimed to guarantee that the use of alternative fuels by the project developer does not deprive other users that, in turn, would switch to fossil fuels. The availability of alternative fuels therefore is the key condition for the development of the project activities under the CDM regulatory framework.

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[95] Cembureau (2000) *Best Available Techniques for the Cement Industry, p.132.* http://www.cembureau.be (2005, November 18)

[96] UNFCCC. *Emissions reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture.*

http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html (2006, June 9)

The methodology specifies that the project boundary covers all production processes related to the production of clinker, and in particular the pyro-processing step. Only emissions of CO_2 from the production of clinker are taken into account because of the intrinsic characteristics of the combustion process, which requires very high temperatures and therefore limits the production of other GHG emissions.

According to the methodology, the project developer needs to select the baseline scenario through a financial or a barrier analysis. The baseline scenario “defines the most likely situation in the absence of the proposed project”[97]. For the baseline definition the project developer need to take into account national and local policies and to demonstrate to adopt a ‘conservative approach’, in order to not over-estimating the environmental benefits deriving from the CDM project. Moreover, the developer needs to demonstrate the additionality of the projects following the “Tool for the demonstration of additionality” prepared by the CDM Executive Board.

The methodology provides a guide for calculating the emission reductions taking into account also on-site emissions from transportation of alternative fuels and emissions outside the project boundary, defined as “leakages”. In a specific section of the ACM0003, entitled “leakage”, the emissions from off-site combustion or decomposition of alternative fuels, as well as emissions from off-site transport and preparation of alternative fuels, are taken into account.

A specific “penalty” should be applied to the project: the combustion of alternative fuels in fact is characterized by coarser and less homogeneous components, if compared to traditional fuels. Therefore the process requires higher heat input in order to obtain the same output in terms of quality and quantity of clinker, which needs to be taken into account for the correct calculation of the emission reductions from the CDM project.

A specific monitoring plan should be followed and applied with the baseline methodology by the project developer in order to check GHG reductions and technical parameters associated to clinker production over time. The plan is described in the document entitled “Revision to the approved monitoring methodology ACM0003”, revised in March 2006[98].

[97] UNFCCC. *Emissions reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture*, p. 2.

[98] UNFCCC. *Emissions reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture, p.12.*

5 CDM implementation in Thailand

The kingdom of Thailand occupies a land area of 514,000 square kilometres and accounts for a population of over 62.42 million (more than 8 million living in Bangkok city)[99].

With a Gross Domestic Product of 7,104 billion Bath[100] in 2005, Thailand belongs to the group of South-East Asian countries that witnessed an intensive growth in the past two decades, both in terms of population and industrial development. The structure of governance is divided into national, provincial (changwat) and district levels, with the 76 provinces headed by changwat governors and districts by districts chiefs. The city of Bangkok (the Bangkok Metropolitan Region) has its own governmental authority known as the Bangkok Metropolitan Authority.

Thai economy is largely dependent on agriculture, industry and services, with the main income activities being manufacture of goods, textiles, cultivation of agricultural products, fisheries, minerals and tourism.

During the past decades, a decline in the environmental health of the country has occurred in conjunction with the rapid industrialization. While Thailand was lauded for its strong economic growth, the country also suffered from increased levels of industrial wastewater, deforestation, severe rise in domestic sewage and hazardous wastes, and dramatic degradation of water and coastal resources. Increased levels of air and water pollution and the loss of natural habitats were some of the most visible consequences of Thailand's unrestrained growth[101]. Pollution affecting the fisheries industry in the Gulf of Thailand, health problems arising from toxic substances in industrial districts and the traffic problems in Bangkok area are only some of the instances of environmental degradation that Thai Government and people are facing.

The experience of Thailand chronicles the example of developing economies, rapidly industrialising and struggling to ensure compatibility between development priorities and environmental conservation and protection. It reflects the typical trade-off between economic growth and sustainability characterizing developing countries, arising from the collision between short-terms and long-terms-benefits.

In recent years, especially after the 1997 financial crisis, more attention has been focused on the country's environmental problems. There is higher awareness that Thai economic development must take into greater account environmental issues in order to be sustainable. The Government has affirmed its commitment to environmental protection in order to help the country to deal with current environmental challenges.

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[99] Bank of Thailand. *Thailand's Macro Economic Indicators* .

http://www.bot.or.th/BOTHOMEPAGE/databank/EconData/Thai_Key/Thai_KeyE.asp (2006, June 19)

[100] 1US$ = 40.3 Bath (2005). Source: Bank of Thailand. *Thailand's Macro Economic Indicators.*

[101] Energy Information Administration (EIA). *Thailand: Environmental Issues.*

http://www.eia.doe.gov/emeu/cabs/thaienv.html (2006, June 25)

5.1 Institutional framework and legislation

The main comprehensive legislation concerning environment in Thailand is the *Enhancement and Conservation of the Natural Environmental Quality Act* of 1992 (EQA). The concept of sustainable development accepted at the Rio Conference in 1992 was imported in Thailand through this Act. The EQA contains provisions for the enhancement of environmental protection (however, several years have been necessary before the provisions came effectively into force), such as the creation of a high-level multi-representational *National Environmental Board* (NEB); the establishment of an Environmental Fund; the formulation of a National Environmental Management Plan; the regulation of air, noise, water and hazardous waste pollution.

On the 2nd of February, 1999, Thailand signed the Kyoto Protocol, which was ratified on the 28th of August 2002. As the others non-Annex I countries, Thailand does not have binding emission reductions targets under the Kyoto framework, as a direct application of the principle of "common but differentiated responsibilities".

However, the Thai Government has recognized the necessity to take action with regard to climate change-related issues. Thai policy on climate change is based on the following 'pillars': adaptation; mitigation; national communication; research and observation systems; education, training and public awareness; capacity building; development and technology transfer; clean development mechanism[102].

In particular, after ratification of the UNFCCC and the Kyoto Protocol, climate-change policy principles were developed. The principles are presented in table 5-1.

Table 5-1 Principles of Thailand's climate change policy[103]

No-regret option	Thailand should participate and cooperate with other parties to achieve the common objective of reducing GHG emissions, but at the same time it should recognize economic development needs.
Precautionary approach	Thailand should take precautionary measures against the potential adverse impacts of climate change.
Common but differentiated responsibilities	As a non-Annex I country, Thailand does not have emissions reduction target obligations under the UNFCCC. Thailand anticipates that Annex I countries will take the lead in GHG emissions reduction both domestically and abroad. Sufficient support provided for voluntary action and public participation is preferred.
Equity	It should address inequalities in health status and access to adequate food, clean water, and others due the adverse effects of climate change.

A detailed institutional and legislative framework for CDM projects is still under development in Thailand. However, project developers need to respect the national laws

[102] Institute for Global Environmental Strategies (IGES) and Office of Natural Resources and Environmental Policy and Planning (ONEP) (2006). *CDM Country Guide for Thailand.*, p.56.

http://www.iges.or.jp/en/cdm/pdf/countryguide/thailand.pdf (2006, July 20)

[103] Institute for Global Environmental Strategies (IGES) and Office of Natural Resources and Environmental Policy and Planning (ONEP). *CDM Country Guide for Thailand.*

related to their activities, such as the Foreign Business Law (1999), the Enhancement and Conservation of National Environmental Quality Act (1992), the Factory Act (1992), the Public Health Act (1992), and the Hazardous Substance Act (1992). In addition, specific regulations for power purchases are applied to power projects[104].

In Thailand there are 43 business sectors that have restrictions on foreign ownership; the Foreign Business Act (1999), which came into force in March 2000, regulates these sectors[105]. The sectors are divided in three main categories and include activities related to national security or involving arts, culture, traditional customs, natural resources, or the environment (like fishery and land trading). The other potential sectors for CDM projects (including energy, waste, and industrial activities) are not subjected to particular restrictions, but the projects proponents need to respect specific environmental standards including air emissions, emissions to water, noise pollution and effects on human health and biodiversity.

Moreover, the Thai government requires proponents of CDM projects or business activities located near rivers, water streams and natural parks to submit an environmental impact assessment report if they operate in sectors like hydro, mining, power (for plants with an installed capacity of 10 MW or bigger), and large industrial operations (such as petrochemical factories, steel and cement industries)[106]. Through environmental impact assessments (EIAs) it is possible to evaluate potential environmental impacts and to adopt measures for their prevention or mitigation. Together with sustainability criteria and guidelines, EIAs are aimed to ensure that environmental issues are properly taken into account since the initial phase of the projects.

5.2 Energy issues

In recent years growing attention has been dedicated to energy issues in Thailand. Energy trends result particularly important both from an economic and from an environmental point of view: at the present economic growth rate, in fact, the domestic energy reserves will not be able to satisfy the increasing energy demand of the country; on the other hand, there are increasing problems of pollution related to energy consumptions in different sectors, especially deriving from industrial processes.

Major concerns arise from the fact that, as many other South-East Asian countries, Thailand is experiencing a rapid economic growth associated to a steady rise in energy consumption. The average energy elasticity to income is 1.4 (in developed countries such as the USA and Japan the energy elasticity is 0.8 and 0.95 respectively)[107]. The ratio between energy

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[104] Institute for Global Environmental Strategies (IGES) and Office of Natural Resources and Environmental Policy and Planning (ONEP) (2006), p. XVIII.

[105] Institute for Global Environmental Strategies (IGES) and Office of Natural Resources and Environmental Policy and Planning (ONEP) (2006), p. 94.

[106] Institute for Global Environmental Strategies (IGES) and Office of Natural Resources and Environmental Policy and Planning (ONEP) (2006), p.77.

[107] This is reflected by the fact that energy demand has been growing more than GDP, the latter witnessing a growth rate of 6.1% and 5.6% in 2004 and 2005, respectively.

Source: Asian Development Bank (ADB). Thailand. Macroeconomic assessment of 2004. [Online]

Available: http://www.adb.org/documents/books/ado/2005/tha.asp (2006, July 25) consumption and GDP in fact increased constantly in the last decade (it was 12.11% in 1997 and reached 15% in 2003).

However, in Thailand, fossil fuel resources are limited and insufficient to satisfy the growing energy demand; the high dependency on imported energy makes Thailand at risk of energy supply disruption[108]. Moreover, the dependency on foreign sources causes a considerable loss of foreign currency, and the country is highly subjected to volatility of energy prices and to loss of foreign currency deriving from energy imports. In 2002 the energy consumption in Thailand accounted for about US$ 20 billion, which was about 14% of the *Gross Domestic Product* (GDP). The value of imported energy exceeded 300 billion Baht.

Among the factors that contributed to the increase in energy prices in recent years, the US-Iraq military crisis had a major role: the conflict caused the oil price to hike at US$ 5.8 per barrel, almost three times higher then it was before the crisis. The Thai government had to introduce oil price stabilization measures in order to mitigate the impacts of oil price hikes on the country.

Table 5-2 presents the main data for energy imports and exports in Thailand. As shown in the table, energy imports represent a large share of the energy consumption.

Table 5-2 *2003 Energy Balances for Thailand (in thousand tonnes of oil equivalent (ktoe), on a net calorific value basis)*[109]

SUPPLY & CONSUMPT.	Coal	Crude Oil	Petr. Products	Gas	Nucl.	Hydro	Geothermal, Solar, etc.	Combustibles Renewables and Waste	Elect.	Heat	Tot
Production	5464	10553	0	16944	0	628	0	14665	0	0	48255
Imports	4190	37993	867	6311	0	0	0	18	213	0	49592
Exports	0	-2979	-4900	0	0	0	0	-4	-25	0	-7909

In order to guarantee long-term development, energy supplies need to be adequate and reliable, and must be provided at reasonable prices; these represent key conditions to ensure the country's competitiveness within the international context. To limit the continuous growth in energy imports, it is indispensable to set the focus on the optimal use of energy

[108] For instance, the level of dependency on oil imports in Thailand is higher then in countries like Indonesia, Malaysia, China and the Philippines. Source: Logistics digest. *Thai oil dependency rates relatively high.*

http://www.logisticsdigest.com/index.php?module=list&name=cat&id=5 (2006, July 15)

[109] International Energy Agency (IEA). *Energy statistics.*.

http://www.iea.org/Textbase/stats/index.asp (2006, July 15) sources such as renewable energy and, in particular, bio-energy obtainable from agricultural sector, one of the 'pillars' of Thai economy. Given the rise in coal prices and its negative impact on Thai economy, in fact, new solutions need to be encouraged to satisfy the increasing energy demand through alternative energy sources, especially when they are locally available and easily accessible. This could enhance national energy security and improve the balance of payments, strongly affected by energy imports. In this context, one of the main goals set by the Thai Government is to increase the use of renewable energy sources, which includes waste. The promotion of biomass power plants in Thailand, increasingly emphasized in the last few years, is an example of the measures adopted by the Government. The high levels of dependency on oil and coal imports in fact is to be counterbalanced through public and private initiatives aimed to rationalize the use of finite resources. On 28 August 2003, the Ministry of Energy held a workshop on Energy Strategy for Competitiveness. The workshop was presided over by Prime Minister Thaksin Shinawatra with the participation of senior officers from related Ministries and private sector representatives. The objective was the individuation of strategic approaches to enhance Thai competitiveness increasing energy security. At present, in fact, 90% of electricity generation in Thailand relies on oil, coal and natural gas. It is projected that in 30 years the supply of coal and natural gas will be exhausted if there is no new exploration and discovery of new sources. This is the reason for which the *Energy Policy and Planning Office* (EPPO) of the Ministry of Energy has increasingly promoted new projects on Electricity Generation from biomass[110].

One of the major targets adopted by the Thai Government is the increase in the share of renewable energies up to 8% of the commercial primary energy by the year 2011 (it was 0.5%, or 265 ktoe, in 2002). The introduction of the *Renewable Portfolio Standard* (RPS) for new power plants, agreed upon by the Government, is an example of this approach. The RPS is to ensure that 4% of the generation capacity of the new plants is obtained through renewables such as solar, wind or biomass. The Government has also encouraged the participation of local communities in renewable energy-fuelled power plants, regarded as activities that positively affect the local economies and the development of rural areas.

Research activities on alternative energy sources have been promoted through the involvement of national and international organizations and the creation of partnership with governmental agencies. For instance, several projects and studies have been developed through joint initiatives between the Thai Government and the *United Nations Environment Programme - Regional Resource Centre for Asia and the Pacific* (UNEP-RRCAP), located in Bangkok. The researches have covered issues like energy efficiency and development of renewable energy of which Thailand has high potential, such as solar, micro-hydropower, wind and biomass (agricultural wastes and municipal wastes). The studies have also involved research institutes like the *Asian Institute of Technology* (AIT) in Bangkok, and universities all around the country. A key component of these studies is the assessment of the impact of the activities under analysis on the environment as well as on local communities.

However, some observers have pointed out that, even if the framework of the national energy strategy has been approved in principle by the cabinet resolution of 2 September 2003, in practice only a limited number of initiatives has actually taken place[111]. More measures should be promoted and effectively supported through economic instruments and

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[110] A.T. Biopower. *What's A.T. Biopower.* http://www.atbiopower.co.th/index_e.htm (2003, August 3)

[111] Praphakornkiat, Winai (2006, July 12). Written interview.

ad-hoc policies, like the introduction of incentive measures encouraging the purchase of power generated by renewable energy, or the provision of tax credits from the Energy Conservation Promotion Fund.

In particular, it is necessary to achieve a better coordination among the different initiatives to be promoted and the concerned ministries and offices, currently suffering from a lack of coordination, bad allocation of resources, and overlapping competences.

In this context, the Clean Development Mechanism represents a guide, an institutional framework that can be used to promote renewable energies in Thailand through the spread of competences and know-how from developed countries. Initiatives adopted at the international level become a means for rationalizing energy production and consumption in a developing country like Thailand at the national and local level, enhancing energy security and limiting dependency and environmental impact of energy use. Moreover, in a key and over-expanding sector like the industry, a more responsible use of finite energy sources is the basis for long-term planning.

The crucial issue is to translate the CDM scheme from the more formal, institutional level, to the actual application, ensuring that it really brings about benefits for the host country and for its communities. The next chapter explains how the CDM framework was set up in Thailand and how the current situation might evolve over time.

5.3 CDM implementation and institutions

In July 2003 the *Ministry of Natural Resources and Environment* (MONRE), established after the Government Restructuring Act (2002), was appointed as Designated National Authority (DNA) for CDM[112]. At the same time, the Cabinet of the ministers established a National CDM Steering Committee chaired by the Permanent Secretary of MONRE. The *Office of Natural Resources & Environmental Policy & Planning* (ONEP) was then appointed by the MONRE as the DNA secretariat and national focal point coordinating the CDM operation and management in Thailand. ONEP coordinates the activities in two major areas: climate-change policy sector, through a specific Climate Change Coordinating Unit, and research and development sector. Following the public sector reform in Thailand during 2001-2002, ONEP launched a project to develop a database system and environmental indicators for monitoring the state of the environment.

The Climate Change Coordinating Unit provides support to ONEP for the design of a national policy on climate change and the CDM. The focus of its activity is to assure contribution to sustainable development, technology transfer, and capacity building.

The approval procedure for CDM in Thailand includes seven steps after the project submission by the project proponent (see figure 5-1).; the Cabinet gives the final approval for the operation of CDM project case by case. Thailand's criteria for CDM projects approval are classified into the following categories[113]:

1. Voluntary participation of the project host;

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[112] Office of Natural Resources and Environmental Policy and Planning. *About ONEP*.

http://www.onep.go.th/eng/about_onep_1.asp (2006, June 19)

[113] Institute for Global Environmental Strategies (IGES) and Office of Natural Resources and Environmental Policy and Planning (ONEP) (2006), p. 64.

2. Contribution to sustainable development;

3. Prevention of any negative impact on the environment;

4. Satisfactory compliance with technical criteria;

5. Compliance with all national, regional, and local legislation and regulations.

The approval procedure, characterized by a high level of complexity, is currently under review. The rigidity characterizing the Thai system mainly derives from shared responsibilities among different authorities and different levels, so that the authorities involved have different priorities and their decisions are expression of different views, operative procedures and approaches to development-related issues.

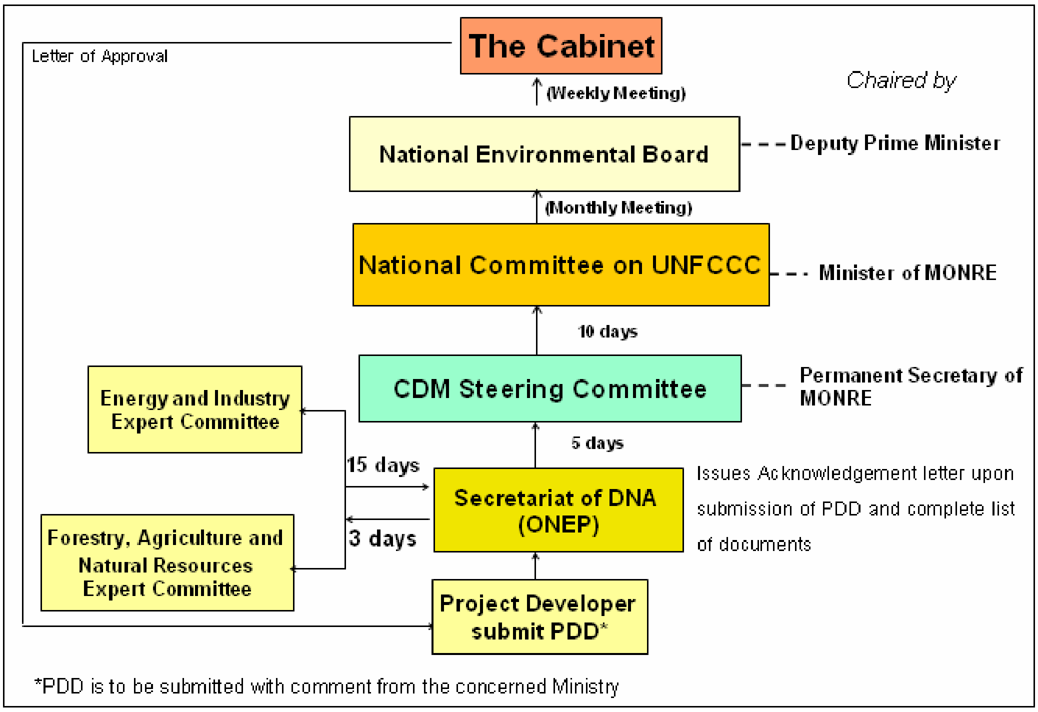

Figure 5-1 Approval procedure for CDM[114].

The plurality of approval steps involved, together with the lack of effective institutional support and coordination among the offices and authorities involved, seem to be the main obstacles to project implementation in Thailand. Criticisms towards the present system concern the lack of authority of the designated CDM agencies[115]. Therefore, the Thai CDM-approval framework is currently in a "frozen" stage. In this context it is evident the need for

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[114] Office of Natural Resources and Environmental Policy and Planning *(ONEP) (2005). CDM implementation in Thailand.* http://*www.onep.go.th/cdm* (2006, July 15)

[115] Stockholm Environment Institute. *Prospect cooperation between Europe and Asia.*

http://www.sei.se/asia/pressrelease-asia.html (2006, June 20) higher efficiency in the national CDM scheme and approval process, in order to effectively facilitate the development of the projects.

A first reform of the present approval system would implies a reduction in the number of steps and administrative units involved; proper administrative and financial resources should be better allocated among the concerned offices, and proper level of authority should be recognized to the institutions involved in CDM implementation in order to enable and legitimate their activity. At the same time outreach activity, information initiatives and training are necessary in order to improve the internal level of organization and coordination and the level of awareness and external services for CDM development.

A new approval procedure has been recently suggested. As figure 5-2 shows, in the new procedure a specific unit, called TGM Board, within a wider institution called Thailand GHG Management Organization, would be responsible for the analysis of the PDD; the Management Board would act as the Designated National Authority, approving or rejecting the projects, and would have only a reporting-duty towards the National Committee for Climate Change. The new CDM structure and approval procedure are foreseen to be functioning by the end of 2006, if the institutional situation in Thailand comes to a change after the new elections of the Parliament, which might be held in October. The previous political elections, occurred in April 2006, were in fact invalidated. The institutional caos that has followed this invalidation has left Thailand in a period of complete paralysis, while the Prime Minister Thaksin Shinawatra is fighting to maintain power against the protests led by the opposition coalition, the People's Alliance for Democracy (PAD)[116].

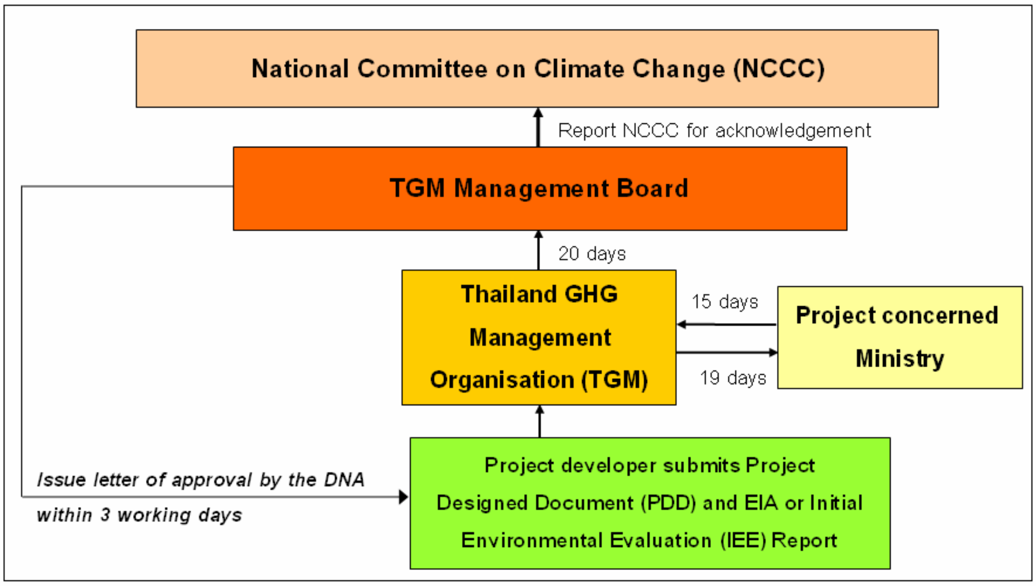

Figure 5-2 New projected procedure for project approval[117]

[116] Thailand political crisis 2005-2006. *Wikipedia Online*. http://en.wikipedia.org/wiki/Thailand_political_crisis_2005-2006 (2006, July 29)

[117] Office of Natural Resources and Environmental Policy and Planning *(ONEP) (2005). CDM implementation in Thailand.* http://*www.onep.go.th/cdm* (2006, July 15)

5.4 CDM projects in Thailand

Thai CDM policy, as designed so far, is intended to prioritize to the stabilisation of GHG emissions from energy sector on both the supply and demand sides. The focus is set on energy and industrial sectors and, in particular, on activities involving energy production, transformation, and intensive consumption[118].

Sectors like power generation, waste management, transports and industry offer the largest potential for CDM projects in Thailand.

There are currently about 40 proposed CDM projects in Thailand, of which only 12 projects are requesting for validation. There are no projects registered yet[119]. Among the projects under validation, eight projects are focused on biogas energy from different sources (wastewater treatment, farms...), one project concerns landfill gases, and the others are focused on biomass cogeneration and waste-to-energy processes. The uncertain definition of the institutional framework for CDM hinders the effective functioning of the mechanism.

Besides the lack of institutional coordination and efficiency, Thailand has problems with regard to the high level of corruption characterising public and private sector, and widespread among high-ranking officials, which significantly influences the way in which resources, competences and roles are distributed and ultimately determines which areas, policies and decisions are prioritized.

According to the CDM Host Country rating, constantly updated by the international association Point Carbon[120], Thailand is classified as a 'CCC country', which is typical of countries with a limited CDM organisational apparatus and project experience; this usually indicates that the investment climate for CDM investments is not attractive.

However, it is predictable that the investment climate and institutional environment will undergo significant changes in the coming months, as discussed in the CDM Country Guide for Thailand, recently published by the Japanese *Institute for Global Environmental Strategies* (IGES) together with the Office of Natural Resources and Environmental Policy and Planning (ONEP)[121]. Moreover, the cooperation between Thai authorities and institutions and a large number of international organizations and partners, from the public and private sector, is expected to influence the Thai CDM framework through the provision of technical assistance and capacity building.

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[118] Institute for Global Environmental Strategies (IGES) and Office of Natural Resources and Environmental Policy and Planning (ONEP) (2006), p. 70.

[119] UNFCCC. *CDM Statistics*. (2006, August 20).

[120] PointCarbon. *CDM Host Country Rating*..

http://www.pointcarbon.com/category.php?categoryID=323 (2006, June 16)

[121] Institute for Global Environmental Strategies (IGES) and Office of Natural Resources and Environmental Policy and Planning (ONEP) (2006). *CDM Country Guide for Thailand*..

5.5 Thai sustainability guidelines

Sustainability issues are coordinated through the Thai National Sustainable Development Coordination Mechanisms implemented under the direction of the *National Economic and Social Development Board* (NESDB), and the *National Environment Board* (NEB).

The NESDB makes recommendations to the Thai Cabinet (comprising the ministers) about economic and social development strategies, and is responsible for the screening of plans, programmes, projects and policies submitted by its secretariat. For the last 40 years the NESDB has been responsible for the collection and analysis of social and economic data for the Thai Government, for the elaboration of the five-year National Economic and Social Development Plans and for the monitoring plans.

The NEB submits policies and plans for environmental enhancement and conservation to the Thai Cabinet and is responsible for the prescription of environmental quality standards and management plans; moreover, it makes recommendations on financial and fiscal issues. Its main role is to ensure consistency between national development priorities and environmental conservation, following the sustainable-development indications provided by the NESDB. The NEB submits annual reports on national environment quality to the Thai Cabinet.

The Government has underlined the importance of associating an 'environmental-friendly' approach to economic growth; in this context, it has been stressed the importance of 'green technology' in industrial processes, as well as the role of new economic activities and partnerships with foreign countries with an advanced know-how. These initiatives represent, according to the governmental agencies, a new stimulus for Thai economy and a contribution to the development of new enterprises, which will support the occupational level encouraging the import of scientific and technical knowledge and expertise from international partners. The CDM offers the regulatory framework for such initiatives, addressing sustainability issues while pursuing economic development objectives.

In July 2005, a tentative set of sustainable development criteria was approved by the Government. At this stage, the criteria are applied only to CDM projects relevant to the energy and industrial sectors[122].
Table 5-3 summarizes the criteria selected.

Given the sub-criteria listed in the table , it is mandatory that "the project either improves one or more of the related indicators, does not deteriorate any of the indicators, or includes mitigation measures in case any of the indicators are deteriorated" [123].

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[122] Institute for Global Environmental Strategies (IGES) and Office of Natural Resources and Environmental Policy and Planning (ONEP) (2006), p. 67.

[123] CDM Country Guide for Thailand, p. 67.

Table 5-3 Sustainable development criteria[124]

Criteria	Sub-criteria	Indicator
Environmental	• Promoting Environmental quality and GHG reduction.	Improve environmental quality – GHG emission reduction – Reduction of air pollution SO2, NOx, PM10 – Reduction of air pollution by other hazardous or toxic substances – Reduction of water pollution – Reduction of noise pollution – Reduction of solid waste – Reduction of land contamination – Reduction of odours from the project site
	• Promoting reduction of natural resource utilization such as underground water and finite energy sources	– Include underground water conservation plan – Reduce utilization from finite energy source
	• Conservation of biodiversity and natural and cultural heritage	– Maintain genetic species and ecosystem biodiversity
Social	• Public participation is a major part of sustainable development, and in order to avoid community conflict, the project developer must seek permission from both local and national authority.	– The project has been presented to the local population, and due respect of their opinions on the project has been given – Local and national authorities approve the implementation of the project
	• Capacity building of local stakeholders	– Training and employment of local staff – Training and employment of local suppliers
	• Improved access of local population to services	– Access to energy – Access to other services
	• Occupational health and safety (OHS) for the workers at the site	– Exposure to air pollution and/or dust – Exposure to explosion risks – Exposure to chemicals – Exposure to dangerous situations
Economic	• To promote local economy in the project area that would reflect national economy	– Employment (in years) – Household income
	• Efficient use of local resources	– Less energy used per product unit

The overall contribution of the project to sustainable development has to be positive with regard to the baseline scenario. Since the Thai DNA has defined the sustainable development

[124] Institute for Global Environmental Strategies (IGES) and Office of Natural Resources and Environmental Policy and Planning (ONEP) (2006), *p.68*.

criteria as "tentative", further developments and changes are likely to occur in the next months.

6 CDM for switching to bio-fuels in Thai cement industry

As previously explained, multiple and severe environmental impacts from cement sector offer a rationale for the adoption of initiatives aimed at reducing GHG emissions. The implementation of CDM projects is of interest for Italcementi Group for two main reasons.

First of all, it contributes to supply credits to the European subsidiaries of the Group that face a strict allocation of CO_2 allowances, within the context of the *European Trading Scheme* (ETS).

Moreover, the substitution of agricultural residues for fossil fuels in cement kilns in developing countries is in line with the approach adopted by Italcementi within the context of the Cement Sustainability Initiative (CSI), reflecting the sustainable development-oriented strategy promoted by the Group. Emissions abatement projects can contribute to the achievement of the target set by Italcementi, committed to bring the CO_2 emissions level down to 711kg/ton of cement produced in the period 2008-2012.

Furthermore, the partial replacement of fossil fuels with biomass in Thailand might represent a relevant issue for Italcementi Group with regard to the following aspects:

- Local lignite reserves are shrinking and it is becoming more difficult to ensure reliable stocks for the medium and long term; due to this increasing imbalance between supply and demand, the price of lignite is increasing, as well as the price of coal imported from Indonesia;

- Environmental policies in Thailand are becoming more stringent;

- The issue of CERs contributes to make the projects financially attractive, while in normal conditions (i.e. without CERs) they would not result interesting for the Group because of existing barriers (of both financial and technical nature).

6.1 Biomass availability for CDM projects

Thailand is one of the countries leading agricultural exports in the world. Biomass resources and, more specifically, agricultural residues potentially usable as energy sources are abundant in the country. Rice husk, bagasse (from sugar cane), palm oil wastes and wood residues are the main agricultural residues available in Thailand[125].

For simplicity, we assume that rice is chosen as alternative fuel for the CDM project under study because of its relative abundance in Thailand and because of the properties that make it suitable as fuel in cement kilns, in terms of calorific value and moisture content.

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[125] Sajjakulnukit, Boonrod., Yingyuad, Rungrawee., Maneekhao, Virach., Pongnarintasut, Veerawan., Bhattacharya, S.C., and Salam, Abdul P (2005). Assessment of sustainable energy potential of non-plantation biomass resources in Thailand. Biomass and Bioenergy 29, p.215.

Residue product ratio (RPR)[126] and calorific values for the main residues are presented in table 6-1.

Table 6-1 Residue product ratio (RPR) and calorific values of agricultural residues[127]

Product	Residue	Moisture (%)	RPR	Energy use factor	Surplus availability factor	LHV (MJ/kg)
Sugarcane	Bagasse	50.00	0.250	0.793	0.207	6.43
	Top & trash	50.00	0.302	0.000	0.986	6.82
Paddy (rice cultivation)	Husk	8.83	0.230	0.531	0.469	12.85
	Straw	8.17	0.447	0.000	0.684	8.83
Oil palm	Empty bunches	8.81	0.428	0.030	0.584	16.44
	Fiber	10.11	0.147	0.858	0.134	16.19
	Shell	13.00	0.049	0.588	0.037	17.00
	Frond	48.34	2.604	0.000	1.000	7.97
	Male bunches	13.82	0.233	0.000	1.000	14.86
Coconut	Husk	12.53	0.362	0.289	0.595	14.71
	Shell	11.79	0.160	0.413	0.378	16.48
	Empty bunches	13.03	0.049	0.144	0.843	13.94
	Frond	11.21	0.225	0.159	0.809	14.55

Recent studies have estimated the agricultural production and the energy potential of agricultural residues in Thailand in the future years. The estimations are based on historical data of harvested land and production statistics from the Center for Agricultural Information[128]. Changes in production have been estimated on historical trends of two parameters: harvested area and product yield, while the other parameters are unchanged. Approximately 38% of the land in Thailand is cultivated, and 27% is covered by forests[129].

The amount of agricultural residue available for energy production during a year is estimated through the following formula:

$$\text{Residue available for energy} = \text{RPR} * \text{Annual production in the country}$$

The following table presents the estimated energy potential of agricultural residues[130].

[126] Residue product ratio (RPR) is defined as the amount of residue generated divided by the amount of agricultural product harvested. Source: Bhattacjaraya et al. (1999), p. 44.

[127] Sajjakulnukit et al. (2005)., p.215.

[128] Sajjakulnukit, Boonrod., and Verapong, Prasert (2003). *Sustainable biomass production for energy in Thailand.* Biomass and Bioenergy 25 (2003), p.558

[129] Sajjakulnukit et al. (2005), p.216.

[130] Sajjakulnukit et al. (2005), p.216.

Table 6-2 Energy potential for selected agricultural residues in Thailand[131]

Product	**Annual Production (Mt)**			**Residue**	**Residue available for energy (Mt)**			**Energy potential (PJ)**		
	1997	**2005**	**2010**		**1997**	**2005**	**2010**	**1997**	**2005**	**2010**
Sugar cane	56.39	63.61	68.58	Bagasse	14.10	15.90	17.15	90.65	102.15	110.14
				Top & trash	16.79	18.94	20.42	114.52	129.18	139.27
Paddy	22.33	23.73	24.66	Husk	5.14	5.46	5.67	66.01	70.15	72.86
				Straw (top)	6.83	7.26	7.54	60.29	64.08	66.56
Oil palm	2.69	4.03	5.20	Empty bunches	0.71	1.06	1.37	11.62	17.42	22.45
				Fiber	0.39	0.59	0.76	6.35	9.52	12.27
				Shell	0.08	0.12	0.16	1.40	2.10	2.71
				Frond	7.00	10.50	13.53	55.80	83.70	107.83
				Male bunches	0.63	0.94	1.21	9.31	13.96	18.00
Coconut	1.42	1.42	1.42	Husk	0.45	0.45	0.45	6.70	6.70	6.70
				Shell	0.18	0.18	0.18	2.96	2.96	2.96
				Empty bunches	0.07	0.07	0.07	0.96	0.96	0.96
				Frond	0.31	0.31	0.31	4.49	4.49	4.49

Concerning rice husk production (classified as "paddy husk" in the table above), Thailand is the fifth larger producer in Asia after China, India, Indonesia and Bangladesh[132]. However, the value of RPR, as well as fuel characteristics (such as carbon content and heating values), within the same country are strongly influenced by variations in soil quality, species of rice and locality, and by factors such as irrigation and farming practices. The data reported in table 6-1 and 6-2 reflect average measures based on a country-wised review[133].

The paddy harvested area in Thailand has been almost constant in the last ten years, at about 9.9 million hectares, while the production has increased due to the raise in product yield. Paddy fields occupy more than half of the total cultivated land[134]. An average increase rate of 0.7% has been used to predict the paddy yield for the year 2010, shown in the tables above. As mentioned, the approved consolidated methodology ACM0003 states that the key condition for recognizing a project within the CDM framework is that the alternative fuels available for the projects are at least 1.5 times the amount required to satisfy the needs of all users consuming the alternative fuels, in order to avoid negative leakages from alternative users.

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[131] Sajjakulnukit et al. (2005), p.216.

[132] Bhattacharaya et al. (1999), p.49.

[133] Bhattacharaya et al. (1999), p.50.

[134] Sajjakulnukit, B., and Verapong, P. (2003), p.558.

However, even if in a country-based perspective the paddy yield is predicted to increase, for the development of the CDM project under study it is indispensable to guarantee availability of biomass residues in the geographic area surrounding the production sites.

For the project developer, availability of rice husk in the vicinity of the cement plants is of key importance for two main reasons:

1. Rice husk is collected and transported by trucks to the cements plants. Emissions from the transportation of alternative fuels represent a fundamental aspect for the assessment of the overall CO_2 emission reductions resulting from the project;

2. Transportation costs affect significantly the financial performance of the project;

In Thailand rice husk is used in heat-consuming industries such as food processing mills, as well as in bricks manufacture, both as fuel and as raw material (ashes)[135]. Traditionally, the left-over from these activities has been burnt or landfilled.

Rice husk is being increasingly used as a fuel in power plants, as part of the renewable energy-based program supported by the Thai government[136]. Professor Salam Abdul, working at the Asian Institute of Technology, in Bangkok, has underlined that "industries start feeling the problem of insufficient supply of biomass, and the lending agencies first need to make sure that there is sufficient supply of biomass available"[137]. In particular, he was referring to the fact that the Thai Government "recently called for tenders for about 300MW power plants from Small Power Producers, mostly from biomass".

As said, availability of biomass is a key variable for CDM project implementation; the increasing competition among different users also contributes to a rise of market price, which in turn affects the internal rate of return (IRR) of the projects.

The availability of agricultural residues from paddy in the area surrounding the site where they are used should be assessed in advance in order to guarantee that the amount of residues available in the area is sufficient for the development of a CDM project.

6.2 Project overview

Cement industry in Thailand is heavily dependent on fossil fuels. The common practice in the country implies the extensive use of lignite locally available and imported coal. Imported coal results more expensive than lignite, but presents a higher calorific value. Since there are no legal obligations for cement companies to burn alternative fuels[138], following the common practice cement companies in Thailand are not likely to shift to the use of alternative fuel and will continue using fossil fuels as the only source for heat generation for clinker production.

Even with consideration for the increase in fossil fuels' price, in fact, the use of alternative fuels might not result attractive from a financial point of view. A sensitivity analysis would be

135 Phraepaisal, Wattana (2006, June 23). Personal interview.

136 Phraepaisal, Wattana (2006, June 23).

137 Salam, Abdul (2006, August 24). Written interview.

138 Phraepaisal, Wattana (2006, June 23).

necessary to check if the IRR of the potential project is in line with the company benchmark. Italcementi has three plants in Thailand:

- Takli Plant (2 kilns), in Nakhon Sawan area, about 250 km North of Bangkok;
- Pukrang Plant (2 kilns), in Saraburi area, about 110 km North-East of Bangkok. Numerous cement plants are in activity in this region of Thailand;
- Cha-am plant (1 kiln), in Phetchaburi area, approximately 160 km South-West of Bangkok, on the way to Malaysia.

Some provinces surrounding these plants are classified as less developed, with low income and poor infrastructures[139].

Some assumptions have been done for the purpose of this work, in order to develop the CDM project simulation. For simplicity we assume that rice husk is the only alternative fuel to be analyzed for the CDM project, following the consolidated methodology ACM0003, previously discussed. The simulation assumes the partial substitution of fossil fuels with rice husk in the three plants of Pukrang, Takli and Cha-am.

Table 6-3 shows the main characteristics of rice husk.

Table 6-3 Characteristics of rice husk[140]

Property	**Value**
LHV (lower heating value)	3,350 to 3,800 Kcal/kg
H2O	Around 10% water content
Density	• 100-150 kg/cubic meter loose • 200-250 kg/cubic meter if ground
Ash content	16-22%

The aggregated clinker production considered is assumed to be 5 Mt/year, for a crediting period of 10 years. We assume that the average mix of fuels used in the baseline scenario[141] is

[139] Institute for Global Environmental Strategies (IGES) and Office of Natural Resources and Environmental Policy and Planning (ONEP) (2006). *CDM Country Guide for Thailand,* p.101.

[140] Source: Italcementi Group

[141] The baseline scenario here is defined as the business as usual scenario (BAU), i.e. the continuation of the production process with the current fuel mix and no substitution with biomass.

composed for almost 2% of fuel oil (by heat) and for 98% of fossil fuels, of which about 50% is local lignite, and approximately 50% is coal imported from Indonesia.

In the baseline scenario about 770Mcal are used for each ton of clinker produced. The average emission factor for coal is assumed to be 96 kg CO_2/ton [142]. Biomass fuel is considered to be carbon-neutral.

Figure 6-1 Italcementi plants in Thailand[143].

The substitution rate is assumed to reach 5% by heat in all the cement plants in 2008, starting with a rate of 0.2% and 3% in 2006 and 2007, respectively. Given these assumptions, about 57,600 tons of rice husk per year are necessary at 5% substitution rate.

Rice husk is assumed to be transported by trucks to the cement plant. No compaction or grinding process would occur. It would be temporarily stored on site and transferred to the calciner via a belt conveyor.

The areas within an average radius of 50 km from the three cement plants should be monitored to assess rice husk availability for the CDM project.

[142] Source: Italcementi Group.

[143] Source: Italcementi Group.

7 Impact of CDM on sustainable development: the case of fossil fuel substitution in cement industry

As discussed in chapter 5, Thai authorities have provided a list of criteria that should be considered when developing a sustainability assessment.

However, the authorities have not specified or suggested any method for the development of such analysis. As in most cases, the approach adopted for the assessment depends on the choice of the project developer.

The following table shows the specific indicators that are going to be assessed in this work, in order to verify the impact of the CDM project under study on the criteria listed by Thai authorities. The indicators under analysis are the ones that are affected by the project. Therefore, the aspects for which no change can be observed are not analyzed.

Table 7-1 Selected indicators for sustainability assessment

Criteria	Sub-criteria	Indicator
Environment	• Promoting Environmental quality and GHG reduction.	Improve environmental quality – GHG emission reduction. **Under analysis** – Reduction of air pollution SO2, NOx, PM10. Not significant in this project. – Reduction of air pollution by other hazardous or toxic substances. Not significant in this project. – Reduction of water pollution. Not significant in this project. – Reduction of noise pollution. Not significant in this project. – Reduction of solid waste. **Under analysis** – Reduction of land contamination. Not significant in this project. – Reduction of odours from the project site. Not significant in this project.
	• Promoting reduction of natural resource utilization such as underground water and finite energy sources	– Include underground water conservation plan. Not significant in this project. – Reduce utilization of finite energy sources **Under analysis**
	• Conservation of biodiversity and natural and cultural heritage	– Maintain genetic species and ecosystem biodiversity. Not significant in this project.
Social	• Public participation is a major part of sustainable development , and in order to avoid community conflict, the project developer must seek permission from both local and national authority.	– The project has been presented to the local population, and due respect of their opinions on the project has been given. **Under analysis** – Local and national authorities approve the implementation of the project. **Under analysis**.

	• Capacity building of local stakeholders	– Training and employment of local staff. **Under analysis** – Training and employment of local suppliers. **Under analysis**
	• Improved access of local population to services	– Access to energy. Not significant in this project. – Access to other services. **Under analysis**
	• Occupational health and safety (OHS) for the workers at the site	– Exposure to air pollution and/or dust. **Under analysis** – Exposure to explosion risks. **Under analysis** – Exposure to chemicals. Not significant in this project. – Exposure to dangerous situations. **Under analysis**
Economic	• To promote local economy in the project area that would reflect national economy	– Employment (in years). **Under analysis** – Household income. **Under analysis**.
	• Efficient use of local resources	– Less energy used per product unit. **Under analysis**

Most criteria are assessed in this chapter through a more qualitative approach. The criteria are not weighted and are considered as having the same relevance. The present analysis does not include the development of ad-hoc quantitative indicators for the measurement of the criteria considered. The choice of a more qualitative approach has been mainly due to time constraints. Moreover, due to the current Thai institutional crisis, there has been no chance to contact designated members and to gain a better perspective of the aspects that might be prioritized in a detailed assessment, in order to have an idea of their relative importance. A more detailed sustainability assessment, developed according to one of the methods discussed in chapter 3, necessarily relies on availability of more detailed information and precise data.

7.1 Calculation of CO_2 emission reductions

The project boundary includes all production processes related to the production of clinker. In practical terms, this covers:

- pyro-processing and

- on-site transportation of alternative fuels.

Emission reductions outside the project boundary are referred to as leakages.

Both emission reductions inside and outside the project boundary (the latter are referred to as leakages) need to be taken into account:

1. Emission reductions within the project boundary. The following emissions should be taken into account:

a) Emissions from fuel burning. The alternative fuel defined in this hypothetical project activity is rice husk. According to the methodology ACM0003, CO_2 emissions from the burning of biomass residues should be considered CO_2-neutral, assuming that the generation of the biomass residues (and any associated emissions) occurs independently of the project activity"[144]. Therefore, emissions from rice husk combustion are equal to 0.

A specific moisture penalty[145] has been calculated for the combustion of biomass: since biomass residues are less homogenous than the finely grounded coal, the heat transfer efficiency in cement manufacturing process is reduced. Therefore the process requires a greater heat input to produce the same quantity and quality of cement clinker. The method of burning rice husk in the calciner results in a higher inleak of air and increases the heat consumption. Moreover, the moisture content of biomass, as compared to coal and lignite, requires higher heating of the moisture. The so-called moisture penalty (mp) applied to the CDM projects is estimated to be around 1 Mcal/ton of clinker at 1% of fossil fuel substitution[146].

The project specific penalty for year y is determined as follows:

$$\mathbf{MP_y\ total = C_{Pr,\,y} * (HC_{AF} * HC_{FF})}$$

Where :

MP_y = moisture penalty (TJ/year)

$C_{Pr,\,y}$ = clinker production for year y

HC_{AF} = specific fuel consumption on project case (TJ/tClinker) in year y

HC_{FF} = specific fuel consumption in the baseline when only fossil fuel is used, in TJ/t Clinker.

Following the ACM0003, other GHG emissions are not taken into account.

The following formula has been applied for the calculation of emission reductions from the project activities:

$$\mathbf{FF_{GHG} = [(Q_{AF} * HV_{AF}) - MP\ total] * EF_{FF}}$$

Where:

FF_{GHG}= emissions from the fossil fuels displaced by rice husk (t CO_2/year)

Q_{AF}*HV_{AF} = total actual heat provided by all alternative fuels (TJ/year)

144 UNFCCC. *ACM0003, p.5.*

145 The penalty results in a decrease in the emissions reductions associated to the use of rice husk, in order to take into account the lower efficiency of the manufacturing process when the usk is used.

146 Default value.

MP total= Total moisture penalty (TJ/year)

EF_{FF} = emission factor for fossil fuel displaced by (t CO_2/TJ). It is the estimated baseline value.

Aggregate values of CO_2 emission reductions from fuel combustion are presented in Annex 1. As the data show, the substitution of fossil fuels at a 5% rate generates an average emission reduction of approximately 66 ktons of CO_2/year.

b) Emissions from on-site transportation: power comparison.

Although coal has a higher heat value than rice husk and should require less transportation on conveyors, it has to be ground finely in the coal mill, which requires more energy. To maintain a conservative approach, the overall power consumption on-site is here assumed to be equal for rice husk and for the coal it displaces.

2. Emissions outside the project boundary (leakages).

The ACM0003 refers to CO_2 emissions outside the project boundary as leakages: these include emissions from open burning, anaerobic digestion of biomass in landfill, off-site transportation, and emissions related to off-site drying and compacting of biomass (if occurring).

In this work only emissions from off-site transportation of alternative and fossil fuels are analyzed in details. If the other aspects were taken into account, this would lead to a further reduction of CO_2 emissions associated to the CDM project activity. However, these reductions are hard to quantify because they would take place in different locations. Therefore, a conservative approach has been adopted, as it reduces the amount of emission reductions deriving from the project activities.

CO_2 emissions from transportation of rice husk to the cement plants have been calculated, and compared with the emissions from the transportation of coal.

a) Emissions from rice husk transportation.

Transportation of rice husk for the CDM project would be entirely carried out on road by trucks collecting the husk at the rice mills and delivering it to the plants. A fully-loaded truck can transport 10 tons of rice husk per trip, running on diesel. In order to transport the necessary quantity of rice husk (about 30 ktons), approximately 532 tons of CO_2/year would be emitted by the trucks running within an average radius of 50 km from the cement plants (see Annex 2 for calculations).

b) Emissions from displaced coal.

- Coal in the baseline is imported from Indonesia. Since specific data concerning sea-transportation are not available, values from a similar registered CDM project are used here to estimate CO_2 emissions from vessels[147]. The trip takes approximately 6 days in barge vessels with a capacity of 4,000 tonnes of coal per trip. Fuel consumption per trip is 30 tonnes of HFO 380.

The following tables present the data related to CO_2 emissions from transportation of coal from Indonesia.

Table 7-2 Emissions from barge vessels: Sumatra-Bangkok[148]

A	**B**	**C**	**D = (C/B)*A**	**E**	**F = D*E**
Total fuel per trip (tonnes)	Cargo weight (tonnes)	Coal replaced by rice husk (tonnes/year)	Total fuel consumption (tonnes/year)	Emission factor (t CO_2/tFuel)	Emission (t CO_2/year)
60	4,000	29,287	439.3	3.21	**1,410**

- After reaching Bangkok, the coal is transported by diesel boats to the provincial areas where the cement plants are located, through the canal system connecting the capital with these regions. The (weighted) average distance for the round trip is 90 km, and the capacity of each boat is 1,000 tons of coal[149].

  The total CO_2 emissions from coal water transportation are equal to 92.254 tons CO_2/year (see Annex 2 for calculations).

- Additionally, coal requires to be transported by trucks from the canals to the cement plants. 30-tonnes diesel trucks are used (the load transported is higher due to the higher density of coal as compared to rice husk); the (weighted) average distance for the round trip to the cement plants is 168 km[150].

  The total CO_2 emissions from trucks in the baseline are equal to 151.31 tons CO_2/year (see Annex 2 for calculations).

- To maintain a conservative approach, the avoided emissions from road transportation of coal in Indonesia (distance covered from the mining to the port) have not been included in this study.

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147 *UNFCCC. Project 0247. Replacement of Fossil Fuel by Palm Kernel Shell Biomass in the production of Portland Cement.*

http://cdm.unfccc.int/Projects/DB/DNV-CUK1137498953.91/view.html (2006, July 19)

148 *UNFCCC. Project 0247.*

149 The weighted average distance for water inland shipping has been calculated on the basis of the production share associated to the three plants.

150 The weighted average distance for trucks transsportation has been calculated on the basis of the production share associated to the three plants.

Table 7-3 synthesizes the data concerning CO_2emissions from off-site transportation in the business as usual scenario and in the CDM-project scenario.

Table 7-3 CO_2 emission reductions from off-site transportation[151]

Emissions from fossil fuels transportation (tons CO2/year)	**Emissions from transportation of rice husk (tons CO2/year)**	**Net reduction (tons CO2/year)**
1,654 (= 1,410 + 92.25 + 151.31)	532	1,122 (= 1,654 - 532)

Most CO_2 emissions come from the transportation of coal from Indonesia. However, since the local reserves of lignite in Thailand are shrinking, the imports of coal in the business as usual scenario is likely to increase, even in conjunction with higher prices. Therefore, assuming the other variables constant, the emissions associated to off-site transportation of coal would tend to increase over time.

The net emission reductions from off-site transportation in the CDM project, as compared to the baseline scenario, are equal to 1,122 tons CO_2/year.

7.2 Reduction of solid waste

As said, the use of biomass as an energy source can be regarded as an effective way to reduce accumulation of agricultural residues in the landfills or open-air combustion of the waste; it contributes to avoid CO_2 emissions, converting a waste product into a useful energy source. Therefore, the use of biomass energy is a means to optimize the use value of domestic energy resources, bringing economic benefits to the concerned local communities.

As previously discussed, the avoidance of GHG emissions related to landfilling or combustion of agricultural residues is the key condition for the applicability of the methodology ACM0003 for cement sector. However, because of the increased demand of biomass for alternative uses (power generation in the first place), mentioned above, the crucial issue for the project is to demonstrate the availability of agricultural waste for the CDM project (equal to 1.5 times the amount required to meet the consumption of all users consuming the alternative fuels).

Since the amount of residues landfilled or burnt is expected to decrease over time, it is difficult to fulfil this requirement and to ensure availability in the medium and long term. At the moment, it is questionable if leakages would occur as a consequence of the CDM project, and to which extent. It is possible, in fact, that the 57.6 kton of rice husk annually required for the CDM project under study would be used even if the CDM project was not implemented, as other users might need it for different purposes. Therefore, in case of limited supply of rice husk, other users might be forced to switch to fossil fuels, which would represent a leakage of the CDM project, and the overall environmental impact of the project activities would result negatively affected.

[151] *Source: author's own calculation*

Dr. Winai, from the Energy For Environment (EFE) centre, has stressed that the Thai Government has clearly expressed the intention to support biomass power plants but the collection of agricultural residues has not been fully organized yet[152]. Therefore, in some areas rice husk is already collected, while in other regions this might happen only in the next months or years. The impossibility to foresee future developments make it impossible for other biomass users to plan their activity. Since the Government might need rice husk for power production in the future, possible conflicts might arise with other potential users for the control of the biomass available. Furthermore, this is valid not only for rice husk, but also for other kind of agricultural residues that might be used as alternative fuels in industrial processes. Among these, residues from sugar cane and palm kernel shells are typical examples.

Given the uncertainty about biomass availability, it is particularly difficult to assess the possible contribution of the CDM project to reduction of solid waste and its effect on open-air combustion or disposal in the landfill: a reduction might happen anyway, thanks to other biomass users. Therefore, this aspect would need further investigation.

7.3 Reduced utilization of finite energy sources

As discussed above (see chapter 6), the Government of Thailand has been promoting the use of alternative fuels as one of the main goals of the national energy policies for the reduction of energy dependency

In this context, the implementation of CDM projects implying the use of alternative fuels contributes to improve the rational use of the resources locally available, reducing both the energy supply burden and the import of non-renewable energy in Thailand.

As discussed in the previous chapters, almost 30,000 tons of coals could be displaced annually through the CDM project. Since this coal is imported from Sumatra in the baseline scenario, this would imply a net reduction in fossil fuels' import and avoids the outflow of foreign currency for international trades.

The spread of similar projects through private or public initiatives hence can bring overall benefits to the country, reducing energy imports and improving the national balance of payments.

Moreover, similar projects might be promoted in order to use efficiently other kinds of agricultural residues locally available and potentially usable in other production processes.

Given the high variety of biomass and industrial processes available, there is a wide range of opportunities for further investigation. This is of key importance in a developing country like Thailand, where biomass waste from agricultural sector is abundant and easily accessible, and the dumping of agricultural residues or open-air combustion still represent common solutions.

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[152] Praphakornkiat, Winai (2006, July 12). Written interview.

7.4 Efficient use of local resources

Through this kind of CDM projects, cement industry in Thailand would rely increasingly on resources locally available, while the amount of fuels imported would be reduced. The use of rice husk hence represents an efficient solution because provides the possibility to obtain the same output (cement production), in terms of quality and quantity, through the substitution of imported fossil fuels with biomass that is cheaper and locally available.

Moreover, as previously discussed, the CDM project is based on the combustion of agricultural residues, and implies an efficient use of waste that traditionally did not have a economic value. Instead of being burnt or disposed of in a landfill, biomass is given an economic value, and becomes a valuable good traded in an organized market.

The competition for biomass and the availability of substitutes ultimately affect the market price of the husk, eventually influencing the revenues of local farmers (producers) and intermediate contractors (distributors). For instance, Professor Salam from the Asian Institute of Technology has stressed that in some areas in Thailand the price of rice husk increased from 200 Bath/ton up to 1,200 Bath/ton in a few months[153]. On one hand, the increased price represents a problem for project developers that need biofuels for their production processes; on the other hand, however, increased prices of biomass significantly affect the income of local farmers and contribute to a general enhancement of the economic conditions of the rural areas.

7.5 Local and national authorities approve the implementation of the project

In principle, the use of biomass is in line with the Governmental directions and objectives concerning the promotion of renewable energy and the valorisation of local resources, as well as the support to activities providing economic and social benefits to rural areas.

Given these guidelines, the CDM project under study might demonstrate consistency with national policies, as it seems to bring benefits at the local, national and global level. The project in fact could be regarded as an example of the transfer of competences and use of clean technology, creation of employment and business opportunities, and attraction of commercial transactions generating revenues both for local communities and for governmental units, in terms of administration taxes.

However, the emerging scenario also shows the competition for biomass resources arising among different private and public actors. The potential leakages arising need to be taken into account. If other biomass users had to switch to fossil fuels because of insufficient supply of rice husk, in fact, leakages would occur and the overall use of fossil, at the country level, would result unchanged (or increased) with respect to the baseline scenario. In this case the CDM project would not respect the formal requirements contained in the baseline methodology ACM0003, nor the DNA's sustainability guidelines, which ultimately would prevent the project from obtaining the validation and the national approval.

For instance, in a country like India, where rice husk has been extensively used for a multitude of production processes, there is currently no "unused rice husk" left, and a project

[153] Salam, Abdul (2006, August 24). Written interview.

activity promoting the use of rice husk as alternative fuel would automatically generate leakages and would not receive the host country approval[154].

On the other hand, CDM activities based on different methodologies (concerning, for instance, energy-efficient technologies) or on other alternative fuels might be encouraged.

Moreover, in order to get the final approval from the national authorities, a well-defined DNA needs to be established in Thailand.

7.6 The project should be presented to the local population, and due respect of their opinions on the project be given.

Stakeholders' dialogue represents a key component of CDM projects. Among the stakeholders, local communities represent fundamental actors directly affected by the project development. Their opinion and inputs therefore need to be taken into account carefully since the very beginning of the project. The PDD of all the registered CDM projects contains a specific section dedicated to stakeholders' dialogue.

Since the collection points for rice husk have not been clearly identified (the risk is to compete with rice mills that might get a supply contract with the government very soon), contacts with local communities and their representatives have not been established yet, and might start during the development of a future feasibility study.

As said, a study might be developed in the next future in order to assess the feasibility of the CDM project. During this initial phase of the assessment, contacts could be established between the Group and authorities and members of national boards, as well as with researchers, consultants and public institutions, in order to gain a better understanding of their opinion about CDM in Thailand and on this project, in particular. Moreover, in case biomas availability was ensured, the villages in the interested areas would be involved in oreder to include their opinion in the design document of the potential project.

7.7 Training and employment of local suppliers

When rice husk is used in production processes in Thailand, it is common practice that it is delivered to the production sites by farmers that are responsible both for the collection at the rice mills and for its transportation to the production sites. Local communities therefore result directly involved in all the activities connected to the sorting and final transportation of the husks. In case the areas interested by CDM projects are characterized by low incomes and poor infrastructures, the provision of new employment possibilities could have a significant positive impact on the communities involved.

The increased demand for rice husk is leading to an increase in its market price, which also means better conditions for farmers. The average income of a Thai farmer is about 600-700 dollars/year. An average annual increase of 5%-10% in the price of rice husk might have a significant impact on this income, especially if the demand keeps increasing.

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[154] Sutter, Christoph (2006, August 3). Telephone interview.

Moreover, the increase in volumes of biomass used for the project and in the number of collection points for CDM projects offers in fact the rationale for a better logistic organization of transports in the region. For instance, additional revenues for local communities might be generated through long-term rice husk supply contracts with local rice mills. This might imply an activity jointly managed by local farmers, for instance in the form of cooperatives organized on a geographical basis, managing collection, storage and delivery of biomass to the production sites. The activities involved hence might include both the transportation and the storage of rice husk. The storage represents the major problem from the logistical point of view, mainly because of the large volumes of rice husk required. Therefore, it should be managed outside the cement plant, possibly in the vicinity of the production sites, in order to guarantee prompt availability of fuel. A well-coordinated activity would be necessary especially with regard to the large number of vehicles involved for road transportation, and to the extension of the collecting area.

The increased road transportation would require the employment of local drivers for the trucks, in order to ensure the constant supply of rice husk to the production sites. This would directly benefit the communities living in the areas surrounding the plants, in terms of new employment opportunities. Additionally, new workers would be necessary to manage the storage facilities.

As said, all the activities mentioned above might be directed by farmers organized in local organizations. This would also be in line with the programs recently implemented in Thailand by the Asian Development Bank, aimed at providing credit for small farmers in rural areas for the establishment of agricultural enterprises: the goal was to increase farm incomes and create more jobs in the rural regions [155].

At the same time, however, the use of rice husk also implies a reduction in water transportation, previously used for coal. The number of workers responsible for transportation of coal along the canals in fact would be reduced: about 30 trips by boat would be eliminated in the CDM scenario, with respect to the baseline scenario. Assuming that an average number of 3 workers/trip are involved for the transportation of coal (and assuming 1 trip/day), this means that approximately 90 workers would see their activity reduced by 30 days/year.

7.8 Training and employment of local staff

The staff members working at the cement plant would deal with all the activities required for handling the rice husk, from its on-site storage and transportation to the final feeding into the calciner. The employees would check that the combustion process respects all the required parameters: fuel characteristics such as moisture content and heating values are among the variables that need to be constantly checked during the production process. Dust emissions and dispersion of particulates associated to the new fuel mix represent other elements to control.

The activities associated to the CDM project implementation would require both skilled and unskilled labour, offering new employment possibilities to qualified workers as well as to local people with no experience in cement manufacture, willing to find a stable occupation in

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[155] Asian Development Bank (ADB). *Support For Small Farmer Credit Project in Thailand.* http://www.adb.org/Documents/News/1996/nr1996015.asp (2006, July 25)

the area. Training programs should be organized at least in the initial phase of rice husk use in the plants, in order to clarify which phases would be mostly affected by the new fuel mix and would require higher attention.

As mentioned, the creation of new job opportunities and additional revenues for the communities living in rural areas represents a crucial issue in Thailand, where the agricultural sector still represents the first sector for number of people employed: more than 50% of the population in Thailand is still engaged in agricultural activities and depends on them for the livelihood. High gaps exist between farmers' and non-farmers' wages, and between rural and urban salaries. Therefore, there is a clear necessity to improve rural conditions and living standards. In this context, the distribution of national income might improve thanks to the CDM project. Another possible benefit concerns the creation of new job opportunities for female workers, especially in biomass sorting and collection, which could limit the migration of women forced by economic circumstances to seek work in urban areas.

The CDM project hence seems to have a potential for improving the living conditions of the workers in rural areas, in line with the programmes promoted by national and international initiatives.

7.9 Access to other services

As discussed above, the CDM project can bring additional economic inputs to the rural communities; these benefits are not only associated to associated to the improvements of the transportation system, indirectly facilitating the access to new services for the local communities. Increased need for transportation in the areas in fact also requires better infrastructures and creation of new services, including improved public transports for employees moving to and from the cement plants and for the families attracted to the working areas by new job opportunities.

In rural areas in Thailand villagers hardly have access to any kind of health services, while the education system is extremely poor, if it exists at all: only small schools in isolated villages, with a unique group of children ranging between six and ten years are available. In average, these small centres can be more than 2 hours far from bigger villages with basic services because of the lack of connections. At the same time, local villagers looking for jobs leave their villages and move to bigger town. Women's migration to urban centres is another phenomenon associated to the economic under-development of Thai countryside, to find employment in factories and service industries where they find low pay, labour-intensive jobs[156]. Older people are often left at the villages to take care of the children. The development of a CDM project can impact on the life conditions of rural communities providing an incentive for the construction of improved infrastructures and the provision of more frequent and safer connections with urban centres. For the villagers, this would mean increased access to basic services, institutions and fundamental facilities such as high schools, universities and hospitals.

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[156] Beth Mills, Mary (1999).*Thai Women in the Global Labor Force: Consuming Desires, Contested Selves.* Rutgers University Press, p.9.

7.10 Exposure to air pollution and/or dust

The transportation and the handling of rice husk on-site might be associated to the dispersion of dust and particulates in the air. The use of masks by the employees handling the husk helps preventing them from breathing the dust. In 2004 new policies were agreed upon by the management of the Group. The policies concerned the collection of data for pollutants, dust, silica and noise exposure at production sites. The decisions adopted on that occasion also concerned clinic general visit, audiometry, spirometry and chest X rays for employees, considered as required health surveys. The importance of updated, detailed collection of information at subsidiary or plant level was stressed. The outcome also consisted in the creation of an Operating Unit made of environmental experts and physicians, with the aim to visit subsidiaries in order to get information and start the monitoring activities.

7.11 Exposure to dangerous situations

Dangerous situation might arise from storage practices. In countries characterized by high temperatures, the risk of fires represents a major threat to the workers' safety and health, in particular to the safety of people working in the area surrounding the storing facility and handling the biomass. This is the case whenever rice husk is not stored or managed carefully, especially when the biomass is dry and left in areas where heat sources are located, the temperatures are high and the biomass is left uncontrolled. This risk is significantly higher during the Thai hot season, from March to May/beginning of June. On the other hand, however, availability of dry biomass is fundamental for ensuring a good combustion in the calciner, since significant efficiency losses are associated to higher moisture content in the biomass used.

The development of the CDM project might imply the installation of a facility for indoor storage to better control the husk. The storage in a close facility would limit the risk of fires through the use of smoke sensors and sprinklers.

7.12 Exposure to explosion risks

Rice husk is explosive and requires handling with maximum care. Experts dealing with safety issues have stressed the fact that, if indoor storage of rice husk can limit the risk of fires, on the other hand it results more dangerous for explosions[157]. Therefore, careful handling is required, and employees dealing with transportation and storage of the husk should be properly informed and trained to spread awareness of the dangers associated to the use of alternative fuels. Training courses on safety issues are part of the normal practices adopted in all the subsidiaries of the Group. In case the CDM project was implemented, explosion and fire risks deriving from the use of rice husk would be discussed as key issues in the courses.

7.13 Discussion

On the basis of the criteria provided by the Thai DNA, the CDM projects results sustainable as it is likely to bring economic and social benefits to the local communities besides bringing positive environmental impacts.

The impacts of the CDM project can be classified into two main categories:

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[157] Source: Italcementi Group.

a) Impacts from activities within the project boundary, i.e. the activities that are under the project developer's control, included in the phases of pyro-processing and on-site transportation ;

b) Impacts from activities outside the project boundary, defined as leakages.

The environmental benefits associated to CO_2 emissions reduction derive both from activities carried out on-site and off-site: the calculations concerning alternative fuel combustion have shown that the CDM project would bring a net reduction in CO_2 emissions of about 66 ktons/year with respect to the baseline scenario. At the same time, emissions from off-site transportation would be reduced by more than 1,100 tons CO_2/year.

The hypothetical project would be in line with the national strategy for the development of renewable energies, effectively contributing to limit energy imports and to an efficient use of resources locally available. It also results in line with the programmes implemented by international organizations and international initiatives aimed at promoting rural development in Thailand.

Both the CDM activities within the project boundary and outside the boundary could have positive impacts in terms of employment and training of local staff, positively affecting the economic conditions of the local communities in the areas in the vicinity of the production sites.. Besides providing employment opportunities at the cement plants, the project would create new jobs in the areas where the biomass is collected, providing the basis to local farmers for the development of cooperatives and associations for the sorting and transportation of the husk. Both skilled and unskilled labour would be necessary.

In terms of employment due to off-site transportation, the level of activity (in terms of potential jobs) created through the CDM project would be much higher than the level of activity interrupted as a consequence the decrease in the amount of coal transported by boat. The overall impact could result in improved income distribution and economic enhancement of the concerned areas.

At the same time the development of new infrastructures might represent an additional positive aspect associated to the CDM project and to the need for increased road transportation, improving the connections between rural areas and larger towns and urban centres. Access to basic services would result facilitated.

Health and safety issues need to be taken into serious account if the CDM project is to be developed, given the specific characteristics of rice husk, which results flammable and explosive. Specific training programmes hence shall be organized for the employees. This is valid both for employees handling the fuel on-site and off-site.

The main issue currently under discussion concerns the leakages arising from the potential competition for biomass resources between project developers and the Government supporting the use of rice husk in power plants. Since the quantity of biomass available is decreasing, in fact, it is questionable whether the amount of biomass available could satisfy the requirements of the baseline methodology ACM0003, applied in the case of fossil fuels substitution with alternative fuels in cement manufacture. In case of leakages, the environmental benefits associated to the use of rice husk as fuel in the cement calciners hence would be counterbalanced by higher CO_2 emissions from other industrial processes.

The institutional crisis contributes to create uncertainties on the concrete feasibility of the CDM project:

- unclear governmental plans, and the lack of a precise schedule concerning biomass requirements for power generation, result in uncertainties on the future availability of rice husk for cement plants, in the medium and long term;

- it is not clear if and when the new institutional capacity for CDM will be effectively operative, which makes the dialogue with stakeholders more complicated and leaves the effective implementation of CDM project totally dependent from the future, uncertain, institutional developments.

8 Conclusions

The Clean Development Mechanism (CDM) is one of the Flexibility Mechanisms for the achievement of the CO_2 emission reductions prescribed in the Kyoto Protocol to the United Nations Convention on Climate Change. The CDM has a twofold objective, since it is aimed to reduce GHG emissions while promoting sustainable development (SD) in developing countries. Therefore, within the United Nation Framework Convention on Climate Change (UNFCCC) context, the promotion of "sustainability" has gained relevance as a key objective for CDM projects. However, the Kyoto Protocol does not specify what "sustainable development" stands for. The definition of sustainable development over time has been extended to indicate a dynamic process involving concomitant progresses in the social, economic and environmental spheres. Sustainability nowadays is regarded as an overarching concept integrating multiple dimensions, reflecting to the so-called "triple bottom line" approach.

Observing the ongoing trends in CDM projects development, three main findings can be stressed: on one hand the number of CDM projects in the pipeline is growing rapidly, with the amount of certified emission reductions (CERs) expected to reach 550,000,000 by the end of 2012; on the other hand, for the majority of the projects in the pipeline, the sustainability component is addressed only as a minor aspect of the project design document. Moreover, the geographical distribution of CDM projects remains highly uneven and is concentrated on a limited number of technologies, usually characterized by low CO_2-abatement costs and by the cheap generation of CERs. This does not support sustainable development, which should be promoted on a more equal basis and should encourage technology transfer. These observations lead to the following conclusions:

a) Developing countries are benefiting differently from CDM implementation;

b) Sustainable development is not actually captured in the assessments of the projects. The second aim of the CDM, aimed at giving more relevance to sustainability issues in project development, is not achieved effectively at present;

b) The present trend is in contrast with the idea of the CDM as a means for reaching technological improvements in non-Annex I countries that were expected to leapfrog to cleaner technologies.

One of the main challenges in the development of CDM project activities consists in the concrete assessment of sustainable development at the project level, which implies a measurement of the project impacts on the three different dimensions mentioned above. Several approaches have been developed to evaluate the sustainability component of CDM projects through the use of both quantitative and qualitative indicators. Some methods suggest a weighing of different sustainability criteria, in order to reflect their relative importance in different contexts. This procedure might imply the involvement of representatives from different social groups. This is typical of methods like MATA-CDM, and is aimed to reflect the preferences of the stakeholders most affected by the project implementation. Other methods, such as the one developed by the non-governmental organization SouthSouthNorth, do not imply any hierarchy in the classification of the criteria, which are all given the same weight. The project developer should choose the assessment method that seems more suitable in the context where the CDM project activities are developed.

In order to be regarded as "sustainable", CDM projects are required to meet the development objectives defined by the Designated National Authorities (DNAs) of the host countries that are free to develop their own list of criteria and indicators, on the basis of the aspects that are considered of prior importance within each national context. Sustainability guidelines or criteria can be used by the DNAs for this purpose. However, during this work it has been underlined that significant difference exist between theory and practice: even if a plurality of assessment methods is available, detailed sustainability assessments are seldom performed for CDM projects. Experts have stressed that the final evaluation of the sustainability component remains exclusive competence of the DNAs that often adopt wide, badly defined guidelines and criteria, in order to attract more investments in their countries. On the other hand, the interviews conducted have highlighted that this is the direct consequence of how the CDM itself was designed: in the Marrakech Accords it was specified that it is exclusive prerogative of the host countries to define their own priorities with regard to sustainable development. No interferences from developed countries can be accepted. In most cases the project developers do not have any incentive to perform detailed sustainability assessments because they simply have to ensure that the project meets the minimum requirements developed by the local authorities.

Moreover, in developing countries additional obstacles such as high transaction costs and lack of information and institutional capacity contribute to make sustainable development assessments complex and time consuming, which further discourages project developers from performing accurate analysis. Furthermore, methods based on a quantitative approach usually require availability of reliable data, and time and costs might increase during the collection of information for the sustainability assessments. This is probably another reason that contributes to make the sustainability assessments presented in the PDDs (Project Design Documents) more qualitative in nature.

Better-defined practices and a deeper experience in the field would contribute to make sustainability assessments easier and probably more consistent with the overall goal of the Kyoto Protocol. At the moment, it seems that the only incentive for a project developer to perform a detailed assessment is in terms of image and/or personal commitment to the issue of sustainable development.

Cement manufacture is one of the major sectors targeted within the UNFCCC framework, being responsible for 5% of the world's man-made CO_2 emissions, and originating about 2 billion tons of CO_2/year. Approximately 70% of these emissions come from developing countries, where the production is expected to increase in the next years. Italcementi is one of the multinational cement groups that gave birth to the Cement Sustainability Initiative (CSI), aimed to address the issue of sustainable development within the cement industry. The CDM offers a framework for the adoption of initiatives and innovative projects in line with the goals pursed through the CSI, tackling environmental issues while impacting the social and economic dimension.

Given the plurality of environmental aspects related to cement sector, several methodologies have been developed within the UNFCCC framework for cement sector. The potential CDM project discussed in this work follows the consolidated methodology ACM0003 approved by the UNFCCC Executive Board. It would imply the use of rice husk as an alternative fuel in the calciners of three cement plants located in Thailand. Fuel combustion is a critical issue as it accounts for approximately 40% of the emissions from cement sector. In the potential project presented, rice husk would be used in the calciners at a substitution rate of 5% by heat, displacing an equivalent (by heat) amount of coal, which is imported from Indonesia in the baseline scenario. A feasibility study could be developed in the future, with the aim of assessing biomass availability within a radius of 50km from the cement plants.

To assess the sustainability of the potential project described, the author of this work has assessed the possible impacts of the project on the (tentative) indicators and criteria suggested by the Thai authorities, selecting the indicators that seemed more relevant with respect to the CDM project under study.

The approach adopted to assess the potential impacts of the CDM project has been mainly qualitative in nature. This choice has been motivated by time constraints as well as by the scarce amount of data available at present. Methods based on a more quantitative assessment, such as MATA-CDM, could be used in the future for a detailed assessment, but would require a longer period and precise data sets to analyze.

The analysis performed has shown that a CDM project could have positive impacts in terms of net CO_2 emission reductions. Emissions from fuel combustion could be reduced by more than 66,400 tons CO_2/year. At the same time, more than 1,100 tons of CO_2/year would be avoided thanks to the reduced off-site transportation of coal from Indonesia. On-site emissions from transportation are estimated to be equal in the baseline and in the project scenarios.

The project could have positive or neutral impacts with regard to all the other criteria assessed. The project might bring social and economic benefits in terms of job creation and economic inputs to the rural areas where rice husk would be collected, sorted and transported. Access to services, infrastructures and communications between rural and urban centres could result improved as well. The project would also result in line with national strategies for the promotion of alternative energy sources and efficient use of local resources. Safety and health issues require prior attention due to high flammability and explosion risk characterising rice husk. Training of local staff and suppliers therefore needs particular attention.

The critical aspect to assess concerns the availability of biomass in the geographic areas concerned. Rice husk availability is a fundamental requirement for the CDM project for two main reasons:

1. Sufficient availability is explicitly mentioned in the ACM0003 as a condition to avoid leakages. The ACM0003 is applicable only "if the alternative fuels available for the projects are at least 1.5 times the amount required to meet the consumption of all users consuming the alternative fuels". In case of insufficient husk, in fact, other users of biomass might have to switch to fossil fuels and the CDM project would not bring around any effective environmental benefit. Insufficient biomass supply would prevent the project from being approved both at the national and international (UNFCCC) level.

2. Biomass supply needs to be ensured in the vicinity of the production sites for the CDM project to be economically feasible and environmentally sustainable.

Transportation costs and related off-site CO_2 emissions would increase and the project might result less (or not) attractive for the Group.

The main difficulty in assessing rice husk availability in the medium and long term is related to the renewable energy programme promoted by the Thai Government, promoting the use of alternative energy as a way to enhance energy security and to improve the balance of payments. The extensive use of rice husk and other agricultural residues for power production is an example of the line adopted by the Thai authorities. These dynamics create competition among potential users of alternatives fuels, i.e. private investors and public companies competing for biomass resources, which eventually has brought to a steady rise in the price of rice husk in many areas. Moreover, uncertainties derive from the fact that Thai institutional framework is currently in a frozen phase, which limits visibility and makes extremely difficult to predict the plans that the Thai Government will promote in the next months/years. Critical issues concern the extent to which Thai authorities will further support the use of biomass, as well as the areas where this will occur with major intensity, and the amount of husk that will be used for power production.

Furthermore, there are still some uncertainties about future developments of CDM regulatory framework in Thailand, such as the identification of concerned authorities, the national project approval procedure, and the effective functioning of the mechanism. The unclear definition of competences and responsibilities contributed to make it more difficult for the author to conduce interviews with members of the Thai Government: no formal roles have been appointed or are operative at the moment, and the DNA has still to be established, so that there is no designated authority to refer to. The new elections of the Thai Parliament are expected for October 2006. After the elections a formal unit for CDM implementation is expected to be appointed in the country.

Therefore, the proposed CDM project could result in principle beneficial with regard to the majority of the criteria considered, bringing social and economic benefits to the local communities involved. However, the risk of leakages –increased by the lack of transparency concerning governmental plans- impacts on the actual achievement of CO_2 emissions abatement, in turn affecting the overall feasibility of the project.

Thailand offers an example of a developing country where the national institutional and political crisis represents the first obstacle for the effective implementation of CDM projects that can reduce CO_2 emissions and may improve sustainable development (as in the case study presented here). The lack of transparency and the limited visibility on the medium and long term are probably the main obstacles to CDM-related investments. The immediate consequence of this situation is the delay in the attraction of potential CDM projects that could dramatically benefit the country in terms of environmental impacts and, besides this, contribution to local economies and community development, transfer of technologies and know-how. The national institutional framework characterizing developing countries results the ultimate variable affecting the actual implementation and the final success of the Clean Development Mechanism, as it limits the development of projects with a significant potential for the effective promotion of sustainable development.

List of abbreviations

ADB	Asian Development Bank
AHP	Analytical Hierarchical Process
AIT	Asian Institute of Technology
BAU	Business As Usual
CC	Climate Change
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CoP	Conference of The Parties
COP/MOP	Conference of the parties/Meeting of the parties
CSI	Cement Sustainability Initiative
DNA	Designated National Authority
EFE	Energy For Environment
EM	Emission Trading scheme
EB	Executive Board
EIA	Environmental Impact Assessment
EPPO	Energy Policy and Planning Office
EQA	Enhancement and Conservation of the Natural Environmental Quality Act
ETS	European Trading Scheme
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GHG	Green House Gases
GJ	Gigajoules
IARC	International Agency for Research on Cancer

IGES	Institute for Global Environmental Strategies
IPPC	Intergovernmental Panel on Climate Change
IRR	Internal Rate of Return
JI	Join Implementation mechanism
LHV	Lower heating value
MAUT	Multi-Attribute Utility Theory
MONRE	Ministry of Natural Resources and Environment
Mp	Moisture Penalty
MWh	Megawatt hours
NEB	National Environmental Board
NESDB	National Economic and Social Development Board
OEs	Operational Entities
ONEP	Office of Natural Resources & Environmental Policy & Planning
PDD	Project Design Document
PIN	Project idea note
RPR	Residue product ratio
RPS	Renewable Portfolio Standard
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SD	Sustainable Development
SS	Small-Scale
SSN	SouthSouthNorth
UNEP-RRCAP	United Nations Environment Programme - Regional Resource Centre for Asia and the Pacific
UNFCCC	United Nation Framework Convention on Climate Change
WWF	World Wilde Fund

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Annex 1

Year		unit		2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Biomass substitution rate		%		0,2%	3,0%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Moisture penalty	**mp**	Mcal/tcl/1% substitution	1											
Moisture penalty	**mp**	Mcal/tcl/% substitution		0,2	3	5	5	5	5	5	5	5	5	5
Total mositure penalty	**Mptot**	Mcal/year		1000000	15000000	25000000	25000000	25000000	25000000	25000000	25000000	25000000	25000000	25000000
	Mptot	TJ/year		4,1	61,5	102,5	102,5	102,5	102,5	102,5	102,5	102,5	102,5	102,5

Data														
Aggregated Prod	(Clinker)	ton		5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000	5000000
Heat cons. fuel	baseline	Mcal/tcl		770	770	770	770	770	770	770	770	770	770	770
Alternative fuel	cdm	Mcal/tcl		*2*	*23*	*39*	*39*	*39*	*39*	*39*	*39*	*39*	*39*	*39*
Fossil fuel	cdm	Mcal/tcl		*769*	*750*	*736*	*736*	*736*	*736*	*736*	*736*	*736*	*736*	*736*
Heat consumption	cdm	Mcal/tcl		*770*	*773*	*775*	*775*	*775*	*775*	*775*	*775*	*775*	*775*	*775*
Fossil fuel	baseline	Gcal		3850000	3850000	3850000	3850000	3850000	3850000	3850000	3850000	3850000	3850000	3850000
Fossil fuel	baseline	ton		668171	668171	668171	668171	668171	668171	668171	668171	668171	668171	668171
Fossil fuel	cdm	Gcal		3843298	3749050	3681250	3681250	3681250	3681250	3681250	3681250	3681250	3681250	3681250
Fossil fuel	cdm	ton		667007,64	650650,82	638884,07	638884,07	638884,07	638884,07	638884,07	638884,07	638884,07	638884,07	638884,07
Fossil fuel	d	ton		1163,14	17519,96	29286,71	29286,71	29286,71	29286,71	29286,71	29286,71	29286,71	29286,71	29286,71

1cal = 4.1 J

Coal heating value		Mcal/ton		5762	5762	5762	5762	5762	5762	5762	5762	5762	5762	5762
alternative ht. value	**HV_{AF}**	GJ/ ton		13,79	13,79	13,79	13,79	13,79	13,79	13,79	13,79	13,79	13,79	13,79
		Mcal/ton		3363	3363	3363	3363	3363	3363	3363	3363	3363	3363	3363
alternative fuel	**Q_{AF}**	ton		2290	34478	57612	57612	57612	57612	57612	57612	57612	57612	57612
Fossil Fuel Em.Factor	**EF_{FF}**	tCO_2/TJ		96	96	96	96	96	96	96	96	96	96	96

Calculation of the baseline GHG emissions from the fossil fuels displaced by rice husk

$$FF_{GHG} = [(Q_{AF} * HV_{AF}) - MP_{total}] * EF_{FF}$$

$FF_{GHG=}$ emissions from the fossil fuels displaced by rice husk

$MP_{total=}$ Total moisture penalty **Biomass penalty: 1Mcal/tcl/1% substitution**

		2006	2007	2008	2009	2010	2011	2012	2013
		27,48	413,95	691,97	691,97	691,97	691,97	691,97	691,97
CO2 savings, total tons	**FF_{GHG}**	**2638,28**	**39739,55**	**66429,40**	**66429,40**	**66429,40**	**66429,40**	**66429,40**	**66429,40**

Annex 2

Emissions calculated from distance travelled

		WEIGHTED AV. DISTANCE, ROUND TRIP
Coal	Distance covered by boat (BKK-Provinces)km)	90
	Distance covered by trucks (km)	168
Rice husk	Distance covered by trucks (km)	100

	Transportation Activity						**CO_2 emissions**				
									Total emissions		
	Transport description	Activity per vehicle (round trip, Km)	Load per vehicle (tonnes)	Total load transported (tonnes/year)	Number of trips/year (round way)	Activity unit	Kg CO_2/unit	Kg CO_2/km	**Kg CO_2/year**	**Tonnes CO_2/year**	
Coal REPLACED	**Boat transport: shipping from Sumatra**									**1410,00**	Calculated following Lafarge CDM project in Malaysia.
	Boat transport: Inland shipping	90	1000	29287	29,287	Metric tonne kilometers	0,0350	35	92254,05	**92,25**	
	Road transportation	168	30	29287	976,23	Vehicle kilometers	0,9226		151306,6656	**151,31**	
	(diesel heavy truck 7 mpg)										
Rice husk USED	**Road transportation**	100	10	57612	5761,2	Vehicle kilometers	0,9226		531505,9105	**531,51**	
	(diesel heavy truck 7 mpg)								**Avoided emissions**	**1122,05**	