CLEAN DEVELOPMENT MECHANISM (CDM)

investor guide

Brazil

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

economy environment employment

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Foreword

Global problems require global solutions and innovative policy instruments. They also require considerable cooperation within the international community and among its institutions, including those of the United Nations, in order to forge the necessary capacity at all levels to achieve the desired policy targets.

Such has been the experience of UNIDO in implementing its component of the global project that brought together three United Nations agencies — UNDP, UNIDO, UNCTAD — as well as UNFCCC, which has been generously supported by UNF funding.

To combat the growing global threat of climate change from increasing anthropogenic greenhouse gas (GHG) emissions, the international community agreed on the Kyoto Protocol in 1997 in Kyoto, Japan. Since then the global efforts led by the United Nations have concentrated on elaborating rules and modalities for the implementation of the Kyoto Protocol and its mechanisms, particularly the Clean Development Mechanism (CDM).

The CDM and other Flexibility Mechanisms of the Kyoto Protocol offer the world for the first time a unique opportunity to deliver cost-effective GHG emission reductions while at the same time advancing sustainable development and the transfer of cleaner, energy-efficient technologies and processes that hold the promise of reduced environmental effects, less costly energy services and ultimately improved competitiveness and greater access to global markets.

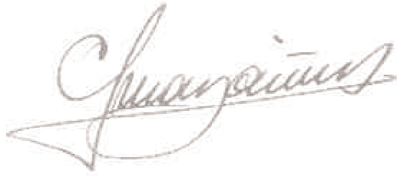
While rules and modalities for the CDM has been largely completed with the guidance provided by the Marrakech Accords and the subsequent COP meetings, the technical details of CDM project development and promotion remain complex, resulting in prohibitively high transaction costs, particularly for small-scale projects.

A considerable capacity-building effort is required by the international community to enable developing countries to participate in the CDM. UNIDO, in cooperation with UNDP, UNCTAD and UNFCCC, has been actively involved in assisting Member States gain greater knowledge and expertise on technical issues pertaining to the identification and design of CDM projects in industry.

The CDM Investor Guide for Brazil is an example of the UNIDO contribution to the capacity-building effort undertaken by the United Nations and those of its agencies for help developing countries, in this case Brazil, to attract CDM investment. The report provides much detail on Brazil´s energy system and the industrial sectors that have considerable mitigation potential and are likely to become central to CDM activities, as well as details on the institutional and organizational mechanisms that shape the CDM process in the country.

The report also provides an up-to-date list of on-going projects together with contact addresses for project sponsors and developers. The Guide will serve as a tool in helping Brazil establish bilateral ties with potential CDM investors in Japan through the UNIDO Industrial and Technology Promotion Office (ITPO) in Tokyo. The UNIDO network of ITPOs will be used in the future to help other Member States to build their national capacity for CDM and forge ties with potential CDM investors abroad.

The CDM Investor Guide for Brazil is the first in a series of similar publications that will address CDM as an investment mechanism to leverage investment in industrial projects that deal with the mitigation of the GHG emissions associated with industrial production and the industrial use of energy. The next issue of the Guide will be devoted to South Africa and will focus on bringing GHG abatement project potential in the industrial sector to the attention of potential investors through UNIDO´s ITPO network.



Summary

Brazil was the first country to sign the United Nations Framework Convention on Climate Change (UNFCCC), on 4 June 1992, and the Brazilian National Congress ratified it on 28 February 1994. The Convention entered into force for Brazil on 29 May 1994, 90 days after its ratification by the National Congress.

Brazil also played a seminal role in the development of the Clean Development Mechanism (CDM). In party discussions before the Third Conference of the Parties (COP3), held in Kyoto, Japan, in 1997, the Brazilian government proposed that, if a developed country exceeded its greenhouse gas (GHG) emissions requirements, an economic penalty would be assessed, and this would be collected in a Clean Development Fund. Monies from this fund would be directed to developing countries, which, then, would use these funds for mitigation projects designed to prevent or mitigate global climate change. During the COP3 discussions the proposal evolved into the CDM, a full-fledged flexibility mechanism of the Kyoto Protocol.

This "CDM Investment Guide for Brazil," aims at providing CDM project proponents in the country, and CDM investors interested in CDM opportunities in the country, with reliable, updated sources of information regarding CDM opportunities in the energy and industrial sectors of Brazil. Although it is apparent that CDM could operate in other sectors of the Brazilian economy as well, including the potential applicability of CDM sinks in the forestry sector, or the potential for CDM projects in the transportation sector as well, the focus of this report is the energy and the industrial sectors.

The report was produced from February 2002 through February 2003 and provides:

- An overview of the institutional infrastructure for climate change/Kyoto Protocol activities and the current views and position of Brazil respect to climate change issues;
- An analysis of the energy sector in Brazil, discussing the potential, and priorities, for CDM projects in both the supply and demand sides;
- An analysis of the industrial sector in Brazil, discussing the potential, and priorities, for CDM projects in this sector with respect to process change, fuel substitution and energy efficiency gains;
- A review of the current state of CDM project development in Brazil, types of projects, location, status of development, etc;
- Some final conclusions; and
- A list of institutions/organizations that are involved with climate change and CDM activities in Brazil, and that could be a useful source of information and contacts for CDM project proponents and investors in Brazil.

The main findings of the report are that:

- Global climate change and greenhouse gas emissions are perceived as being very important issues for Brazil, and the country is, indeed, conducting a variety of efforts in the area of climate change and CDM (including the development of criteria and indicators for appraising CDM projects in the country). Brazil already has an institutional infrastructure for climate change that is well-prepared to deal with CDM projects, including the Interministerial Commission on Global Climate Change, created for the purpose of coordinating the actions of the government in this area, with the authority to verify whether CDM project activities conform with the sustainable development objectives of the country and, if so, emit a formal approval of the CDM project activities in Brazil;

- A large potential for CDM projects does exist in the energy sector in the country in the areas of fuel substitution and energy efficiency, as the 1980s and 1990s were years marked by a growing share of fossil fuels use in Brazil's energy sector. CDM project activities in the energy sector of Brazil are a way of helping reverse this trend, since renewable energy sources (in the form of sugarcane products, wood, urban solid and agricultural wastes, hydroelectricity, solar and wind resources), and potential efficiency gains in energy production/generation and transportation/transmission/distribution, are widely available in the country as substitutes for fossil fuels, and as such can potentially reduce carbon emissions by avoiding, or postponing, the consumption of non-renewable, carbon-intensive, fuels;

- A large potential for CDM projects does exist in the industrial sector in the country in the areas of process change, energy efficiency and fuel substitution, as basic materials industrial subsectors (aluminium, cement, chemicals, ferroalloys, iron and steel, pulp and paper, etc) are responsible for an important share of total energy use, and total carbon emissions, by industry in Brazil. CDM project activities opportunities are widely available in these industrial subsectors not only because these subsectors have, on average, a relatively high specific energy consumption (energy use per ton of product produced) (and as such, in most cases, high specific carbon emissions) compared to the specific energy consumption (specific carbon emissions) associated with the deployment of the best production technologies available worldwide, but also because process heat and direct heat based on the use of carbon intensive, fossil fuels are an important share of end-uses in industry in the country, and these demands can be very easily met, in most cases, by the use of renewable energy sources that are widely available in Brazil, or through the use of combined-heat and power production in specific industrial subsectors (particularly in chemical plants, iron and steel plants, oil refineries, pulp and paper industries, and sugar mills);

- Various CDM project development activities and types are currently underway in the country at different stages (under consideration, in preparation, or ready to be submitted as a CDM project), which may be eligible for validation provided they are registered by 31 December 2005. This confirms the perception that Brazil is seen by the international business community as one as one of the most promising countries to host future CDM projects. These project activities are highly concentrated in three main mechanisms for carbon abatement: use of renewable energy sources, cogeneration or energy efficiency measures to displace energy obtained from carbon-intensive, fossil fuels; and

- Because expertise is held by a relatively small group of governmental and university officials, there is an urgent need for CDM capacity building in Brazil.

In summary, Brazil is fully aware of the many technical and political issues that surround CDM formulation and implementation. And a high potential for CDM does exist in various sectors of the Brazilian economy, in particular in the energy and industrial sectors as outlined here. As a matter of fact, the Brazilian scientific and technical expertise to deal with the climate change and the Kyoto Protocol issues is probably unique among developing countries. However, such expertise is held by a relatively small group of governmental and university officials, with high level decision-makers, both at the governmental and private sectors, normally showing little familiarity with the various and complexes issues involved in the global climate change discussions in general, and in the CDM processes in particular. As a consequence, effort should be made, both domestically and internationally, for further capacity development for CDM in Brazil.

Explanatory notes

AA	Assigned amounts; GHG emissions assigned to Annex I countries under the Kyoto Protocol
AIJ	Activities Implemented Jointly; projects conducted with the objective of establishing protocols and experiences, but without allowing carbon credit transfers between developed and developing countries
ANEEL	Brazilian Regulatory Commission for Electrical Energy
BNDES	Brazilian National Bank for Development
CDM	Clean Development Mechanism
CEBDS	Brazilian Business Council for Sustainable Development
CENTROCLIMA	Centre for Integrated Studies on Climate Change and the Environment
CER	Certified Emissions Reduction; the carbon dioxide credit unit generated from CDM project activities
CNP	National Petroleum Council
CONPET	Oil Products and National Gas Rational Use National Programme
COP	Conference of the Parties; Conference of the Parties oversees global negotiations on climate change until the Kyoto Protocol is ratified
COPPE/UFRJ	Post-graduate School of Engineering of the Federal University of Rio de Janeiro, Brazil
DRSAMBBAA	De Rosa, Siqueira, Almeida, Mello, Barros Barreto e Advogados Associados (Law Firm)
ERU	Emissions reduction unit; the output of CDM or JI projects
ET	Emissions trading
FAPERJ	State of Rio de Janeiro Science Foundation
FBDS	Brazilian Foundation for Sustainable Development
FIESP	Industry Association of the State of São Paulo
FNMA	Brazilian National Fund for the Environment
gC	Grams of carbon
GDP	Gross domestic product
GDP PPP	Gross domestic product in purchasing power parity
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change; body established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to provide scientific, technical and socio-economic advice on climate change issues to the world community and in particular to the 170-plus Parties to the United Nations Framework Convention on Climate Change (UNFCCC)
IPP	Independent Power Producer
IVIG	International Virtual Institute for Global Change; research centre of COPPE/UFRJ.
JI	Joint Implementation
kgC	Kilograms of carbon
kgoe	Kilograms of oil equivalent; the amount of energy equivalent to 45,200 joules
LIMA	Interdisciplinary Environmental Laboratory; research centre of COPPE/UFRJ
MCT	Ministry of Science and Technology of Brazil
MMA	Ministry of Environment of Brazil
MMA/SQA	The Human Settlements Environmental Quality Secretary of the Ministry of Environment of Brazil
MME	Ministry of Mines and Energy of Brazil
MtC	Million tons of carbon
MRE	Ministry of Foreign Affairs of Brazil
ODA	Official Development Assistance; funding provided by various multilateral development banks and development agencies to developing countries

OE	Operational Entity; certification body that is eligible to validate a CDM project activity
PDD	Project Design Document; document that is the output of the Project Design phase of the CDM
PPE	Energy Planning Programme; teaching and research centre of COPPE/UFRJ.
PROCEL	Brazilian National Electricity Conservation Programme
QUELRO	Quantified Emission Limitation and Reduction Obligation
SP	Self Production of electricity
SSN	South-South North Project
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICA	Sugar Cane Agro-Industry Union of the State of São Paulo
UNOPS	United Nations Office for Project Services
USP	University of São Paulo
WBCSD	World Business Council for Sustainable Development
1MWh = 0,086 Mtoe	One million watt-hour of electricity is equivalent to one million metric tons of oil equivalent
toe	Ton of oil equivalent; the amount of energy equivalent to 45,200 thousand joules

Abstract

This “CDM Investment Guide for Brazil,” aims at providing Clean Development Mechanism (CDM) project proponents and CDM investors interested in CDM opportunities with a reliable, updated source of information concerning CDM opportunities in the energy and industrial sectors of Brazil. The report was prepared from February 2002 to February 2003 and provides:

- An overview of the institutional infrastructure for climate change/Kyoto Protocol activities and the current views of Brazil on climate change issues;
- An analysis of priority sectors for CDM projects in the energy sector in the country;
- An analysis of priority sectors for CDM projects in the industrial sector in the country;
- The current state of CDM project development in the country;
- Conclusions; and
- An appendix with a list of institutions/organizations that are involved in climate change and CDM activities in Brazil, which are useful source of information and contacts for CDM project proponents and investors in the country.

The main conclusions of the report are as follows:

- Brazil is conducting a variety of efforts in the area of climate change and CDM (including the development of criteria and indicators for appraising CDM projects in the country) and has an institutional infrastructure for climate change that is well prepared to deal with CDM projects;
- A large potential for CDM projects exists in the energy sector in the areas of fuel substitution and energy efficiency in the country;
- A large potential for CDM projects exists in the industrial sector in the areas of process change, energy efficiency and fuel substitution in the country;
- Various CDM project development activities are currently underway in the country, which may be eligible for validation provided they are registered by 31 December 2005; and
- Because expertise is held by a relatively small group of governmental officials and researchers, there is an urgent need for CDM capacity-building in Brazil.

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Introduction

Brazil played a seminal role in the development of the Clean Development Mechanism (CDM). In party discussions before the Third Conference of the Parties (COP3), held in Kyoto, Japan, in 1997, it proposed that, if a developed country exceeded its greenhouse gas (GHG) emissions requirements, an economic penalty would be assessed, and this would be collected in a Clean Development Fund. Monies from this fund would then be directed to developing countries, which, then, would use these funds for mitigation projects designed to prevent or mitigate global climate change. During the COP3 discussions the proposal evolved into the CDM, a full-fledged flexibility mechanism of the Kyoto Protocol.

From the decisions made during the Seventh Conference of the Parties (COP7), held in Marrakech, Morocco, in 2001, any project activity starting after 1 January 2000 will be eligible for registration and earn Certified Emissions Reductions (CERs) as long as it meets the interim criteria for CDM projects agreed upon there. The Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) adopted as its Eighth session (COP8), held in New Delhi, India, in 2002, the modalities and procedures for the small-scale CDM projects and rules and procedures covering the work of the CDM Executive Board. Thus, enough regulatory and methodological structure has been put in place to support the uptake of CDM projects and it is reasonable to expect that there will be a significant increase in CDM project activities in the near future, probably in 2003. This prompt start of the CDM asks for reliable and updated sources of information regarding CDM opportunities in countries considered attractive for CDM projects.

This report, "CDM Investment Guide for Brazil," GLO/99/HO6/A/IV/31A, aims at providing CDM project proponents in the country, and CDM investors interested in CDM opportunities in Brazil, with reliable, updated sources of information regarding CDM opportunities in the energy and industrial sectors. Although it is apparent that CDM could operate in other sectors of the Brazilian economy as well, including the potential applicability of CDM sinks in the forestry sector, or the potential for CDM projects in the transportation sector as well, the focus of this report is the energy and the industrial sectors. In the future, other reports should also cover these other sectors as well.

The report was written by a team of national experts in the field of energy planning and climate change from the Energy Planning Programme (PPE), Graduate School of Engineering (COPPE), Federal University of Rio de Janeiro (UFRJ), a leading academic institution in this field in Brazil. The drafting and research team was led by Dr. Roberto Schaeffer, Associate Professor at UFRJ. Research assistance and contributions were provided by Dr. Claude Cohen and Dr. Ricardo Cunha, both Associate Researchers at UFRJ. This report was prepared as a part of the activities of UNIDO carried out within an inter-agency project entitled "Engaging the Private Sector in Clean Development Mechanism". The project is implemented by UNDP, UNIDO and UNCTAD in cooperation with the UNFCCC and with the support of the United Nations. Foundation. The implementation of the UNIDO component is managed by Ms. M. Ploutakhina, Industrial Development Officer at the UNIDO Industrial Energy Efficiency Branch.

The report was initiated in February 2002 and ended in February 2003, and is structured in five sections and five annexes, so as to cover its following six original objectives:

- To provide an overview of the institutional infrastructure for climate change/Kyoto Protocol activities and the current views and position of Brazil with respect to climate change issues;
- To analyse the energy sector in Brazil, discussing the potential, and priorities, for CDM projects in both the supply and demand sides;
- To analyse the industrial sector in Brazil, discussing the potential, and priorities, for CDM projects with respect to fuel substitution and energy efficiency gains;
- To review the current state of CDM project development in Brazil, types of projects, location, status of development, etc;
- To present some final conclusions; and
- To provide a list of institutions/organizations that are involved with climate change and CDM activities in the country and that could be a useful source of information and contacts for CDM project proponents and investors in Brazil.

The original objectives of the report were attained, although some problems were found with respect to presenting an updated review of the current state of CDM project developments in Brazil. Information in this realm is not easily available because it is often spread among the various stakeholders, or it is incomplete, or it is considered confidential by the parties involved. In any case, an effort was made to get the most updated, comprehensive and reliable spectrum of information regarding CDM projects under consideration in Brazil as of February 2003, although some omissions probably do exist. UNIDO will be grateful for comments, suggestions and additional information that would help to make this report more useful to project developers and CDM project investors interested in CDM project opportunities in Brazil.

1 Institutional infrastructure for climate change in Brazil

Overview of the institutional infrastructure for climate change

Brazil was the first country to sign the United Nations Framework Convention on Climate Change (UNFCCC) on 4 June 1992 and the Brazilian National Congress ratified it on 28 February 1994. The Convention entered into force for Brazil on 29 May 1994, 90 days after its ratification by the National Congress.

In the Third Conference of the Parties (COP3), held in Kyoto, Japan, in 1997, the Kyoto Protocol was adopted.[1] In this Protocol, the developed countries accepted differentiated emissions limitations or reduction commitments between 2008 and 2012 (representing, for the developed countries as a whole, a reduction of at least 5% in relation to the combined emissions of greenhouse gases in 1990). The economic effort needed to comply with the goals established in the Protocol is perceived by some as resulting in significant costs to the economies of each industrialized country. As a result, three mechanisms were established to help developed countries comply with their greenhouse gas emission reductions or limitation targets. One of these mechanisms, defined as the Clean Development Mechanism (CDM),[2] emerged from a proposal originally presented by Brazil in the work of preparing for Kyoto, and involves both developed and developing countries. Its implementation is of particular interest to Brazil, because it will allow the transference of resources and technologies for the reduction of the country's greenhouse gas emissions.

1 On 23 July 2002, the Brazil ratified the Kyoto Protocol.
2 See annex II.

The purpose of the Clean Development Mechanism is to assist Parties not included in annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in annex I in achieving compliance with their quantified emission limitation and reduction commitments under article 3.

Under the Clean Development Mechanism, parties not included in annex I will benefit from project activities resulting in certified emission reductions (CERs); and parties included in annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol.

This subsection will begin by presenting a brief description of the national context on climate change and global warming issues. Next, an overview of the institutional infrastructure for climate change/Kyoto Protocol activities in the country will be presented.

Organization of the country for the implementation of the United Nations Framework Convention on Climate Change (UNFCCC)

Climate issues in Brazil are addressed mainly through the Climate Change Programme, carried by the Ministry of Science and Technology (Ministério de Ciência e Tecnologia—MCT), while CDM is addressed by three main ministries: Ministry of Science and Technology, Ministry of Foreign Affairs (Ministério das Relações Exteriores—MRE) and Ministry of Environment (Ministério do Meio Ambiente—MMA).

The Global Change General Coordination Office

The Coordination on Global Change Research of the Ministry of Science and Technology is responsible for:

- Giving assistance to the Ministry of Science and Technology on global change matters, especially on climate change;
- Following the negotiating meetings of the United Nations Framework Convention on Climate Change (UNFCCC);
- Following the scientific work of the Intergovernmental Panel on Climate Change (IPCC) and managing the disclosure of IPCC's reports and documents to the Brazilian experts;
- Coordinating the implementation of the UNFCCC in Brazil.

The Climate Change Programme

The Climate Change Programme emerged after the ratification by Brazil of the United Nations Framework Convention on Climate Change (UNFCCC) in February 1994. The strategy of the Programme was defined by the Brazilian Government, and especially by the Ministries of Science and Technology and of Foreign Affairs, in order to meet the initial commitments of Brazil under the Convention.

The objective of the Programme is to support the development of scientific information related to greenhouse gas emissions (GHG) as the basis for the creation of a policy for responding to climate change. Actions to respond to climate change take place internally and especially externally.

As an effort to implement the United Nations Framework Convention on Climate Change (UNFCCC) nationally, the national coordination for implementation of the UNFCCC has been attributed to the Ministry of Science and Technology by a presidential decree (decree No. 160 of 21 June 1994), which established the Interministerial Commission for Sustainable Development—CIDES (Comissão Interministerial para o Desenvolvimento Sustentável).

The decree that created CIDES was revoked by another decree of 26 February 1997, establishing the Sustainable Development and National Agenda XXI Policies Commission.

The objective to further institutionalize the issue of climate change, through the strategic characteristics of the Programme, led to the creation by presidential decree, on 7 July 1999, of the Interministerial Commission on Global Climate Change (Comissão Interministerial de Mundança Global do Clima), for the purpose of coordinating the actions of the government in this area. The Ministers of Science and Technology and of Environment are, respectively, the President and the Vice-President of the Committee. This decree establishes that the Minister of Science and Technology shall hold the presidency of the Commission and the Minister of Environment the Vice-Presidency. The Ministry of Science and Technology shall also exercise the function of Executive Secretariat.

The Committee is made up of representatives of the Ministries of Foreign Affairs; Agriculture and Food Supply; Transport; Mines and Energy; Planning, Budgeting and Management; Environment; Science and Technology; Development, Industry and Commerce; and Civil House of the Presidency of the Republic. The decree creating the Committee calls for coordination with representative bodies from civil society, with the participation of public and private bodies and specialists.

The Interministerial Commission on Climate Change was formed to integrate the response of the Brazilian government to climate change issues. More importantly, this group has the authority to authorize individual projects as CDM projects, and thus make Credits for Emissions Reductions (CERs) available.

There is, however, a demand for greater political participation by some sectors, in particular the industrial sector. The Brazilian Forum on Climate Change (Fórum Brasileiro de Mudanças Climáticas) was then created, including representatives of the government, the private sector and non-governmental organizations involved with the issue, which allow a greater political participation on the issue. This group was formed in August 2000, with at the time President Cardoso at its Head. Its purpose is to take into account the views of the private sector, NGOs, the academic community, etc concerned about climate change, as well as those of the governmental agencies represented by the Interministerial Commission (Raufer, 2002).

The Climate Change Programme has been under way since June of 1996 with external resources provided mainly by the Global Environment Facility (GEF) and also through a bilateral agreement with the United States, under the "U.S. Country Studies Programme". The resources from the GEF are provided for in Article 4.3 of the Convention.

The Framework Convention on Climate Change UNFCCC states that the developed countries should provide new and additional financial resources to cover the agreed full costs incurred by developing countries in complying with their obligations in article 12. By virtue of this obligation, the Ministry of Science and Technology decided that the implementation of the Programme would be based initially only on the resources coming from the GEF, and over the next years new resources would be gradually added to the budget to give greater dynamism and autonomy to the Programme.

By the end of December 2000, The Human Settlement Environmental Quality Secretary of the Ministry of Environment (MMA/SQA), jointly with the "Instituto Alberto Luiz Coimbra — Coordenação de Programas de Pós-Graduação e Pesquisa em Engenharia" (Alberto Luiz Coimbra Institute for Research and Postgraduate Studies of Engineering) of the Federal University of Rio de Janeiro—COPPE/UFRJ, created the Integrated Studies Centre on Environment and Climate Change (Centro Clima).

Centro Clima has also established a partnership with the University of São Paulo—USP. One of the objectives of the Centre is to support the Brazilian Forum on Climate Change by enabling the participation of the country's various stakeholders. Dissemination of the knowledge generated by the Centre provides input for developing public policies and non-governmental initiatives that make use of the opportunities provided by the United Nations Framework Convention on Climate Change (UNFCCC) to promote sustainable development in Brazil.

Activities carried out by Brazil under the Convention

Despite the fact that, in accordance with the principle of common but differentiated responsibilities of countries, Brazil does not have commitments to reduce or limit its anthropogenic emissions of greenhouse gases, there are many programmes in Brazil that, although not developed for the purpose of reduction of global warming, result in a considerable reduction of greenhouse gas emissions.

Some of these initiatives have contributed to the fact that Brazil has a relatively "clean" energy matrix, and were undertaken because of the increasing dependency on foreign exchange resulting from the oil price shocks, such as in the case of the ethanol,[3] or in order to delay investments in new power generation facilities or oil refineries, such as in the case of programmes to increase energy efficiency.[4]

Several other initiatives that are being implemented, in particular to combat deforestation, have also contributed to changing the curve of greenhouse gas emissions in Brazil.

It is important to note that, since 1995, the dissemination of all the activities of the Programme has been conducted through electronic publication (at low cost) on the Internet, by means of the climate change homepage at the MCT site (www.mct.gov.br/clima), in three languages (Portuguese, English and Spanish). This was considered a pioneering effort in the context of the Convention and served as a model for the establishment of the site of the Convention Secretariat itself and for other developing countries. Along with this, the publication of the text of the Convention in Portuguese was carried out in cooperation with the Secretariat of the Convention, and with the support of the United Nations Environmental Programme (UNEP).

The commitments of the developing countries, including Brazil, are described in Article 4.1[5] of the Protocol and the initial commitment in the Convention, cited in Article 12, is that of developing a report called the National Communication. This report, expected to be available in the beginning of 2003, will present the Brazilian inventory of net emissions of greenhouse gases

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3 In 1975, Brazil launched the National Alcohol Fuel Programme, known as PRO-ALCOOL, to increase the production of ethanol as a substitute for gasoline. The Programme was aimed at producing both anhydrous ethanol to be blended with gasoline and pure hydrated ethanol for use in vehicles running on this new fuel.

4 In 1985, Brazil launched the National Electricity Conservation Programme, known as PROCEL, to promote end-use efficiency and transmission and distribution loss reductions.

5 See annex III.

not included in the Montreal Protocol, and a general description of the steps taken or anticipated in the country to implement the Convention.

The Brazilian National Communication

Brazil is finalizing its first National Communication, which includes the Brazilian Inventory of Greenhouse Gases (already available in the homepage of MCT: www.mct.gov.br/clima). Because of its wide-ranging and detailed nature, covering the emissions of the principal greenhouse gases (CO_2, CH_4, N_2O, CO, HFC, NOX, CF_4, C_2F_6, SF_6, among others) from the energy, industrial, forestry, agriculture and waste treatment sectors, the Brazilian inventory of anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol involves specialists in many disciplines from around 60 institutions, involving several ministries, federal institutions, state bodies, sectoral associations, private companies and cooperatives, non-governmental organizations, universities and research centres.

The development of the National Communication is a multidisciplinary effort, involving institutions and specialists spread throughout all the regions of the country. This Communication is also a great challenge, because of the need to develop domestic capacity in this area, and in many areas involves pioneering and complex work. It consists of two main chapters:

- An inventory of the main greenhouse gas (CO_2, CH_4 and N_2O) emissions in the energy, industry, forestry and land use, agriculture and livestocks and waste treatment sectors, and;

- A general description of the steps taken or envisaged by Brazil to implement the Convention.

The Actions of the Climate Change Programme

The implementation strategy of the Climate Change Programme is based on the establishment of partnerships and on decentralization of the implementation of activities. In terms of the financing of the activities, the implementation strategy was strongly based on external resources (GEF and USCS), while providing for a gradual transition in the future to a greater share of domestic resources in the implementation of the Programme.

Since the Programme began in 1996, a greater involvement in the Programme has been sought from institutions and specialists, whether in the development of the inventory or in the discussion of issues relevant to the negotiation of commitments and implementation of the Convention and the Kyoto Protocol. In the case of the Inventory, three different types of participation involvement can be identified: contracting of institutions and specialists with resources from the GEF/USCS, involvement of federal institutions at the request of MCT, and participation on a voluntary basis on the part of private sector companies, sector associations, and university professors.

These different types of participation have been a management challenge at different levels. In the case of the contracted studies, it is easier to make demands for products and deadlines, which is not the case for the institutional participation at the request of MCT, for public corporations and other Ministries, and in the case of volunteer participation in the Programme.

The partnerships that will be encouraged and broadened, with decentralized actions and involvement of key partners, are indispensable to the implementation of the Programme. The basic proposal for implementation of the Programme consists of the following elements:

- The maintenance and strengthening of existing partnerships;

- The effort to increase the operational capacity of these institutions in relation to climate change, and establishing new partnerships, especially in new areas such as health, with the involvement of Fundação Oswaldo Cruz, an important medical research institution in Brazil, and with the states and municipalities that, for the purposes of the inventory, have responsibility for treatment of sewage and landfills, respectively.

Other actions undertaken by the Government

- Development of studies on vulnerability and adaptation to the impacts of climate change;

- Development of prediction models to monitor climate changes;

- Development of a National Mitigation Plan of Climate Changes Resulting from the Greenhouse Effect;

- Fomenting the development of technologies, practices and processes for reducing greenhouse gas emissions;

- Implementation of a Greenhouse Gas Emissions Monitoring System;
- Maintenance of the Greenhouse Effect Information System;
- Operationalization of the Clean Development Mechanism, and;
- Operationalization of the Clean Development Mechanism Legal Basis Purpose.

One last important aspect is the analysis of the interface of the Climate Change Programme with other programmes of the Government.

There are connections that need to be identified, and a process of dialogue should be initiated with the managers of each of the projects related to climate change to seek out synergy and explore partnerships. For example, the action related to vulnerability in the area of health due to climate change is an example that could have an important connection with programmes that seek to combat contagious endemic diseases, such as malaria and dengue.

By virtue of the international recognition achieved by these activities, both for the inventory, which is recognized by the GEF/UNDP itself as the most wide-ranging and successful work of all the projects in developing countries, and also resulting from the negotiating positions in Kyoto originating in the Brazilian proposal, in particular the creation of the CDM, there are real possibilities for international cooperation, beyond those which the GEF is obligated to provide, especially for carrying out studies about the Clean Development Mechanism. The government of Switzerland and the United States state of New Jersey, for instance, have already proposed projects for international cooperation.

The aims are to maintain and enhance the diffusion of information on the Programme, particularly on the inventory and the CDM. Among the actions expected are the following:

- Maintenance and enhancement of information diffusion by means of the Internet, on the site of MCT;
- Publication of relevant IPCC studies in Portuguese;
- Preparation of a workshop for the discussion of the National Communication to be submitted to the Convention.

Last but not least, the Presidency of Brazil, through meetings of the Brazilian Forum on Climate Change[6] asked the Ministry of Environment (MMA) to constitute a portfolio of potential projects aiming to reduce greenhouse gases emissions. In order to contribute to the selection process, Centro Clima[7] was asked by The Human Settlements Environmental Quality Secretary of the Ministry of Environment (MMA/SQA) to establish a set of eligibility criteria, additional to the International Executive Commission rules and compatible to the UNFCCC position and the Brazilian policy for sustainable development. These criteria have been discussed, analysed and presented in seminars attended by representatives of universities, public and private sectors and research institutes.

Some of the country's enabling activities

The following projects refer to the several country's activities and actions, undertaken by Brazilian authorities together with parties, in order to facilitate and implement the UNFCCC proposals.

Project UNDP BRA/00/029

Actual starting date: 30 June 2000.

Duration: 2 years, until 30 June 2002.

Executing Agency: Ministry of Science and Technology (MCT).

Implementing Agency: National Electrical Energy Agency — (ANEEL).

Inputs: ANEEL — Agreement MCT/ANEEL of 28 December 1998.

Objective: Enabling the Brazilian energy sector to gather scientific information on greenhouse gas emission in the sector, with a view to providing inputs to assist Brazilian policy actions on climate change.

6 See previously in this chapter, page 4 and annex III.
7 See previously in this chapter, page 5 and annex III.

Project UNDP/BRA/00/037

Actual starting date: 1 January 2001.

Duration: 12 months until 20 December 2001.

Executing Agency: Ministry of Science and Technology (MCT).

Inputs: MCT — Climate Change Programme and UNDP — Project BRA/98/019.

Objective: Enabling the Ministry of Science and Technology to prepare projects in compliance with the country's commitments under the United Nations Framework Convention on Climate Change, as well as develop awareness-raising material on climate change.

Project UNDP/BRA/95/G31

Actual starting date: August 1996.

Duration: Initially 18 months, extended until 30 June 2000.

Executing Agency: Ministry of Science and Technology (MCT).

Inputs: Global Environment Facility (GEF).

Objective: Prepare the First Brazilian National Communication to the Conference of the Parties, pursuant to article 12 of the United Nations Framework Convention on Climate Change, as well as enable Brazil to fulfil its commitments under the Convention on a permanent basis.

United States Country Studies Programme — USCS (The Case Study of Brazil):

Objective: Prepare the Brazilian emission inventory in the energy, agriculture, forestry and waste treatment sectors. The available financial resources were not sufficient though for the necessary data collection and analyses to produce high quality and highly reliable estimates in all such sectors, because of the territorial dimension of the country and the high costs involved in the preparation of inventories based on satellite images of the Amazonian Forest.

Brazilian National Fund for the Environment—FNMA

Since its creation, through the 7797 Law of 10/07/89, the Brazilian National Fund for the Environment (FNMA) financed more than 900 projects with several themes in 25 of the 27 Federal States of Brazil. In the last three years it has focused in eight main fields: Forest Extension, Integrated Management of Protected Areas, Sustainable Management of Flora and Fauna, Sustainable Uses for Fishing Resources, Environmental Education, Sustainable Amazon, Environmental Quality and Integrated Management of Solid Residues. It has also selected projects related to these areas in some specific issues such as Climate Change, as stated in the Climate Change 09/2001 Edital. The FNMA funds come from four main sources: the loan 1013/SF-BR from BID of 29 April 1999 and Government funds, the technical cooperation agreement with the Netherlands, mainly for climate change and desertification issues, the Law against Environmental Crimes, and the Ministry of Environment of Brazil funding through revenues coming from fines applied over environmental damages from the oil industry, among other polluting industries.

Brazilian Regulatory Commission for Electrical Energy—ANEEL

Objective: Support the implementation of the technical-financial cooperation agreement made in December 1998 between the Ministry of Science and Technology (MCT) and ANEEL, with the purpose of implementing research activities on climate change in the Brazilian energy sector, as well as building the technical and institutional competence of ANEEL on the issue, comprising actions related to the Brazilian inventory of greenhouse gas emissions, climate vulnerability of the Brazilian energy sector, mitigation measures for the reduction of global climate change risks and awareness raising on climate change and its probable effects.

Current views and position of the country on climate change issues

Brazil is quite proud of the seminal role that it played in the development of CDM. In party discussions before the Kyoto COP, it proposed that if a developed country exceeded its emissions requirements, a penalty would be assessed, and this would be collected in a Clean Development Fund. Monies from the fund would then go to developing countries, and would be used for mitigation projects designed to prevent climate change. During the Kyoto COP discussions, this Brazilian proposal evolved into the Clean Development Mechanism, a full-fledged flexibility of the protocol.

The origins of CDM: from Activities Implemented Jointly to the Brazilian Proposal

The concept of Joint Implementation (JI) is vaguely reflected in article 4.2 of the Convention. It is a complementary mean of implementing commitments that enables countries Parties to the Convention to carry out joint projects in order to achieve their targets as to the reduction of emissions or the enhancement of greenhouse gas sinks.

The reinterpretation of the concept of Joint Implementation that has been advocated by developed countries within the Convention attempts to establish a "regime of credits" by means of which they would compensate, by financing projects in other countries, the non-fulfilment of the targets freely assumed by them and that should be accomplished in their own territories with regard to the reduction of greenhouse gas emissions.

Brazil has sustained, pursuant to what has been agreed upon in the relevant decisions of the First Conference of the Parties, that Joint Implementation should be an additional and complementary mean for the fulfilment of the obligations under the Convention, and not an expedient by which developed countries may register credits as a compensation for the non-fulfilment of their commitments. In this sense, Brazil has expressed concern with the tendency of giving excessive emphasis to the notion of Joint Implementation with detriment to discussions on the effective fulfilment of the obligations clearly expressed in the Convention.

Moreover, Brazil always defended that cooperation between developed and developing countries should take place under article 4.5 of the Convention, which states the transfer of technologies to developing countries and the enhancement of their technological capacities with a view to enabling them to adequate their development process to cleaner matrix with regard to the emission of greenhouse gases. The Decision of the First Conference of the Parties on the Actions Implemented Jointly (AIJ) pilot phase refers to article 4.5 stating that Joint Implementation is one way to execute it.

Since the beginning of the AIJ pilot phase, insistent pressure was exerted upon developing countries so that they endorsed the reinterpretation of the concept of joint implementation within the Convention.

Also, some public enterprises in Brazil as well as the private sector (especially in the forestry area) started to experience some pressure from external interests that suggested the possibility of providing resources for the execution of joint implementation projects in the country.

The previous considerations emphasized the necessity of defining global actions to be taken by the Brazilian Government concerning the subject, including actions within the Convention. According to the Ministry of Science and Technology (MCT—www.mct.gov.br/clima), the following aspects concerning joint implementation were considered crucial and explain why a new proposal, the Clean Development Mechanism, emerged:

- Given the incipient nature of the AIJ pilot phase, there was little information available on the impact and scope of projects implemented jointly in developing countries;
- Joint implementation originally included an element of iniquity in addressing climate change as it would transfer to developing countries the responsibility to adopt measures which, in practice, would authorize the increase in developed countries emissions;
- Joint implementation would imply the immobilization for a long period of the environmental assets in developing countries, especially of their forestry areas;
- The statement that the adoption of measures to reduce emissions and enhance greenhouse gas sinks would be more efficient and cost effective in developing countries is not necessarily true and lacks scientific basis;
- Developed countries could continue favouring joint implementation in order for the Activities Implemented Jointly to benefit them with a "regime

of credits" that would partially exempt them of their obligations within the Convention;

- There was the obvious risk that joint implementation would replace in the Convention the commitment by developed countries to assist developing countries with financial resources and proper technologies;

- The great majority of non-governmental organizations related to the environmental area was not supportive of joint implementation;

- In Brazil, the sectors potentially more interested in exploring the possibility of receiving external resources from joint implementation projects would have been the industrial reforestation and the sugar cane agro-industry sectors.

- At the initial stage, Brazil would have been interested in the execution of projects aiming at energy conservation, particularly in the oil sector. But there was no indication that developed countries intended to allot all the required resources to meet the necessities of the Brazilian case;

- As the energy matrix in Brazil was and still is essentially clean (renewable and non-pollutant energy sources), external interest in joint implementation projects would have tended to concentrate on projects regarding the protection of sinks (rain forests).

In view of the considerations above, the MCT suggested the following guidelines:

- Keeping under the Convention context the opposition of developing countries to Activities Implemented Jointly between developed and developing countries that might generate credits by means of which developed countries might compensate the non-fulfilment of their targets under the Convention as to the reduction of the current level of greenhouse gas emissions in their territories;

- Keeping a consentaneous attitude in relation to initiatives deriving from the Miami Action Plan.

Following from this, as far as the Brazilian Government position is concerned, the perception is that Brazil's responsibility for climate change is in proportion to its small historic emissions, resulting from a more recent process of industrialization. However, the Convention is based on the reports by the countries of their annual anthropogenic emissions of greenhouse gases. This fact has led societies of many countries to establish a direct relation between current annual emissions and responsibility for the increase in global warming. High emission levels of greenhouse gases in Brazil would thus be associated with the responsibility of the country for causing global warming, which would have unfortunate political consequences.

Thus, under the Convention, there was great pressure on the Brazilian government to carry out studies for the development of mitigation plans or measures, vulnerability studies and measures for adaptation to the adverse effects of climate change, either supported by the GEF or by means of bilateral agreements.

Because of these considerations, there was a perception in the Brazilian government that the emphasis on mitigation and vulnerability corresponded to a disguised attempt to transfer the burden of combating climate change to some developing countries, through including them in the group of countries with emission reduction or emissions limitation commitments, which would be contrary to the stated spirit of the Convention. Among the developing countries, some are considered key countries, with rapid processes of development in the coming years, including Brazil, India, China, Mexico and Republic of Korea.

As a result of this perception, the strategy proposed by the Brazilian government was to prioritize work on the Brazilian inventory of greenhouse gas emissions, which would have a dual objective — to provide a diagnostic assessment of the current situation and to focus only on the initial commitment under the Convention. The strategy adopted was to give priority to the work on the inventory in the first phase, so that later, with the capacity acquired by the institutions and specialists involved, the mitigation, adaptation and vulnerability plans, which are also among the commitments set out in the Convention, could be implemented. Another relevant aspect was the search for actions in relation to education, awareness-building and publicizing of the climate change issue, given the limited amount of information existing in Brazil about climate change, and especially the small number of publications in Portuguese.

Thus the studies of mitigation and vulnerability, although no less important, received less effort at first and were left for a second stage. There was also concern that the strategy for the inventory should be as broad as possible and should stimulate the creation of endogenous capacity in the country. To complement this, the awareness-building and dissemination activities were also given priority.

The Brazilian proposal

It was against this background that the single most remarkable development of the entire Kyoto negotiations occurred: one element of the sweeping proposals that Brazil had put forward in June 1997 was that annex I parties should be subject to a financial penalty if they did not comply with their quantified commitments under the Protocol, with the fine being levied in proportion to the degree of non-compliance. The money would be paid into a Clean Development Fund that would be used to support appropriate projects in developing countries, for limiting emissions and potentially for adaptation. The proposal included ways of apportioning the proceeds between developing countries, and suggested a penalty of US$10 per ton of excess carbon-equivalent emitted.

The idea that industrialized countries would agree to being subject to assessed financial penalties as a compliance measure seemed unlikely to be accepted. However, by the end of the final pre-Kyoto negotiating session, there was a twist in the proposal, it was suggested that the penalty should be levied at a sufficient rate to fund carbon-saving projects in developing countries that would save emissions equivalent to the excess emissions from annex I parties. This made the proposal compliance system very similar to joint implementation, though under a rather different legal and institutional framework.

In some way, this new proposal reconciled the United States proposals for joint implementation with the most apparently aggressive proposals from the G-77, and was first floated in the negotiations in November 1997. The United States supported then some modifications of the basic idea of the proposal, shifting the "line of compliance" to encompass such investments as contributing to compliance, rather than being a penalty for not complying. Companies transformed the idea of a penalty on governments into a mechanism for investment. The multilateral character of the framework was retained, but it became a mechanism, rather than a "fund", and the Clean Development Mechanism or the CDM emerged.

Under this perspective, as has already been mentioned in the beginning of this section, Brazil, through its Ministry of Environment, has been establishing its own set of eligibility criteria and indicators for the appraisal and evaluation of CDM project proposals (Novaes et al, 2002). These criteria have been based on the work developed in 1999 by a NGO,[8] HELIO International,[9] made public through a report highly disseminated (Thorne and La Rovere, 1999).[10]

In December 2001 and April 2002, the Interministerial Commission on Global Climate Change[11] promoted seminars to debate the Ministry of Environment's proposal of eligibility criteria. What emerged from the former proposal of a set of four eligibility criteria was a new set of two criteria, eight sustainability indicators and three multiplier potentials to classify the projects.

Similarly important was a series of on-going efforts designed to address CDM within a south-south perspective. The south-south-north (SSN) project,[12] which links four south countries (Bangladesh, Brazil, Indonesia and South Africa) and one from the north (the Netherlands), can be cited as a particularly appropriate example of the kind of efforts that should be fostered within the capacity building project. Following the same idea of Thorne and La Rovere (1999), the SSN project has also attempted to develop a series of project evaluation criteria that could be employed to address the broader issue of sustainable development to accompany the GHG reduction role of the individual projects.

Finally, as of December 2002, a resolution (resolution No. 1) by the Interministerial Commission on Climate Change made provisions about the approval process for CDM project activities in Brazil.

As can be seen, Brazil really played an active role in establishing the CDM under the Kyoto Protocol. The country is conducting a variety of ongoing efforts in this area and its institutional infrastructure for climate change is well prepared to deal with CDM projects.

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8 Non-governmental organization.
9 NGO based at 56, Rue de Passy, 75016, Paris, France. E-mail: helio@globenet.org.
10 Dr. La Rovere is the Executive Director of Centro Clima, a professor of COPPE/UFRJ who has published extensively on CDM issues.
11 See previously in this chapter, page 4 and annex IV.
12 See annex IV.

2 Priority sectors for CDM projects in the energy sector

In this section, before presenting some priority sectors for CDM projects in the energy sector, we introduce some general socio-economic aspects, some particularities of the energy sector, as well as some major forces driving energy use and carbon emissions in Brazil. In this sense, initially we provide a brief overview of the country and present information that are necessary to estimate some emission indicators useful to portray its energy sector.

Energy supply and demand in Brazil

The Brazilian socio-economic context

The Brazilian socio-economic context has changed considerably during the past five decades. In the first half of the twentieth century the Brazilian population was concentrated in rural areas, with agriculture playing an important role in the economy. For instance, the Brazilian population in 1940 was 41 million inhabitants, 70% of which living in rural areas. During the 1960s, the urban and rural populations were already balanced. The urban population growth had increased tremendously by 1970s. As of today, urban population is still growing, while rural population has been decreasing since the 1970s.

According to the Brazilian census for 2000 provided by IBGE (the Brazilian Institute for Geography and Statistics), 81% of the country's 170 million inhabitants lived in urban areas in that year (IBGE,2002). This composition is similar to that presented in industrialized countries. Table 1 shows the evolution of the population composition from 1940 to 2000.

Table 1. Brazilian population (in thousand)

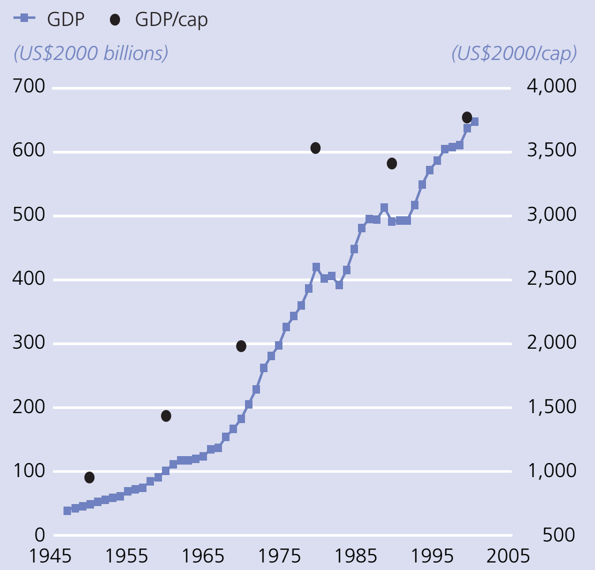
Year	Urban		Rural		Total
1940	12,880	31%	28,356	69%	41,236
1950	18,783	36%	33,162	64%	51,944
1960	31,303	45%	38,767	55%	70,070
1970	52,085	56%	41,054	44%	93,139
1980	80,436	68%	38,566	32%	119,003
1990	108,924	76%	35,167	24%	144,091
2000	137,670	81%	31,874	19%	169,544

Source: www.ibge.gov.br.

One of the reasons for the high urban population development was the rapid economic growth observed during the thirty-year-period after the Second World War. During those three decades, the Brazilian government adopted an import substitution economic model that, of course, triggered the industrialization process. The automobile industry was one of the most important sectors to push economic development. Between 1950 and 1980, the country's average economic growth was 7.4% per year.

The 1980s was the "lost decade" for Brazil. The economy was seriously disturbed by both the second oil shock in 1979 and the Mexican financial crisis in 1982. In 1983, the economy collapsed. During the 1980s, the country's average economic growth was only 1.6% per year and income per capita growth was negative (-0.4% per year). To face the economic problems, the government adopted adjustment structural change policies in the late 1980s, but the economic benefits from these policies during the 1990s were small. The GDP grew at an average rate of 2.7% per year during that decade,

Figure I. Brazilian GDP and GDP per capita



Source: www.ipeadata.gov.br.

but only 1% per year on a per capita basis (IPEA, 2002). Figure I presents the evolution of Brazil's GDP and GDP per capita in 2000 US$.[13]

Despite the economic problems faced by the country during the past two decades, it is important to stress the significant economic structural changes taking place over time. While in 1950 the agricultural sector contributed with 24% of the Brazilian GDP, in 1980 this percentage was down to 9%. In 2000, its contribution increased to 11%, thanks, to some extent, to a sharp increase in exports of agricultural products. The industrial sector progressed in an opposite direction. With the same share of GDP as agriculture in 1950, it reached 41% in 1980 and 31% in 2000. The services sector grew from 52% in 1950 to 57% in 2000.

In summary, during the first stage of modernization of the Brazilian economy, the infrastructure had to be improved. In this context, the role of industry and transportation sectors in the economy increased and then the energy consumption profile changed significantly. That is why we analyse the energy sector more accurately in the next section.

The energy sector in Brazil

In the first half of the twentieth century, biomass was the major energy source in Brazil. According to the Brazilian energy balance for 1941, traditional biomass contributed some 77% of the total energy supply, 73% of which was fuel-wood. Hydroelectricity and coal were responsible, each, for 7%, and oil for 9% (Leite, 1997).

After World War II, the high economic growth rates, the fast urbanization process and the industrialization model centred on the automobile industry contributed to changes in the Brazilian energy profile. During that time, the government played an important role in the economy. During the 1950s and the 1960s, two important national companies, Petrobras and Eletrobras, were created in order to assure oil products and electricity supplies.

The market share of these two energy sources increased notably even during the 1960s. In 1965, oil products accounted for 34.8% and hydroelectricity for 14.9% of total energy supply. Fuel-wood decreased drastically, accounting for 40.4% and coal for 3.7%. Charcoal, bagasse and natural gas market shares were 1.5%, 4.6% and 0.1%, respectively (MME, 1976).

The tendency of replacing traditional biomass by modern energy sources remained until the two oil shocks of the 1970s. After that period, the government decided to valorize some national energy sources such as modern biomass and hydroelectricity. The international financial crisis in the beginning of the 1980s forced the country to reduce imports. Oil was the product that weighted the most in the trade balance. In 1973, when the economy had not felt yet the impacts of the first oil shock, the country produced only 17% of its oil demand. In 1990, this percentage reached 60% (85% as of early 2003).

Table 2 shows that the share of traditional biomass in total energy supply decreases continuously over time. During the 1970s, it was replaced mainly by hydroelectricity and oil. In the 1980s, hydroelectricity remained increasing and ethanol[14] started to replace part of gaso-

[13] GDP in dollars is calculated as a function of GDP in 2001 constant national currency prices and the average 2000 exchange rate (1.8291 R$/US$).

[14] In Brazil, ethanol is produced from sugar cane. As table 2 presents only primary energy sources, ethanol production can be estimated from sugar cane products production.

Table 2. Energy balances

	1970		1980		1990		2000	
	Mtoe[a]	%	Mtoe[a]	%	Mtoe[a]	%	Mtoe[a]	%
Crude oil	24.7	37.2	54.3	48.1	56.6	40.5	86.7	46.4
Natural gas	0.2	0.3	1.1	1.0	4.2	3.0	9.5	5.1
Coal	2.7	4.1	5.8	5.1	9.5	6.8	13.8	7.4
Nuclear	0.0	0.0	0.0	0.0	0.6	0.4	1.8	1.0
Total non-renewable	27.6	41.6	61.2	54.2	70.9	50.7	111.8	59.9
Hydroelectricity	3.5	5.3	11.1	9.8	20.0	14.3	30.1	16.1
Fuel-wood[b]	31.8	47.9	30.7	27.2	28.2	20.2	21.5	11.5
Sugar cane products	3.5	5.3	9.0	8.0	18.5	13.2	19.3	10.3
Others	0.0	0.0	1.0	0.9	2.1	1.5	4.0	2.1
Total renewables	38.8	58.4	51.8	45.8	68.8	49.3	74.9	40.1
Total	66.4	100	113.0	100	139.7	100	186.7	100

[a] For electricity,1MWh = 0,086 Mtoe (million metric ton of oil equivalent).
[b] Including non renewable production.

Source: MME (2001)

line consumption.[15] This was possible thanks to an aggressive public policy and because the government played an important role in the energy sector. Eletrobras and Petrobras exerted the monopoly of the electricity and oil markets. Finally, it is important to point out that the Brazilian energy balance became cleaner during the 1980s not because of environmental concerns, but mainly because of the economic constraints regarding the balance of payments.

During the 1990s, the public sector played a more modest role in the economy with the privatization of some utility companies. The subsidies for the ethanol programme were reduced and then it has been replaced naturally by gasoline. The supply of fossil fuels has increased thanks to an aggressive strategy adopted by Petrobras to invest in off-shore oil production. Besides, a pipeline transporting natural gas from Bolivia to large consumption centres in the Brazilian south-east was built in the late 1990s.

Table 2 shows that in a context where fossil fuel prices are low and the economic subsidies for renewables are diminishing, the market shares of natural gas and oil products have increased. Despite the fact that the natural gas market share has been still small in 2000, it is important to note that its average growth rate during the 1990s was 8.4% per year. Petrobras estimates that natural gas will contribute with 12% of total primary energy supply by 2010.

As for renewables, hydroelectricity production has not increased as in the past because natural gas is now competing, in part, with it. The private sector is more willing to invest in natural gas-fired power plants rather than in hydroelectric power plants due to the higher up front costs of the latter, mainly in the context of economic uncertainties, lack of financing for this kind of investment and environmental concerns. As of early 2003, however, the uncertainties and regulatory indefinition in the power sector are such that new investments in the expansion of the system practically came to a halt. The emphasis now seems to be changing to the expansion of the transmission system so as to improve the reliability of the power system at a lower cost than investing in new, expensive power plants. This strategy has its limits, though.

The biomass production is almost stabilized in absolute terms, but it decreases in relative terms. Sugar cane products market share decreases from 13.2% in 1990 to 10.3% in 2000.[16] Nevertheless, the total amount of sugar cane products remains almost constant between 1990 and 2000. This is due to the fact that the percentage of ethanol mixed to gasoline has increased[17] and

[15] Note that during the 1980s, renewables increased significantly their participation in the energy balance.

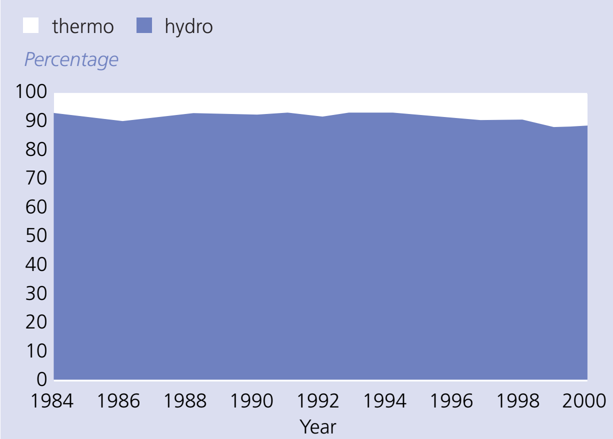
[16] Note that table 2 shows only primary energy sources. Almost 30% of total sugar cane products are transformed in ethanol, a secondary energy source.

[17] There are two kinds of automobile fuels for cars in Brazil: hydrated ethanol and gasohol. The latter is composed of a mixture of gasoline (75%) and anhydrous ethanol (25%). This blended was 82% and 18% in the past. It varies as a function of the ethanol availability in the market. The first ethanol crisis was in 1990, when the sugar price in the international market was high. Ethanol producers drove their productions towards sugar at the expenses of ethanol consumers.

the gasohol car fleet has grown significantly during the past decade.

In the residential sector, traditional biomass consumption has decreased naturally over time and in industry, notably in the steel industry, charcoal has been replaced by coke or by coal. The energy substitution process was triggered with the privatization of most steel companies. Charcoal technology became less competitive when market barriers to import coke were eliminated. Furthermore, the price of charcoal has increased markedly with the current obligation that steel mills have to use charcoal coming from renewable forests. In a context of low relative fossil fuel prices, coal and coke market shares have increased.

Figure II. Power generation



Source: MME (2001).

Power generation specificities

As mentioned earlier, the government had adopted an aggressive strategy to encourage hydroelectricity during the period of economic difficulties, mainly related to the balance of payments due to the obligations with the payment of the external debt. During the 1980s, hydropower accounted for more than 90% of the electricity supply. Non-hydropower generation was developed primarily to support the grid during the dry season and in remote areas not connected to the grid (Schaeffer et al., 2000).

This configuration remained until the first half of the 1990s. According to Schaeffer et al. (2000), the cornerstone of the electric power sector reform was the Law 8631 approved in 1993, which triggered to the following market changes:

- Eliminated tariff equalization between regions, allowing power generation and distribution utilities to set tariffs according to operating costs;
- Abolished credits held by federal generation utilities with state distributors, i.e., the cross-subsidies between state distributors; and,
- Introduced supply contracts between power generation and distribution utilities.

The utility privatization process was launched by the government in 1995 when the first distribution company, ESCELSA, was sold (BNDES, 2000). The privatization of the transmission and generation utilities was scheduled for later. Significant delays on this transfer have occurred due to macroeconomic instabilities and uncertainties related to the level of initial prices for electricity transmission and generation. But this privatization may never take place. This is because there is a growing public opposition in the country against the recent reforms in the power sector, and also because a more important role is expected again from state-owned companies in the power sector during the new Presidency of Brazil that started in January 2003.

Despite the fact that the reform has failed to attract the private sector to expand the generation capacity, contrarily to what happened with the distribution utilities, the fossil fuels market share increased significantly during the 1990s at the expense of hydropower. The recent growth in importance of thermal power generation is observed in figure II.

Prior to the beginning of the privatization process, hydropower plants contributed 93.3% of total power generation. In 1999, hydropower's share of electricity was reduced to 88.1%.

The efficiency of power generation in Brazil has decreased because thermal power generation is less efficient than hydropower. The average efficiency of thermal generation varies intermittently from 29% to 32% in Brazil. Therefore, there is no real improvement over time. However, in the case of hydropower, the long distance between the plants and the consumption centres implies in high levels of losses. The total (transmission and distribution) losses for 2000

Table 3. Energy sources for thermal power generation

	1985		1990		1995		2000	
	ktoe	%	ktoe	%	ktoe	%	ktoe	%
Oil products	1,021	26.4	1,288	31.6	1,960	34.0	3,948	35.5
Natural gas	0	0.0	74	1.8	183	3.2	623	5.6
Coal	1,080	27.9	1,037	25.4	1,360	23.6	2,839	25.5
Nuclear	899	23.2	587	14.4	878	15.2	1,741	15.6
Total non-renewable	3,000	77.5	2,986	73.2	4,381	75.9	9,151	82.2
Fuel-wood	136	3.5	119	2.9	123	2.1	144	1.3
Sugar cane products	374	9.7	387	9.5	515	8.9	668	6.0
Others	360	9.3	589	14.4	750	13.0	1,172	10.5
Total renewables	870	22.5	1,095	26.8	1,388	24.1	1,984	17.8
Total	3,870	100.0	4,081	100.0	5,769	100.0	11,135	100.0

Source: MME (2001)

are estimated at 17% of electricity generation (MME, 2001).

Table 3 shows the different energy sources used to produce thermal power in Brazil. During the 1990s, non-renewable energy consumption for thermal power generation tripled, while renewable consumption only doubled. The latter has increased thanks, mostly, to the recuperation of some sources such as black liquor in the pulp and paper industry.

With respect to non-renewable energy, in spite of the initially small share of natural gas in electricity generation, it increased 140% between 1995 and 2000. This was possible thanks to the GasBol pipeline built in the late 1990s to transport natural gas from Bolivia to the Brazilian Southeastern region. The present pipeline capacity of 30 million cubic metres per day may be augmented to 50 million cubic metres per day in the near future. In its first phase, 4 million cubic metres per day would supply industries and in the second phase more than 16 million cubic metres per day would be used directly by thermal power plants (Gazeta Mercantil, 2002). As of February 2003, however, only some 3 million cubic metres of natural gas are being transported in the GasBol pipeline per day.

Some studies have estimated a strong penetration of natural gas to generate electricity if the present market conditions remain. Schaeffer et al. (2000) estimate that the Brazilian natural gas installed capacity (NG & LNG) will grow from less than 0.1 GW in 1995 to 11.8 GW in their baseline scenario for 2015. Nevertheless, in some alternative scenarios, non-renewables are replaced by wind, biomass or hydropower. Table 4 summarizes their results related to the installed capacity for four different scenarios for 2015 (Baseline, Technology, Environmental and Non-Carbon) by energy sources.

Table 4. Scenarios for installed capacity for 2015 (GW)

Source	1995	Baseline	Technology	Environ-mental	Non-carbon
Coal	1.1	1.4	1.4	1.4	0.0
Biomass	0.8	1.9	1.9	5.3	13.0
Petroleum	2.6	3.2	1.7	1.7	0.0
NG and LNG	0.0	11.8	11.6	0.8	0.0
Hydropower	50.7	73.3	73.1	87.8	80.0
Nuclear	0.7	2.6	2.6	2.6	2.6
Wind	0.0	0.0	1.6	0.0	1.5
Total	55.9	94.2	93.9	99.6	97.1

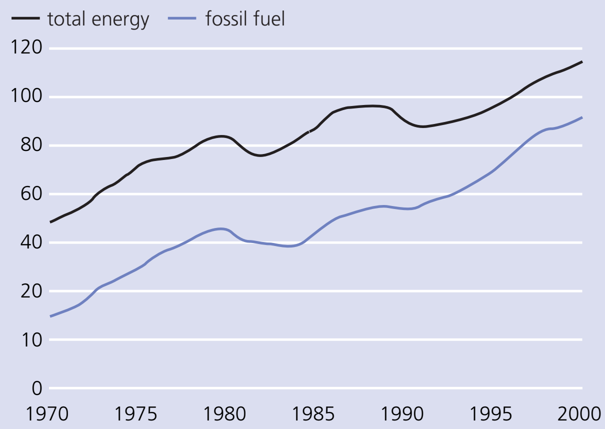
Source: Schaeffer et al. (2000).

Carbon dioxide emissions from energy use

In this section, carbon emissions from energy use are estimated covering the period until 2000, according to energy balance data and carbon emission coefficients employed by the Ministry of Science and Technology (MCT) of Brazil. MCT provides carbon emissions estimations from 1990 to 1994 in its web site (MCT, 2002). It follows one of the methodologies proposed by the Intergovernmental Panel on Climate Change (IPCC).[18]

[18] The only difference between the results presented here and those from the MCT is related to the fact that the higher heating value of the fuels is considered here, such as in the Brazilian energy balance, and MCT considers the lower heating values such as it is suggested by IPCC. The emission coefficients by source are considered constant for all period.

Figure III. Carbon emissions (MtC)



Source: www.mct.gov.br and MME (2001).

Table 5. Energy use and carbon emissions indicators

	1970	1980	1990	2000
GDP (billion 2000 US$)	184	420	491	638
Population (million)	93.1	119.0	144.1	169.5
Primary energy (PJ)	3,000	5,105	6,315	8,437
Carbon emissions (MtC)	53.7	81.6	84.7	105.4
GDP/cap (US$/cap)	1,972	3,530	3,409	3,764
Energy intensity (MJ/US$)	16.3	12.1	12.9	13.2
Carbon/cap (kgC/cap)	577	686	588	622
Carbon intensity (gC/US$)	293	194	172	165
Carbon content (tC/TJ)	17.9	16.0	13.4	12.5

Source: Adapted from MME (2001).

Figure III shows total energy and fossil fuel emissions in Brazil from 1970 to 2000. Total energy emissions include the carbon released from the non-renewable biomass combustion. MCT adopts the assumption that half of the household fuel-wood consumption is non-renewable (from deforestation). For industry, we assume that the fraction of renewable biomass on total biomass use increases over time according to ABRACAVE data, the Brazilian union for renewable forestry (ABRACAVE, 2000). In this context, as long as industry relies less and less on non-renewable biomass and households phase out fuel-wood use, the lines for total energy and fossil fuel emissions tend to converge.

It is important to notice that carbon emissions increased very fast during the 1970s due to high economic and population growths. The modernization of the country relied on investments in infrastructure and in energy intensive industries. In the beginning of the 1980s, carbon emissions decreased because the economy slowed down. As mentioned before, domestic renewable energy sources replaced imported fossil fuels. During the 1990s, the country again increased its carbon emissions in the same way of the 1970s, in spite of the fact that neither the economy nor the population grew at that period at a comparable rate. Fuel substitution is another important reason that explains the significant increase in carbon emissions in the last few years. This is explored further later.

Indicators for the energy sector

- Based on the information provided in the previous sections, some indicators are presented here, which can be useful to characterize the energy sector's performance of an economy. The following indicators have been built:

- Energy intensity: total energy use per unit of GDP (MJ/$);

- Carbon intensity: total carbon emissions per unit of GDP (gC/$);

- Carbon emissions per capita: total carbon emissions per inhabitant (kgC/capita); and

- Carbon content: total carbon emissions per unit of energy (MtC/TJ).

The two first indicators are related to economic performance and its implications for the national energy needs and the carbon released per each dollar produced by the economy. Generally speaking, they can be used as a proxy for the environmental impacts and energy efficiency of an economy. The third indicator is more suitable to an equitable international comparison because no monetary values are taken into account.[19] The forth indicator captures some of the technological characteristics of the energy sector.

Table 5 summarizes the information presented in the previous sections, as well as the evolution of some indi-

[19] It is clear that energy needs differ from a country to another. But the gap in energy consumption per capita between industrialized countries and less developed countries is still tremendous.

Table 6. Energy and carbon emission indicators: international comparison, 1998

	World	OECD	Non-OECD	Brazil
GDP (billion 1990 US$ PPP)	33,654	19,753	13,900	907
Population (millions)	5,865	1,101	4,765	166
Total primary energy supply (PJ)	402,569	213,400	183,932	7,325
Carbon emissions (MtC)	6,198	3,277	2,724	81
GDP PPP/cap (US$ PPP/cap)	5,738	17,948	2,917	5,468
Energy intensity (MJ/US$ PPP)	12.0	10.8	13.2	8.1
Carbon/cap (kgC/cap)	1,057	2,978	572	486
Carbon intensity (gC/US$ PPP)	184	166	196	89
Carbon content (tC/TJ)	15.4	15.4	14.8	11.0

Source: IEA (2000).

cators. GDP in US dollars is calculated as a function of the 2000 average exchange rate and GDP in constant national currency of 2001.

In an international comparison, it is necessary to correct some indicators using monetary values such as the GDP. In this case, it is more appropriate to use the GDP purchasing power parity (GDP PPP) as this restates the difference in the relative prices between countries. Table 6 gives the indicators for the world, for the OECD countries, for the non-OECD countries and for Brazil for 1998. Carbon emissions in this table do not include emissions caused by the consumption of non-renewable biomass, but rather cover only the consumption of fossil fuels.

Although the energy and carbon emissions indicators in Brazil are lower than the global average or those for the OECD countries and even the non-OECD nations, it should be stressed that the energy demand income elasticity is higher than one in the country. With the probable increase in Brazil's per capita income and the rapid penetration of fossil fuels in the energy matrix, it is quite probable that these indicators will reach the average figures for the OECD nations in a not so distant future.

In the next section, we cover, in greater detail, areas that offer more potential for CDM projects in the Brazilian energy sector. These areas were selected mainly on the basis of the Brazilian experience with using renewable energy sources, as well as the potential for using renewable sources of energy and for using energy more efficiently in Brazil.

Priority energy sectors for CDM projects

As seen previously, over the past decade there has been a marked penetration of fossil fuels in Brazil's energy matrix. The share held by renewable sources of energy is still quite significant, though. In this section, we analyse energy options that are potentially eligible as CDM projects and that can help lower the fossil fuels penetration rate in Brazil.

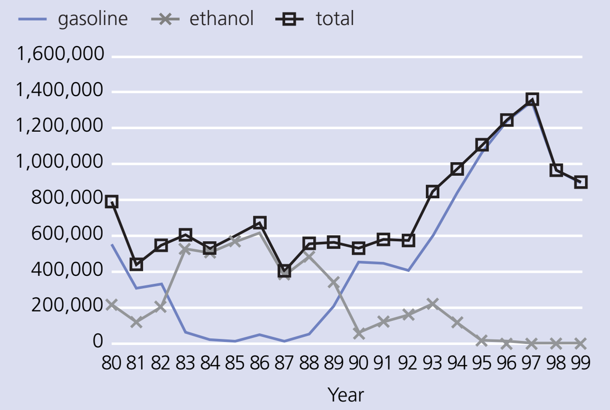
Two strategies may be adopted: one substituting fossil fuels by other fossil fuels that are less carbon-intensive or even by renewable sources of energy, and the other designed to boost energy efficiency or curtail losses. These two options help reduce carbon emissions by avoiding or postponing the consumption of non-renewable carbon-intensive fuels.

For instance, it is worthwhile stressing that the expansion of the power sector was recently moving more in the direction of non-renewable sources, particularly natural gas. Within this context, we present below the projects based on renewable sources and energy efficiency that could prompt an turnaround in the trend towards the marked penetration of non-renewable sources in Brazil's energy matrix. These examples include both projects that have received some type of government backing in the past, as well as those that could entry the Brazilian market if some type of incentive is offered or barriers to entry are lowered or removed.

Biomass

Biomass has been widely used for quite some time in Brazil as fuel by the transportation and industrial sectors, within a context of greater environmental concern, the international community has been devoting a reasonable amount of attention to biomass as an energy source, particularly for use in developing countries. For instance, the Global Environment Facility (GEF) has supported two significant research, development and demonstration projects in Brazil: Biomass Integrated Gasification/Gas Turbine — BIG/GT technology, and Energy Generation from Sugar Cane Bagasse and Wastes (La Rovère, 2000). The main power generation alternatives based on renewable energy sources or cogeneration are described below.

Figure IV. Automobile sales



Source: Anfavea (2000).

The PRO-ALCOOL fuel alcohol programme

Brazil's national fuel alcohol programme was established in 1975 in order to replace gasoline for individual transportation, with the introduction of indigenous technologies in the market during the 1970s. The 1979 oil crisis endowed this programme with fresh life, peaking in the mid-1980s, but as oil prices dropped during the second half of that decade, it began to flounder. In 1985, sales of private automobiles fuelled by ethanol accounted for 96% of the domestic market, plummeting to a mere 13% by 1990, due largely to the ethanol supply crisis in 1989. In parallel, cane-growers slanted their output more towards sugar, quoted at attractive prices on the international market. Figure IV shows the development of the share in automobile sales held by vehicles fuelled by ethanol and gasoline.[20]

However, ethanol production did not follow the drop in the sales of ethanol-fuelled automobiles immediately, as the composition of the Brazilian fleet did not alter to any great extent, while during the second stage a larger percentage of anhydrous alcohol was blended with gasohol. Furthermore, recent automobile sales have increased significantly, boosting the consumption of anhydrous alcohol. Figure V shows the development of gasoline consumption, as well as anhydrous and hydrated alcohol in Brazil.

In terms of the Brazilian automobile market, studies are currently underway on manufacturing a more flexible engine that could work with a percentage of ethanol in the gasohol that varies from 10% to 100% (neat ethanol). Within this context, ethanol supplies could be channeled only to places close to ethanol production centres that are competitive. Furthermore, during the off-season period between harvests, consumers could use a lower percentage of ethanol in the blend.

This seems to be a global trend in countries that lack an ethanol supply network, with this added flexibility appearing on the consumption side. Some countries are interested in importing ethanol from Brazil in order to add it to gasoline, with added leverage for this possibility appearing if the environmental laws of some countries were more stringent.

Within this context, ethanol production could well become feasible in some parts of Brazil. The potential for reducing carbon emissions would depend on the average percentage of ethanol used in the gasohol blend, as well as the size of the potential international market.[21]

Wood gasification

The Brazilian Wood BIG-GT Demonstration Project for Power Production, financed by the GEF, is a prototype designed for replication at the commercial level. This technology is based on the gasification of woodchips, using a gas-fired micro-turbine in combined cycle.

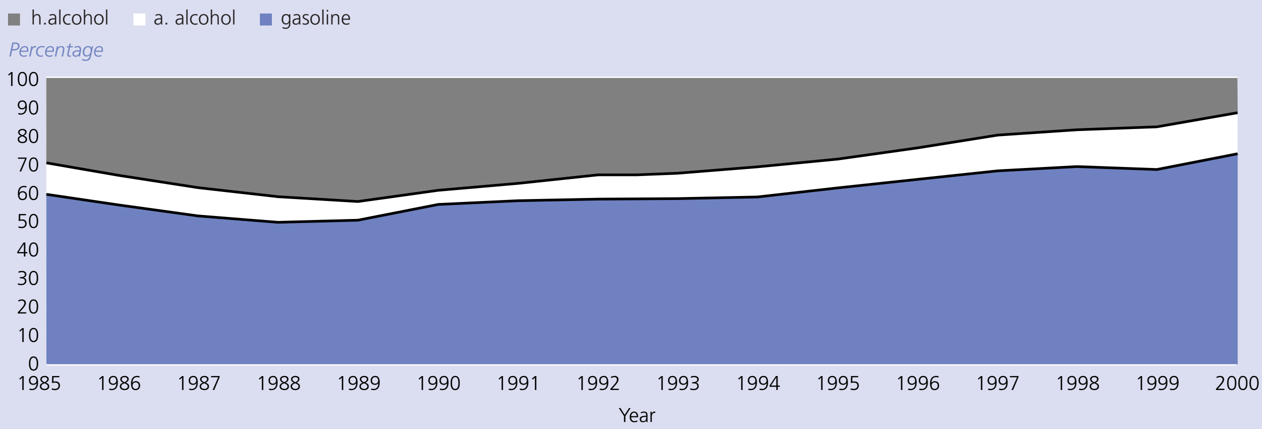
The SER Consortium was set up in 1991 to develop wood gasification technology, backed by Eletrobras, Companhia Hidrelétrica do São Francisco (Chesf), Companhia Vale do Rio Doce (CVRD) and Shell do Brasil. Should the commercial feasibility of this Project be demonstrated, the next step would consist of building a demonstration thermal power plant with a capacity of 32 MW. Not only would this boost the supply of renewable electricity, it might also serve as a benchmark for future power plants fuelled by biomass.

As this technology is still quite incipient, it is hard to estimate the potential power that could be generated by this renewable source. However, it is worthwhile stressing that gas-fired micro-turbines offer significant

[20] In fact, automobiles running on gasoline use a mixture of gasoline and anhydrous ethanol called gasohol. The percentage of ethanol in the fuel as of today varies from 20% to 25% in Brazil.

[21] The next section will analyse the possibility of producing electricity by co-generation in the sugar and alcohol sector.

Figure V. Market shares: ethanol and gasoline



Source: MME (2001).

potential for technological innovation, and could be used by various sources of energy, breaking away from the large-scale production paradigm to some extent. Consequently, this would be particularly applicable in more remote regions, or at places with ample supplies of biomass wastes.

Sugar-cane bagasse

One of the factors making ethanol more competitive on the fuels market would be a reduction in production process losses. Some technical and economic feasibility studies have been undertaken for this purpose, focusing on sugar-cane by-products such as bagasse and straw.

In 2001, the installed power generation capacity of Brazil's sugar and alcohol sector reached 1,541 MW (Coelho et al., 2002). Studies on converting bagasse into electricity indicate the immediate technical possibility of boosting usage levels from 4% at the moment to 16% when including co-generation using waste materials throughout the entire year.[22] Based on the BIG/GT Gas Turbine Project, gasification technology might even step up these conversion levels to over 27%, although this is still at the development stage.

Five different technologies available in Brazil to produce electricity from sugar-cane products are presented by Coelho et al. (2002). Their productivity rates vary between 10 kWh per ton of cane (tc), when producing electricity only during the harvest season (150 days/year), and 126 kWh/tc, when producing electricity 7,450 hours/year, at a capacity factor of 85%.

Based on the more efficient 126 kWh/tc technology, at an approximate cost of US$ 1,000/kW, Coelho et al. (2002) estimate the technical power generation potential based on bagasse at 3,852 MW. A more optimistic stance is adopted by Tolmasquim et al. (2002) for power generation potential based on sugar-cane by-products. There are two aspects contributing to these results. The first is the harvesting technique: using traditional methods, only 270 kg of bagasse/tc become available, while mechanized harvesting produces a yield of 390 kg of bagasse/tc.

The second aspect is related to power generation technology. Four different types are analysed: the current counter-pressure method (10-20 kWh/tc); boosting the efficiency of the traditional counter-pressure cycle (14-44 kWh/tc at a cost of US$ 222-667/kW); condensation and extraction steam turbine — CEST (80-100 kWh/tc at a cost of US$ 1,450-1,650/kW); and the biomass gasification integrated power generation cycles (200 kWh/tc at a cost of US$ 950-1,150/kW).

Table 7 gives the cogeneration potential for the sugar and alcohol sector used by Tolmasquim et al. (2002).

It is important to stress that power production based on sugar-cane bagasse matches up perfectly with Brazil's

[22] Tolmasquim et al. (2002) indicate some factors that explain the fact that the cane bagasse recycling level is well below optimum.

Table 7. Cogeneration potential in the Brazilian sugar and alcohol sector, by technology

Cycle	Harvesting method	Capacity (MW) 2001	2005	2010
Current counter-pressure	Without recovery	1,040	1,127	1,214
	With recovery	1,493	1,618	1,742
Efficiency-enhanced counter-pressure	Without recovery	3,121	3,381	3,641
	With recovery	4,480	4,853	5,227
Condensation and extraction cycle	Without recovery	5,964	6,461	6,958
	With recovery	9,951	10,780	11,610
Biomass gasification and combined cycle	Without recovery	12,344	13,373	14,402
	With recovery	18,264	19,786	21,309

Note: The method without recovery consists of the system producing 270 kg of bagasse per ton of sugar-cane produced, while the method based on recovery consists of mechanized harvesting, using only the straw and tips, making 390 kg of biomass/tc available.

Source: Tolmasquim and Neto (2002).

hydro-based system. The dry season coincides with the period when there are ample supplies of sugar-cane bagasse available (Góes and Schaeffer, 2002). However, Brazil's current option to step up the share held by natural gas for power-production purposes competes directly with a hydro-based system, as the gas-fired thermo-fired power plants must function non-stop in order to be feasible in economic terms. In other words, natural gas-fired thermal power plants will enter the power generation base as guaranteed energy. Should the hydro-dams hold surplus water, this energy would be wasted if the water is released. Consequently, the use of sugar-cane bagasse would serve not only to shift the consumption of natural gas by thermal power plants, but also to boost the efficiency of Brazil's power generation sector, while reducing its carbon emissions.

Urban solid wastes

Recycling solid wastes has proven more attractive in major urban centres. In 1999, the Brazilian Regulatory Commission for Electrical Energy (ANEEL) authorized the São Paulo City Council to set up a 26.3 MW thermal power plant fuelled by urban wastes. During this initial stage, all the electricity produced by the Electricity and Incineration Company (Companhia de Incineração e Energia Elétrica (CIEL)) should be consumed by the local authorities themselves. Any surpluses could be channeled to street lighting.

In addition to São Paulo, other city councils have shown interest in recycling garbage, including Rio de Janeiro, Porto Alegre and Curitiba. In the case of Rio de Janeiro, in particular, a recent emissions inventory showed that methane emissions from the Gramacho Landfill are the main source of greenhouse gases emitted by that city (La Rovère et al., 2000).

Overall, Brazil produces some 45 million tons of urban solid wastes a year, according to data drawn from the Basic Sanitation Survey undertaken by the Brazilian Institute of Geography and Statistics (IBGE) in 2000. As some of the garbage can be recycled and the remainder could be used to generate electricity, this volume of solid wastes would be equivalent to generating some 140 TWh/year[23] (Oliveira et al., 2002). This would account for a significant portion of the electricity consumed in the major urban centres of the country, or almost all the electricity consumed by the residential, commercial and public sectors together, which reached some 160 TWh in 2000 (MME, 2001).

In fact, these figures are affected by the technologies used. Looking only at power generation, Tolmasquim et al. (2002) present five different technologies for obtaining fuel: simply tapping biogas, accelerated digestion; pre-hydrolysis of biomass; gasification; and incineration. These two latter technologies are not attractive in commercial terms at the moment, with investment costs of US$ 3,250/kW and US$ 4,500/kW respectively (Tolmasquim et al. 2002).

Brazil's technical power generation potential based on urban solid wastes was estimated by Oliveira and Rosa (2002) on the basis of the three more attractive technologies listed above, without gasification or incineration.

Table 8 highlights the pre-hydrolysis technology due to its low investment costs, high yield and consequently ample power generation potential.

Generating electricity from solid wastes is particularly noteworthy as an excellent alternative in major urban centres due to low technology costs, easy availability of feedstock and lighter local environmental impacts caused by garbage disposal, while postponing or even cancelling the construction of natural gas-fired thermal power plants. The CDM projects for garbage recycling plants would play an important role in energy conservation, while using urban solid wastes to fuel thermal

[23] Of the total, 68 TWh/year come from conservation, 54 TWh/year from generation based on modern garbage processing technologies and 18 TWh/year from incineration.

Table 8. Results of power generation technologies fuelled by solid wastes

	Tapping biogas	Accelerated digestion	Pre-hydrolysis
Investment (US$/kW)	1,000	1,500	840
Useful life (years)	15	30	30
Installation period (months)	12	9	18
Emissions avoided (tC/MWh)	1.7	1.7	0.4
Brazilian potential (MW)	267	535	2,968
Generation cost (US$/MWh)	44.69	43.03	28.77

Note:

(1) These figures do not include taxes.

(2) Tapping biogas and accelerated digestion are mutually exclusive. Consequently, the total power generation potential based on solid wastes varies from 3,235 to 3,503 MW.

Source: Oliveira and Rosa (2002).

power plants would contribute to renewable energy generation, avoiding carbon emissions.

Rice husks

Studies on recycling rice husks as fuel to generate electricity have been underway for quite some time. In 1996, the first thermal power plant was established at São Gabriel in the Rio Grande do Sul state, at a cost of some US$ 2 million, with an installed capacity of 2 MW, representing an investment cost of US$ 1,000/kW.

At the moment, it is producing sufficient electricity to meet all the demands of the rice processing industry, with a monthly output of 300,000 bags of rice. The surplus electricity is traded with the regional power utility. According to estimates by the industry itself, rice husk wastes in that state alone would be sufficient to produce 1,200 MW.

The Rio Grande do Sul state power utility (Companhia Geral de Distribuição Elétrica (CGDE)) intends to invest US$ 64.5 million in building 13 cogeneration plants. Their installed capacity could reach 110 MW, which would represent some 8% of the current installed capacity of the state.

With the expansion of rice production towards the mid-west of Brazil, rice processing mills are eager to build thermal power plants in Mato Grosso state through partnerships with other players. Technical and economic feasibility studies are being prepared through the Brazilian National Fund for the Environment (Fundo Nacional de Meio Ambiente (FNMA)). At the moment, the objective of this programme is to identify eligible projects that could be proposed as CDM projects by the Brazilian Government.

Small hydro-power plants

The recent Ten-Year Expansion Plan for 2000-2009, drawn up by Eletrobrás, notes that there were 147 small-scale hydro-power plants in 1999, with an installed capacity of 932 MW (Eletrobrás, 2000). Moreover, this Plan stresses the 730 MW in companies with applications under the aegis of the National Power Plant Programme (Programa Nacional de Centrais Elétricas (PNCE)), in addition to a further 1,185 MW with market potential over the medium term.

Slightly more modest figures are presented by ANEEL. According to this source, in 2001, the installed capacity of small-scale hydroelectric power plants in operation reached 864 MW, with an average annual growth of only 30 MW since 1998 (ANEEL, 2002). Although Eletrobrás agrees that the real expansion of supplies is still very modest, it should be stressed that many of the applications for authorization or approval of feasibility studies or basic designs come from investors with no track-record in hydro-power generation. This reflects the inflow of fresh players to this market and the probable attractions of the business.

The costs are not very high, hovering around US$ 1000/kW (Schaeffer et al., 2000). Some government measures have been taken to attract private capital, in terms of both regulations and financial incentives. Through the PCH-COM programme established in February 2001, Brazil's National Social and Economic Development Bank (BNDES) is financing up to 80% of these investments. The PCH-COM programme also guarantees the purchase of any energy produced by the small hydro-power plants at a price equivalent to 80% of the rated value established by ANEEL. The BNDES target is to install an average of 400 MW a year from 2001 through 2003.

Another similar programme was launched in Minas Gerais state in November 2001. The PCH-MG programme guarantees the purchase of electricity generated by small hydro-power plants at a rate equivalent to 100% of the value stipulated by ANEEL. Despite its financial attractions, this programme is limited to Minas Gerais state and companies with a capacity of over 5 MW (Tolmasquim et al., 2002). The target of the

Table 9. Investor stakes in small hydro-power plants (percentage)

Status	Government	Self-producer	Independent producer
In operation	53.78	32.13	14.09
Under construction	11.34	11.78	76.88

Source: ANEEL (2002).

Minas Gerais State power utility (CEMIG) is 400 MW over the next three years.

It seems quite clear that the process of market transformation is already underway as reflected in the emerging profile of entrepreneurs building small hydro-power plants in Brazil. In the past, the government sector had a greater market presence, (see table 9) through the significant percentage held by the government sector. However, when looking at power plants under construction, a significant increase in independent power producers is noted.

Estimates for the remaining potential of the small hydro-power plants vary widely. Some sources, such as Tiago (2001), rate this potential at 7 GW, while the Ministry of Mines and Energy estimates it at 14 GW (MME, 2002). This lack of certainty to some extent discourages the private sector. Preparing an inventory of the remaining potential in Brazil's river basins would significantly mitigate the risks of companies while helping disseminate this source of energy.

Within this context, small-scale hydro-power plants could help cut carbon emissions by the power sector in the near future, as they would be competing directly with thermal power plants covered under the Expansion Plan for this sector. The downside of this option is the construction period, which is normally longer than for the thermal power plants, delaying returns on investment for companies.

Photovoltaic Solar Power

Photovoltaic systems post installation costs of around US$ 7,000/kW (Nascimento, 1998). This figure may increase even more to around US$ 9,000-12,000/kW, when including the battery replacement costs. The low capacity factor at around 20% also boosts these costs.

At this stage, as the technology is still maturing, government intervention is required in order to ensure that it begins to penetrate the market. Government programmes such as the Light in the Countryside (Luz no Campo) and the Municipal and State Energy Development Programme (Programa de Desenvolvimento Energético de Estados e Municípios (PRODEEM)) are underpinning the development of photovoltaic energy. The Light in the Countryside Programme was established in December 1999 in order to provide one million rural properties and homes with electricity over a three-year period, underwritten by grants from Eletrobras through the Global Reversion Reserve (Reserva Global de Reversão (RGR)). The PRODEEM programme has a potential market of 100,000 communities in remote locations, with capacity of around 35 MW, estimated by Tolmasquim et al. (2002), based on a 25% capacity factor, with 3,114 communities assisted by the PRODEEM programme through to 2001.

Another important government action to encourage the spread of alternative sources of energy in isolated communities is outlined in the draft resolution prepared by ANEEL in 2000, imposing mandatory universal access to electricity, which is a target for all Brazilian citizens. According to data provided by the Brazilian Institute of Geography and Statistics (IBGE, 2002), 25% of the rural population still lacks access to electricity.[24]

The retail market is expanding at an annual rate of between one and two megawatts thanks to the revolving funds and financing for micro-entrepreneurs established through partnerships between non-governmental organizations and development banks. The Bahia State Small Farmers Association (Associação de Pequenos Produtores do Estado da Bahia (APAEB)), the Teotônio Vilela Foundation and the Institute for Sustainable Development and Renewable Energies (Instituto de Desenvolvimento Sustentável e Energias Renováveis (IDER)) have already installed over 2,500 household systems supported by the Banco do Nordeste.

In addition to this partnership, the NREL Laboratory in the United States and the Eletrobrás Research Centre (CEPEL) have installed 1,200 photovoltaic systems in several states. However, Tolmasquim et al. (2002) stressed the fact that 35% of a sampled 180 systems mentioned in Ribeiro (2001) were out of operation, due mainly to a lack of technical assistance from the power

24 In 1990, the percentage was 45%.

utility. In addition to high costs, this would be a further barrier slowing the spread of photovoltaic technology among remote communities in Brazil.

Solar energy is particularly appropriate for remote communities in northern Brazil, where it could reduce or even replace the current stand-alone power generation systems based mainly on oil products. However, government programmes require fine-tuning in order to pave the way for photovoltaic power to spread into more isolated parts of the country. Otherwise, fossil fuels will prevail within the context of mandatory universal access to electricity.

Wind energy

Wind power potential is based on data collected for Brazilian Wind Power Potential Atlas (Atlas do Potencial Eólico Brasileiro) (MME/Eletrobras/Cepel, 2001). This publication ranks regions with competitive potential as those where average wind-speeds exceeds 6.7 metres/second (m/s), as power generation costs hover around US$ 40-US$ 50/MWh (Pereira, 1998), with the installation costs rated by Nascimento (1998) between US$ 900-US$ 1,400/kW for old plants and US$ 760-US$ 1,000/kW for new plants, with the arrival on the market of a new generation of turbines.

In northern Brazil, only the coastal regions of Para and Amapá states seem attractive, where winds reach speeds of 5.0 to 7.5 m/s. North-east Brazil offers the best potential, particularly in the coastal strip running 100 kilometres inland in Maranhão, Piauí, Rio Grande do Norte and Ceará states, where average wind speeds vary from 6 to 9 m/s. The escarpments of north-east Brazil also post high wind speeds of around 6.5 to 8 m/s.

In mid-west Brazil, on the border with Paraguay and the south-east region in Rio de Janeiro and Espírito Santo states, as well as in higher parts of São Paulo state, wind speeds of 7.5 m/s are also recorded. Along the southern coastline, average wind speeds of 7 m/s are posted, with an average wind speed of 8 m/s at Palmas in Paraná state.

It is worthwhile noting that in south-east Brazil there is only limited complementarily between the wind and hydro-power systems. In contrast, north-east Brazil offers a high potential wind/hydro complementarity, as the windiest season coincides with the lowest water levels in the São Francisco River (Tolmasquim et al., 2002).

Table 10. Estimated wind-power potential

	Potential (MW)	Generation (TWh/year)	Capacity Factor (%)
North	12.84	26.45	24%
North-east	75.05	144.29	22%
Centre-west	3.08	5.42	20%
South-east	29.74	54.93	21%
South	22.76	41.11	21%
Brazil	143.47	272.2	22%

Source: MME/ELETROBRÁS/CEPEL (2001).

The technical potential for wind power in Brazil is 143 GW, with this potential by region given in table 10. The north-east is particularly outstanding with 52% of the total, followed by the south-east at 21%.

At the moment, only 21.2 MW are installed, mainly at Prainha (10 MW) and Taíba (5 MW) in Ceará state, and Palmas (2.5 MW) in Paraná state (Muylaert et al., 2001). However, feasibility studies for several wind-power projects are reaching an advanced stage. There are two 30 MW projects in Ceará state run by the local power utility (COELCE), in addition to a wind farm planned for Jeriquaquara (100 MW). There is also the possibility of building a 100 MW wind farm in Ceará state under an agreement with the Thyssen-Krupp company. Studies are also underway in other parts of Brazil establishing wind farms: 50 MW by the Wobben company at Salinópolis in Pará state; 50 MW at Cabo Frio in Rio de Janeiro state; and the expansion of the Palmas wind farm with a further 85 MW in that region (ANEEL, 2000).

According to the Brazilian Energy Balance, there is a capacity of 3,757 MW for plants being licensed by ANEEL (MME, 2001). The largest projects are located in north-east Brazil with capacities of up to 756 MW. Within this context, wind power is an interesting alternative for CDM projects in north-east Brazil, as it would avoid or at least postpone the construction of thermal and/or hydro-power plants[25] or stringing power lines from northern Brazil.

25 It is worthwhile noting that the climate in north-east Brazil is semi-arid, and the intensive use of water courses for producing electricity could trigger conflicts with the users of these resources for other purposes.

Energy efficiency

Two government programmes have been established in Brazil in order to deal with the issue of energy efficiency in a direct manner. The Brazilian National Electricity Conservation Programme (Programa Nacional de Combate ao Desperdício de Energia Elétrica (PROCEL)) was established in December 1985 and the Oil Products and Natural Gas Rational Use National Programme (Programa Nacional de Racionalização do Uso de Derivados de Petróleo e do Gás Natural (CONPET)) was established in June 1991.

Working on both the demand and the supply sides, the PROCEL programme initially focused its activities on the demand side, such as labelling, household appliances, energy auditings and street lighting. Later, from 1994 onwards, the PROCEL programme expanded its range of action to include actions focused on lighting in the domestic and commercial sectors, boosting the efficiency of government buildings, reducing losses in the power system and others.

From 1996 through 1998, the PROCEL programme attained power savings of around 1.9 TWh/year. In other words, this means that, on average, power plant with a capacity of over 400 MW was not built, or its start-up date was postponed.

Table 11 gives the results of the PROCEL programme for this three-year period. Dividing the investments allocated by the equivalent plant capacity shows that conservation actions costs are relatively low. However, it should be stressed that it is difficult to calculate the exact amount of energy saved, as well as identifying all of the transaction costs involved in an energy conservation programme.

In 1997, its projects designed to boost energy efficiency were still focused on the demand side. Of the 1,758 GWh saved that year, only 194 GWh were related to power generation and distribution activities.

Table 11. Global results of the PROCEL programme, 1996-1998

	1996	1997	1998
Approved investments(US$ million)	50	113	137
Investments made (US$ million)	19.5	37.7	43.4
Energy saving (GWh/year)	1,970	1,758	1,977
Equivalent plant (MW)	430	415	460
Reduction in peak load (MW)	293	976	532
Investments avoided (US$ million)	856	770	793

Source: Eletrobras/PROCEL (1998).

Table 12. Results of the PROCEL programme by lines of action, 1997

	Energy savings (GWh/year)	Reduction in demand (MW)
Refrigerators and freezers	333.2	47.5
Engines	216.0	37.9
Air conditioning	49.4	10.8
Lighting	592.7	135.2
Installing meters	228.1	83.3
Power generation and distribution	194.3	30.8
Advertising campaign	–	600.0
Others	144.1	30.1
Total	1,757.8	975.6

Source: Eletrobras/PROCEL (1998).

Table 12 gives the results of the PROCEL programme by category.

Although initially focusing its activities on the demand side, the planned investments in the PROCEL portfolio for 1998/1999 were slanted towards the supply side. Of the total amount, 51% were allocated to reducing losses, 17% to upgrading load factors, 19% to street lighting and marketing, 4% to the industrial sector, 3% to the residential sector, 3% to government buildings and 3% to other activities (Eletrobras/PROCEL, 1999).

In terms of electricity conservation potential, some authors estimate that the technical potential hovers around a 30% reduction in power consumption in Brazil as a whole, with the economic potential at around 20% and the market potential at around 10% (Almeida et al., 2001).

Efficiency enhancement projects for Brazil's power sector would be equivalent to postponing the construction of new natural gas-fueled thermal power plants. But in order to energy efficiency projects to be eligible for CDM projects, it is necessary to develop reliable baselines so as to guarantee that the additionality criterion is met. Additionally, it is important to analyse the barriers blocking the start-up of these projects. If the transaction costs are not too high, then the CDM could consequently help lower the barriers blocking the entrance of these energy-efficiency projects into the market.

In summary, because Brazil's energy structure is already dominated by renewable energy but a vast potential for further projects (hydropower, wood, sugar cane and other biomass resources, wind) in this area still exists (although the business-as-usual scenario for the power sector clearly points to an expansion in power capacity with natural gas-fuel power plants), energy demand is growing fast, and like any developing country Brazil also has readily available energy efficiency opportunities, a great potential for CDM projects does exist in the energy sector in the country in the areas of fuels substitution (mainly renewable energy) and energy efficiency.

3 Priority sectors for CDM projects in the industrial sector

This chapter presents potential gains in energy efficiency, as well as the possibilities for substituting fuels in industry. The potential for gains in energy efficiency is estimated by the gaps between the energy intensities of Brazilian industries and those in other countries, as well as the energy efficiency gaps noted in useful energy balances. The possibilities for substituting fuels are calculated on the basis of the energy consumed for process heat and direct heating. This demand could well be met by fuels that are less carbon-intensive or through cogeneration.

Initially, we undertake an aggregate analysis of Brazilian industry, comparing some energy intensities with international standards. We then break down this industry for analysis, highlighting the main energy consumption sectors. An analysis of the potential energy efficiency and possibilities for cogeneration in key sectors complete this section.

Potential for energy efficiency gains and fuel substitution in industry

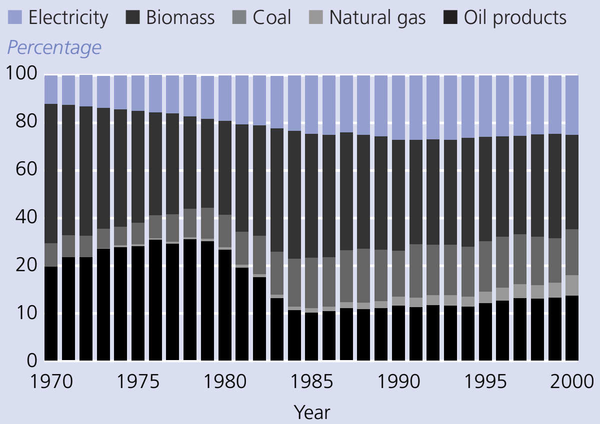
In chapter 2, we stressed the notable penetration by renewable types of energy in Brazil's energy matrix during the 1980s. Brazilian industry was one of the main sectors of the economy providing leverage for this trend. In fact, industry proved sensitive to relative price changes or constraints on fuel supplies, demonstrated through the rising participation of renewable sources of energy in industrial consumption immediately after the second oil crisis in 1979, within a context that favoured renewable sources of energy. However, since oil prices began to drop in 1985 renewable energy sources have been losing market share.

In parallel to higher fossil fuel prices during the early 1980s, the Brazilian Government cut oil imports and imposed fuel quotas on industry until 1983, as oil was the main item on Brazil's import listings. The National Petroleum Council (Conselho Nacional do Petróleo (CNP)) imposed across-the-board cuts of 10% and 5% in fuel oil and diesel oil respectively, for industrial supplies.

Offsetting the recessive steps forced on industry, the Brazilian Government offered financial and tax incentives during the 1980s, particularly for substituting and conserving energy. For instance, the Conserve energy conservation programme was established in 1981 to foster energy conservation by industry, with the development of products that were less energy-intensive, wider use of processes that were more efficient in energy terms, and encouragement for the substitution of imported fossil fuels by other energy sources domestically produced. A fund was set up to underwrite this programme, providing loans under favourable conditions only to companies under complete Brazilian control.

The recession that swept through the early 1980s left much idle industrial capacity in its wake. This blunted the interest of the business sector in investments, with a consequent drop in the demand for loans, even those provided under the Conserve programme. The Brazilian Government was obliged to take firm steps, as some hydro-power plants were in the final construction phase.

Figure VI. Share held by energy sources in industry



Source: MME (2001) .

With the idle capacity in Brazil's power generation sector, the Brazilian Government introduced the Guaranteed Energy for Specific Time (Energia Garantida por Tempo Determinado (EGTD)) rate for the industrial sector, mainly for companies wishing to substitute oil products by electricity. This tax incentive was the final step required to boost electricity consumption by industry, as this sector, under this programme, had the guarantee of very low electricity tariffs for a couple of years. This programme ended in 1986, but the consequences of it is that, even as of today, some industries still use electricity for heating purposes.

Figure VI shows the market shares held by the main energy sources in Brazilian industry. Heavy penetration by fossil fuels appears during the 1970s, with this situation being reverted during the first half of the 1980s. Renewable energy sources have increased appreciably, particularly biomass. However, during the 1980s, the market share held by fossil fuels began to increase again, particularly natural gas.

Despite the penetration of fossil fuels over the past few years, the share of renewable energy sources on total industrial energy consumption is still quite significant. In 2002, electricity and biomass accounted for 53% of industrial energy consumption.[26] Although the share held by these sources is high, it is important to recall that in 1984 they peaked at 64%, which, to some extent, indicates that there are possibilities for further expansion of renewable sources of energy in industry.

In terms of biomass, it is worthwhile stressing that the percentage of renewable fuelwood used to produce charcoal has risen significantly over the past few years in Brazil. Table 13 shows the percentages of non-renewable fuel wood for charcoal-making, reflecting a trend that seems to be moving firmly away from felling

Table 13. Percentages for charcoal produced from native timber

1976	1980	1984	1988	1992	1996	2000
91%	86%	83%	78%	61%	30%	28%

Source: ABRACAVE Yearbook, various editions.

Table 14. Energy consumption (thousand toe)

	1985	1990	1995	2000
Industry	40,296	42,799	50,618	59,977
Mining	1,250	1,269	1,527	2,238
Manufacturing Industry	39,047	41,529	49,091	57,738
Non-metals	4,506	4,518	4,789	6,574
Ferrous and Non-ferrous	14,335	16,207	18,479	19,960
Chemical	4,045	4,158	4,689	6,320
Foods and Beverages	8,601	8,211	11,088	12,528
Textiles	1,021	1,198	1,086	1,029
Paper and Pulp	3,123	3,564	4,800	6,135
Other	3,416	3,674	4,161	5,194
Energy sector	11,277	11,785	12,564	12,041

Source: MME (2001).

Table 15. Share of Industry in total GDP (percentage)

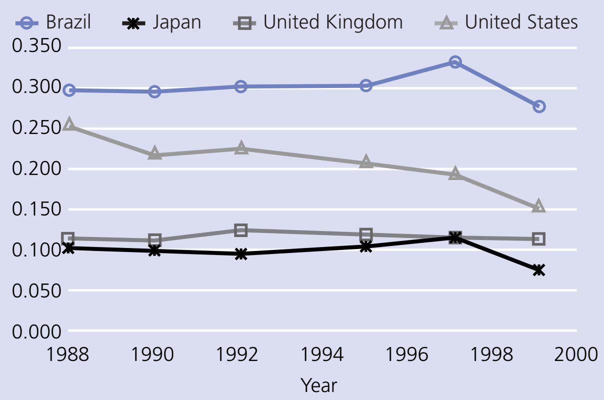
Country	1988	1990	1992	1995	1997	1999
Brazil	35.2	34.2	34.0	33.0	31.5	30.8
Japan	40.7	41.2	40.4	38.2	34.0	32.1
United Kingdom	37.0	35.0	31.8	31.7	31.0	28.6
United States	29.9	28.1	26.1	26.9	27.0	27.0(*)

(*) 1997 value.

Source: MME (2001), www.wri.org and World Bank, World Development Indicators 2002, www.worldbank.org/data.

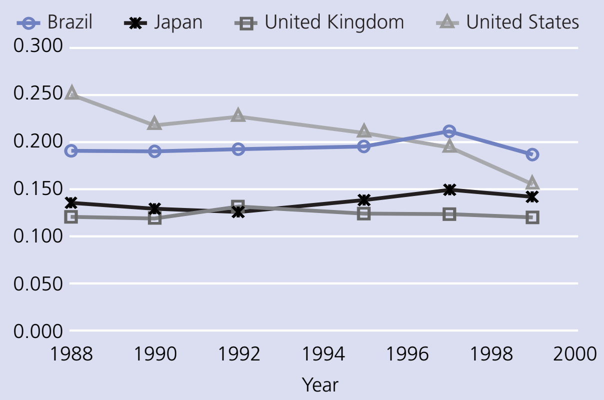
26 It is clear that a certain percentage of biomass is non-renewable in origin. Table 13 shows the percentage of charcoal produced from native forests. Taking this same percentage of 28% for fuelwood and charcoal consumed by industry as being non-renewable in origin, the percentage of the renewable energy in Brazil's energy matrix drops from 53% to 51%.

Figure VII. Energy intensities in constant US dollars, 1990 (kgoe/US$90)



Source: MME (2001), IEA (2000), www.wri.org and www.worldbank.org/data.

Figure VIII. Energy intensities in US dollars PPP, 1990 (kgoe/US$90 PPP)



Source: MME (2001), IEA (2000), www.wri.org and www.worldbank.org/data.

native timber to make charcoal. It is expected that this trend will be repeated in various other economic segments.

Offering an idea of the scope of industrial energy consumption in Brazil, table 14 provides information on industrial energy consumption by industrial sub-sectors.

In terms of energy efficiency, an assessment can be undertaken by measuring energy intensities. There is no doubt that this indicator is affected by product prices in various countries, as well as the composition of the basket of goods produced by any specific country.[27] However, energy intensity is an indicator that is used worldwide. Here, we introduce some corrections into the calculation for this indicator[28] and also undertake some supplementary analyses further on.

In this specific case, we compare the industrial energy intensities of four countries: Brazil, Japan, United Kingdom and the United States. The industrial value added was calculated on the basis of the portions of the GDP allocated to industry. Table 15 shows the share in the industrial GDP for all four countries.

The energy intensities are calculated in two different ways. The first is based on value added in constant US dollars, base year 1990. Figure VII shows the development of industrial energy intensities for the four countries in question. It can be noted that the energy intensity of the Brazilian industry is extremely high, three times as much the rate for the country posting the lowest energy intensity. The United States has managed to reduce its energy intensities significantly over time, although its figures are still higher than those of Japan and the United Kingdom.

The other way of calculating the energy intensity is based on the GDP — purchasing power parity (GDP PPP) in US dollars — 1990 (IEA, 2000). The percentages shown in table 15 are applied to the GDP PPP in order to estimate a GDP PPP for industry.[29] Figure VIII shows the industrial energy intensities calculated through the GDP PPP. In this case, Brazilian industry shows to be less energy-intensive, but the figures are still high compared to those for Japan and the United Kingdom. The industrial

27 Developing countries generally produce goods that are less sophisticated and more energy-intensive. In other words, industrial energy intensities in developing countries are generally higher than in industrialized countries, because the average value added by the sectors are lower in developing countries, while energy consumption is higher than in the industrialized countries.

28 In an international comparison, it is not only the monitoring unit used for the added value of the sectors that should be compatible, but also the energy transformation coefficient. Moreover, the calculation should include both commercial and non-commercial energy.

29 This is a relatively simple way of correcting the difference in prices among countries. In the case of Brazil, an average relative price is used for the economy as a whole. The price correction could be improved with a better knowledge of the relative prices in each economic sector.

energy intensity of the United States exceeded the figures for Brazil for quite some time, but over recent years its industrial energy intensity has dropped to a level close to that of Japan.

Consequently, analysing Brazilian industry as a whole shows that there is probable potential for either enhanced energy efficiency or lower losses as well as the substitution of fossil fuels by sources that are less carbon-intensive. Moreover, there is a possibility for a higher penetration of renewable energy sources if comparing their current market shares with the levels attained during the 1980s.

Priority sectors for CDM projects

The potential for energy efficiency gains or the reduction of energy losses is based on an analysis of indicators such as energy intensity, specific energy consumption, current and rated equipment performance, or type of end-use. The energy intensities for the subsectors of the Brazilian industry are calculated through the two schemes presented in the previous section, namely: by a constant 1990 US$ and by a 1990 US$ PPP. The added values in US$ PPP are calculated for the shares of each subsector in 1990 US$ PPP and GDP PPP.

The energy intensities of the selected subsectors of the Brazilian industry can be compared to the energy intensities of corresponding subsectors of the United States industry.[30] In this case, it would be appropriate to compare the energy intensities after correcting for the price differences. Nevertheless, this type of analysis is flawed to some extent because the composition of the basket of goods produced by a given subsector differs from country to country.[31] A more detailed analysis could be undertaken, based on a thorough knowledge of the composition of the basket of products manufactured by each subsector, as well as the technology used in the production processes. However, this type of analysis would have to be backed by detailed industrial energy auditings, which are difficult to conduct and are consequently rarely available.

We also estimate the potential for substituting fossil fuels by energy sources that are less carbon-intensive, focusing on energy used to produce process heat and direct heating. This analysis is undertaken in greater depth when estimating the cogeneration potential in key sectors through the ratio between electricity and heat consumption by each subsector. The subsectors rated as having a good potential for cogeneration based on gas-fired turbines are those with an electricity/heat consumption (E/H) ratio ranging between 1/3 and 1 (Eletrobras, 1999).

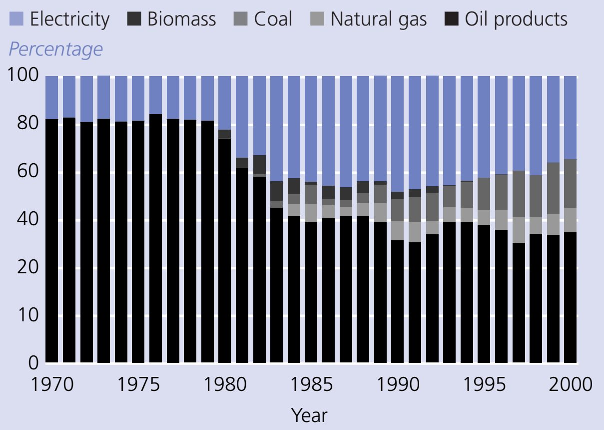
Mining

The mining sector had high consumption levels of oil products during the 1970s. After the second oil crisis, there was initially an upsurge in electricity replacing oil products, followed by an increase in coal and natural gas use. Later on, these two fuels began to replace electricity during the 1990s, while biomass played a minor role, with an almost negligible share throughout the 1980s. Figure IX provides information on the share of different energy sources for the mining sector.

The larger share held by fossil fuels over the past few years has boosted the energy intensity for this sector, as these fuels have yields lower than that of electricity. Figure X shows the trends in energy intensity for the mining sector in Brazil over time.

In the current economic context, the energy intensity could be lowered if natural gas replaced the coke used for direct heating during the ore fines pelletizing

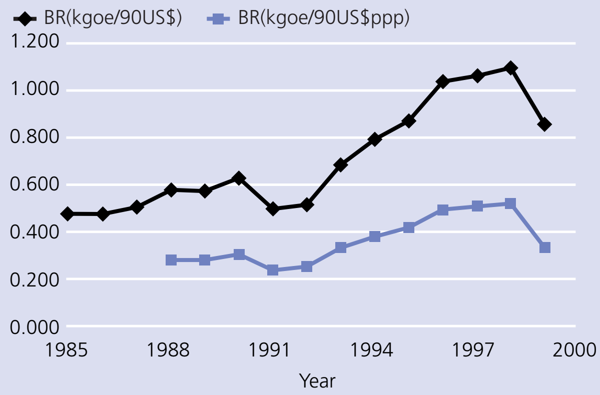
Figure IX. Share of energy sources in the mining sector (percentage)



Source: MME (2001) .

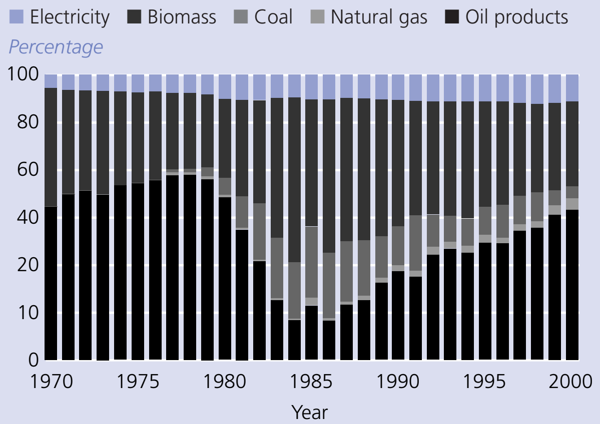
30 The selection of the United States for this comparison was prompted by the easiness of access to more detailed data.
31 This problem is not specific to the energy intensity indicator (energy/value), as the specific energy consumption indicator (energy/mass) suffers from the same problem.

Figure X. Energy intensities for the mining sector



Source: MME (2001).

Figure XI. Shares held by energy sources in the non-metals sector (percentage)



Source: MME (2001).

stage.[32] The gains in energy efficiency would be 11% through simply substituting the fuel, rising to 33% using the reference technology for the useful energy balance — 1993 (MME, 1995).

Carbon emissions could be cut by 30% to 45% if natural gas replaced coal and oil products. These estimates are based on the differences in fuel emission coefficients and the limited participation of natural gas in this sector at only 8% in 2000. Emissions could be reduced even further if charcoal were used instead of coke, although this would not result in any reduction in energy efficiency for pelletizing, according to the latest Brazilian useful energy balance (MME, 1995).

Non-metals

The non-metals sector turned largely to biomass and Brazilian coal to cope with the crises of the 1980s, while the penetration of electricity remained relatively modest over the years. In 1984, the share held by fossil fuels on total energy consumption by this sector shrank to under 40%. But once their prices dropped, oil products once again took over a significant portion of energy consumption by this sector. Today, the share of fossil fuel have risen back to almost their 1970 levels.

Figure XI shows the evolution over time of the share of different energy sources in the non-metals sector. Particularly noteworthy is the nimbleness with which this sector substituted energy sources during the years when constraints blocked the supply of fossil fuels. It is also worthwhile underscoring the penetration of biomass over this period, which, to a certain extent, reflects the potential of this source for the sector, should market conditions change.

This flexibility is explained by the fact that much of the energy consumed is used for direct heating purposes. According to the last balance of useful energy (MME, 1995), fuel oil was the main source of energy for heating in the cement industry, while fuelwood played a leading role in the ceramics sector. For the former, there are no gains in energy efficiency through switching to natural gas, while for the latter there would be a 43% gain in energy efficiency, but CO_2 emissions would increase.

A certain stability is noted in Brazil's energy intensity over time, with an upshock during the second half of the 1990s, looking at the index calculated in dollar PPP.[33] The energy intensity of the United States non-metals sector, on the other hand, shrank drastically over

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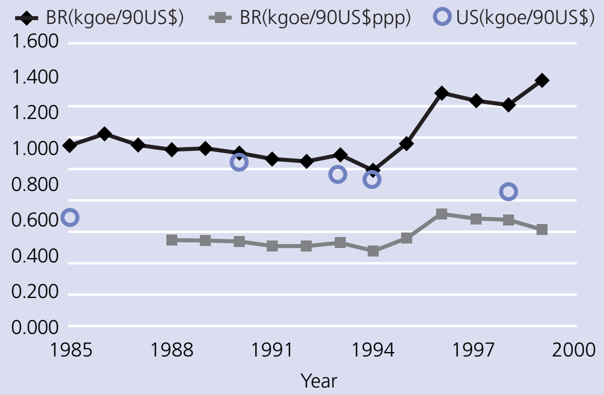
32 Direct heating presented some 22% of energy consumption by the pelletizing sector in 1993, or some 8% of the entire mining subsector.

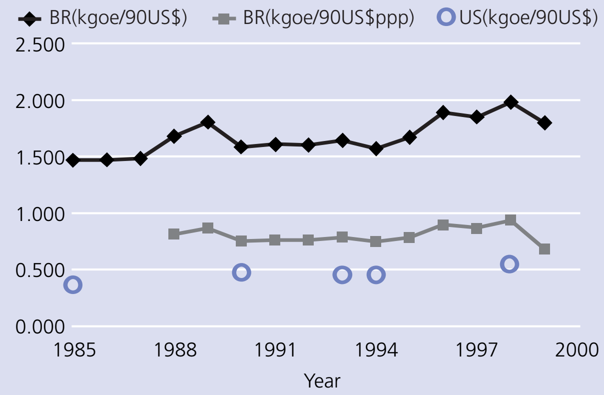
33 The increase in the energy intensity calculated in constant United States dollars — 1990 may have been affected by variations in relative prices, as the energy intensity in dollar PPP did not vary as sharply.

Figure XII. Energy intensities for the non-metals sector



Source: MME (2001), US Census Bureau (2001), www.eia.doe.gov and www.unido.org.

Figure XIV. Energy intensities for the metallurgical sector



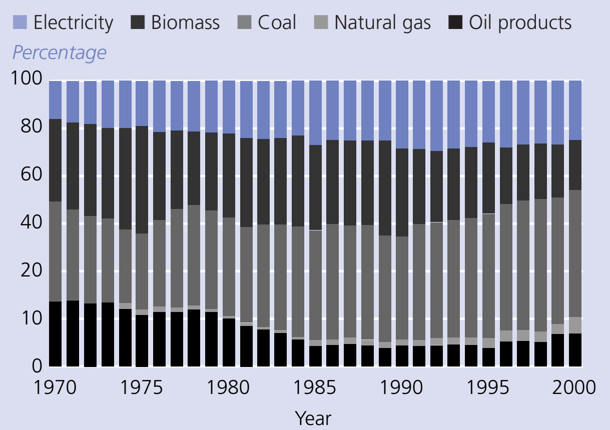
Source: MME (2001), US Census Bureau (2001), www.eia.doe.gov and www.unido.org.

the years, moving toward Brazilian levels, when compared to the calculation in PPP. Figure XII gives the development of the energy intensities for the non-metals sector in Brazil and the United States.

Ferrous and non-ferrous metals

The main sources of energy used by Brazil's metallurgical industry are charcoal, coke and coal, channelled largely to producing pig iron and steel. Figure XIII shows the rising participation of fossil fuels over the past decade, particularly coal (including coke) and natural gas.

Figure XIII. Share of energy sources in the metallurgical sector (percentage)



Source: MME (2001).

In general, coal is used by small and medium-size mills to produce pig iron. It is also used fairly widely by the ferroalloys industry at the moment. With the privatization of Brazil's steel sector, integrated steel production technology based on coke began to predominate. These fuels offer the same efficiency ratings for direct heating, which is the main use for energy sources by the pig iron and steel industry. The current trend is due to gains in scale through integrated production, relative fuel prices, and the experience of foreign investors in coke-based production.

The metallurgical sector is a good example of how to check whether the basket of products and the processes used affect the energy intensity or the specific consumption of the sector. For instance, a coke-fuelled integrated process posts a specific energy consumption of 16.8 GJ/t of raw steel, while processes based on electric-arc blast furnaces post a specific consumption of only 6.6 GJ/t of raw steel (Henriques Jr, 1995). The share held by steel production based on electrical processes reached 21% in Brazil and 39% in the United States at the start of the last decade (Henriques Jr, 1995).

These differences between production processes affect the energy intensities for the sector. Figure XIV shows that the energy intensities in the United States are well below those in Brazil, even when correcting the added values by the PPP.

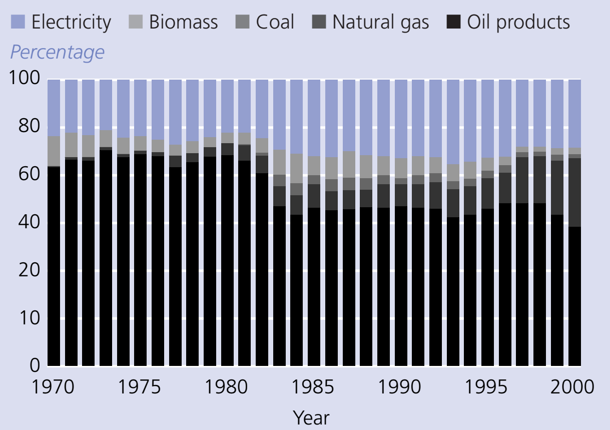
In Brazil, the gains for voltaic arc technology, or the semi-integrated route, would consist not only of a reduction in specific consumption or the energy intensity, but also a drop in CO_2 emissions, as power generation is largely hydro-based. It should be stressed that the steel production process using the semi-integrated route needs a certain amount of scrap. However, as scrap recovery activities in Brazil are still somewhat limited, resulting in some transaction costs, this would require some incentives to become really effective at the moment.[34]

The most immediate solution for the sector with regard to carbon emissions would be incentives to replace coke by charcoal, bearing in mind that Brazil has full mastery of this technology with significant potential for innovation, producing high-grade pig iron with few impurities that could prompt more interest among potential purchasers.

Chemicals

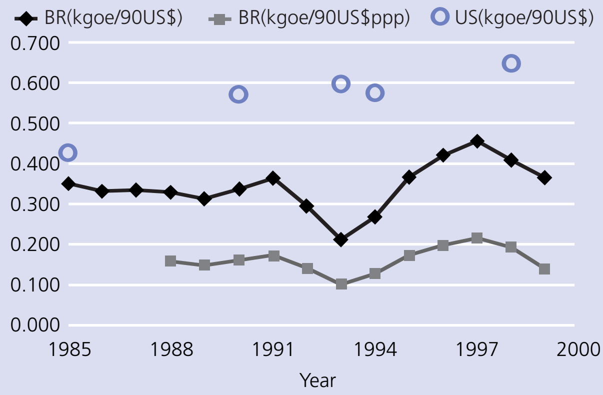
The chemical industry turned to electricity, fuelwood, natural gas and steam coal during the difficult years of the 1980s. At the moment, natural gas stands out as an increasingly important energy input material, with the contributions of fuelwood and steam coal shrinking rapidly. Figure XV shows the share of different energy sources of energy in the chemical sector.

Figure XV. Share held by the sources of energy in the chemical sector (percentage)



Source: MME (2001).

Figure XVI. Energy intensities for the chemical industry



Source: MME (2001), US Census Bureau (2001), www.eia.doe.gov and www.unido.org.

At the start of the past decade, natural gas was used only for direct heating, according to the Brazilian balance of useful energy (MME, 1995), while this sector turned mainly to fuel oil for process heat. There are no gains in efficiency through replacing fuel oil by natural gas, and this substitution would be feasible only if gas prices were competitive and if gas were easily available, or with possibilities of connections to the distribution grid.

The energy intensity for the Brazilian chemicals sector varied during the period under analysis, bottoming in 1993 and peaking in 1997. The high energy intensity of the United States chemical industry can be explained by the composition of the products manufactured by this sector[35] rather than by the consumption of fuels that have lower efficiency of use, as in 1998 the United States industry basically consumed electricity and natural gas. Figure XVI shows trends over time of the energy intensities of the chemical industry.

The short-term options for this sector to reduce its carbon emissions would be substitute fuel oil by natural gas and cogeneration. There is a considerable potential for reducing specific energy consumption levels for soda-chlorine and ethylene production. These possibilities are analysed below, together with cogeneration.

34 On various occasions, the Brazilian Government turned down the suggestion put forward by the automobile industry that the entire fleet should be scrapped in order to encourage domestic vehicle production and reduce environmental pollution. This suggestion also indicated that tax reductions would be required in order to underpin its feasibility.

35 According to the ranking in the US energy balance, the main products were Other Basic Organic Chemicals and Plastics Materials and Resins (EIA/DOE, www.eia.doe.gov).

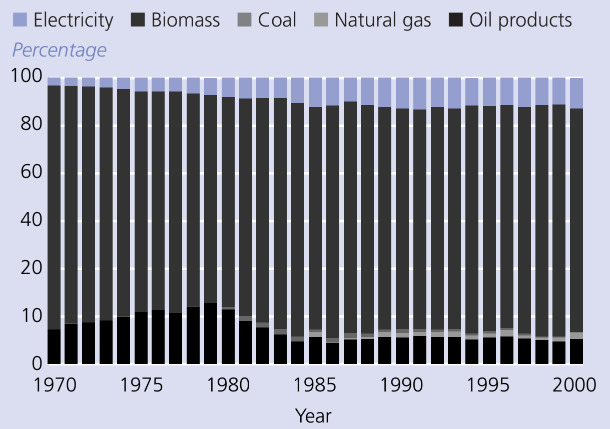
Food and beverages

The food and beverages sector in Brazil has a particular characteristic consisting of a high biomass consumption rate for energy purposes. Almost all biomass can be considered as renewable, since 80% of the biomass consumption consists of products deriving from sugar cane, with the remaining 20% being fuel wood.

Biomass was the main energy source substituting oil products during the 1980s. Electricity was the second most important energy source over this period, but since 1985 its contribution has levelled off at around 10%. Similarly, fossil fuels did not increase their shares significantly over the past decade. Figure XVII also shows that natural gas has not proven competitive for this sector, which uses sugar-cane by-products as its main fuel.

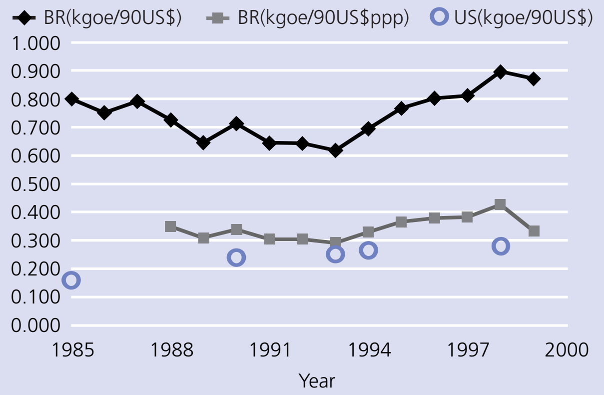
With regard to energy intensity, Brazil seems to be less energy efficient than the United States. However, the Brazilian food and beverage sector basically uses renewable energy sources, while electricity and natural gas are preferred choices in the United States. The use of these sources in Brazil to replace biomass could well step up the energy efficiency by 15% to 20% for process heat and 60% to 100% for direct heating, according to data in the Brazilian balance of useful energy (MME, 1995). However, these substitutions would imply in higher carbon emissions by this sector. Figure XVIII shows the trend over time of the energy intensities of the sector.

Figure XVII. Shares held by energy sources in the food and beverages sector (percentage)



Source: MME (2001).

Figure XVIII. Energy intensities for the food and beverages sector



Source: MME (2001), US Census Bureau (2001), www.eia.doe.gov and www.unido.org

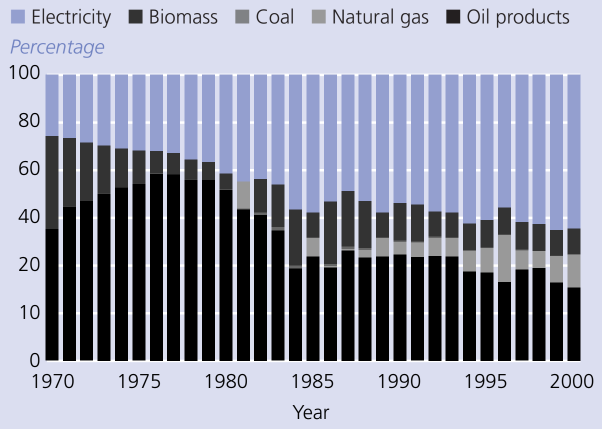
According to the balance of useful energy, there are possibilities for improvements of some 10% in the energy efficiency for process heat, which is the main end-use for this sector. This improvement would not imply any reduction in emissions though, because this sector basically works with renewable sources of energy. However, the food and beverages sector offers a large potential for cogeneration, particularly industries requiring cooling and refrigeration facilities, carbonization, electricity and process heat. This would be a potential class of CDM projects for this sector.

Textiles

The Brazilian textile industry posted an upsurge in oil products consumption during the first half of the 1970s, while electricity consumption rose even more sharply, reaching significant levels around 2000. Electricity and fossil fuels replaced much of the biomass during the 1970s. Although this sector returned to biomass for a while during the 1980s, natural gas has proven more competitive over the past few years, replacing both biomass and oil products. Figure XIX shows the share held by different energy sources in the textile sector.

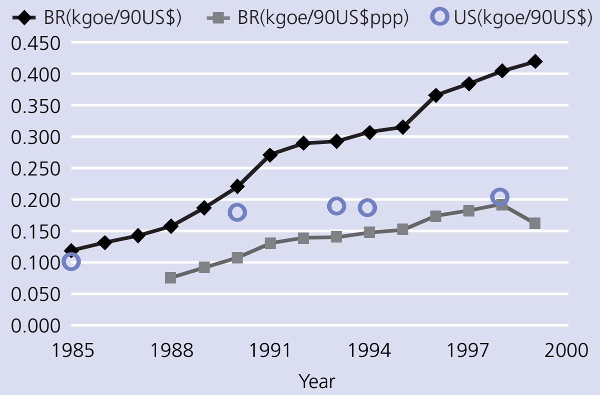
Despite the already large share held by electricity and natural gas, the energy intensity of the Brazilian textile sector has risen over the past few years. In contrast, the energy intensity of the United States textile sector has remained relatively stable over time. These levels are comparable to those of the Brazilian textile industry, when calculated in dollar PPP. Figure XX shows the trends in energy intensities for the textile sector over time.

Figure XIX. Shares held by energy sources in the textile sector (percentage)



Source: MME (2001).

Figure XX. Energy intensities of the textile sector



Source: MME (2001), US Census Bureau (2001), www.eia.doe.gov and www.unido.org.

Based on the balance of useful energy, the potential improvement in energy efficiency in the textile sector is limited. However, it would be desirable for the Brazilian textile industry to replace fuel oil used for process heat by natural gas. Within this context, a reduction in carbon emissions would take place not because natural gas can be used more efficiently, but rather through the substitution of a carbon-intensive fuel by another that is more environmentally friendly.

Pulp and paper

During the first half of the 1970s, oil products were replaced by biomass and electricity in the pulp and paper sector. Still during the last half of the 1970s, biomass began to play an even more important role in the sector, with a share of around 60% since 1984. Electricity and fossil fuels use remained stable over the past few years, while natural gas proved non-competitive. Figure XXI provides information on the shares held by different energy sources in this sector.

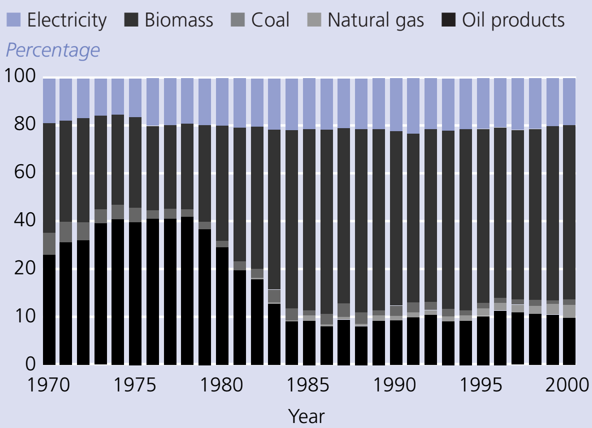
In terms of energy intensity, this sector became less energy intensive during the 1980s. However, an upsurge in the energy intensity is noted during the 1990s. When corrected by the US$ PPP, the Brazilian figures are always lower than those for the United States. Figure XXII displays these trends.

The CDM alternatives for the pulp and paper sector are not the replacement of energy sources, as a significant portion of the energy consumption in this sector is already based on renewable sources. In fact, there is a large potential for improving energy efficiency of the sector and also for a more widespread use of cogeneration, particularly through the reuse of waste materials generated in the production process. These aspects will be covered in the following sections.

Energy efficiency potential in energy-intensive sectors

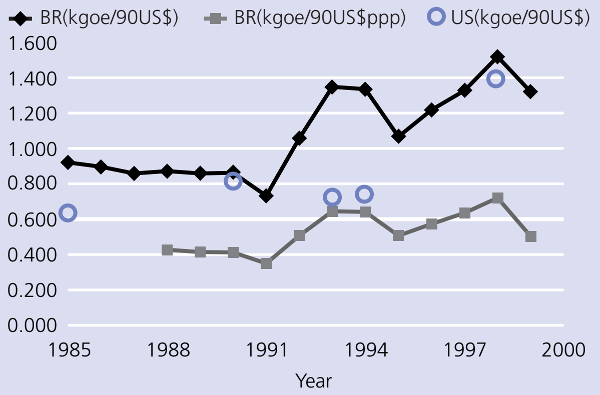
Although a significant share of the energy consumed in Brazil is already renewable, a large potential for carbon emissions reductions do remain in the industrial sector

Figure XXI. Share of energy sources for the pulp and paper sector (percentage)



Source: MME (2001).

Figure XXII. Energy intensities for the pulp and paper sector



Source: MME (2001), US Census Bureau (2001), www.eia.doe.gov and www.unido.org.

Table 16. Specific energy consumption in selected energy-intensive sectors

	Current technology	Technology available	Advanced technology	Brazilian technology
Ferrous and non-ferrous (GJ/t)				
Raw steel	23.4	14.7	12.9	25.9
Finished steel	21.2	13.8	12.1	21.2(*)
Aluminum	126.4	103	90.1	107.7
Chemicals				
Soda chlorine (kWh/t)	—	2,980	—	3,379
Ethylene (GJ/t)	—	19.5	—	22.8
Pulp and Paper (GJ/the)				
Kraft process for				
Woodpulp	8.7	5.2	4.6	8.7
Newsprint	14.6	9.8	5.9	14.6
Cement (MJ/t clinker)	—	3,985	2,241	5,837

(*) Assuming the same specific consumption for the United States in 1989.

Source: Adapted from Henriques Jr., (1995).

as more energy-efficient technologies are widely available for both the renewable and non-renewable parts of energy consumption.

There are at least two ways for estimating the potential for energy efficiency gains. The industrial sector potential may be estimated as follows:

- The difference between the specific energy consumption in the sector in question and the specific energy consumption of the technology used by an industrialized country or the technology available in these countries, or a more sophisticated technology with some market penetration potential.
- Through energy auditings in the sector. In this case, equipment performance can be measured and process technologies can be disclosed by product. However, this is a laborious task, which normally prevents it from being undertaken with frequency, with this kind of procedure being generally limited to just a few industrial sectors.

Both these methodologies were used by Henriques Jr,. (1995) to estimate the potential for energy efficiencies gains for energy-intensive sectors in the industrial sector in Brazil. For the former, the author used as benchmarks three classes of technologies presented by the United States Congress Technology Department.

Table 16 summarizes the specific energy consumption figures for some energy-intensive sectors studied by Henriques Jr., (1995). The references for calculating the potential gains in energy efficiency are the technologies used in the United States in 1989 (current technology), the best technology available in the market, and a more sophisticated technology available in the near future.

Table 16 shows that the specific energy consumption of raw steel produced through the integrated coke technology could be cut by 10% in Brazil, when compared to the figures for the Unites States in 1989, by 43% compared to the best available technology, and by 50% compared to the cutting-edge technology. When compared with the European standard (19.7 GJ/t), the specific energy consumption could be cut by 24% (Henriques Jr., 1995).

However, for finished steel, it was assumed that the specific consumption for the Brazilian industry does not differ significantly from that for the United States in 1989, with potential reductions of 35% and 43% compared to the best available and cutting-edge technologies respectively. The Brazilian aluminium sector is already more efficient than its United States counterpart in 1989, despite further potential for energy consumption reductions of 4% and 16%, based on the best available and cutting-edge technologies.

In the chemical sector, the energy efficiency of soda-chlorine production could be improved by 12%, with 15% for ethylene. If compared with the average European standard (15.4 GJ/t), this latter could be improved by 32%. On average, the pulp and paper

Table 17. Potential energy savings (percentage)

	Fuel	Electricity	Total
Steel	21.3	12.7	15.6
Aluminum	5.0	7.2	7.1
Ferroalloys	5.0	10.7	10.6
Soda-chlorine	18.9	14.4	15.7
Ethylene	18.9	13.7	15.7
Pulp and paper	15.5	14.4	14.9
Cement	15.8	14.2	15.2
Total	17.2	11.1	13.1

(*) Assuming the same specific consumption for the United States in 1989.

Source: Adapted from Henriques Jr., (1995).

sector could reduce its specific consumption by 30% and 40%, and the cement sector by 32% and 62% respectively, through the best available or cutting-edge technologies.

The potential gains in energy efficiency were also estimated by Henriques Jr., (1995) based on some energy auditings. In this case, some end-uses are selected and two energy sources studied: electricity and fuels. The electricity consumption study was divided into engines, furnaces and electrolysis, while fuel consumption was split into three categories: fuel upgrades for furnaces and boilers, heat recovery, and better insulation.[36] Table 17 presents the potential gains in electrical efficiency and for fuels, in energy-intensive sectors.

The potential for fuel consumption reductions and the resulting drop in carbon emissions by the steel, cement and chemical industries are significant in the case of Brazil, this is because, as shown before, these sectors are large consumers of energy sources in general, and of non-renewable energy sources in particular.

With regard to electricity, although the Brazilian power generation sector is based largely on renewable energy sources, electricity efficiency is important today in order to delay the construction of new power plants, some of which will certainly be fossil-fuel thermal power plants.

[36] Technological innovations are excluded, such as those related to modifications or the introduction of new industrial processes.

Cogeneration potential in selected sectors

The Power Systems Planning Coordination Group (Grupo Coordenador do Planejamento dos Sistemas Elétricos (GCPS)) set up by Eletrobrás carried out a study in April 1999 on Brazil's cogeneration potential in the sugar and alcohol, chemicals, oil refining, steel, and pulp and paper sectors (Eletrobras, 1999). This study analysed the specific characteristics of each sector in terms of the availability of waste materials suitable for use as fuels, access to natural gas, sectoral capitalization levels, location in industrial hubs, capacity to set up partnerships, and size of the industries.

Table 18 gives the market and technical potential for cogeneration, with the market potential split into self-producers and independent power producers (IPPs). The market potential estimates are presented for 2003, but it is worthwhile noting that some progress has taken place since the publication of the Eletrobras study, lowering some of the barriers that used to prevent a more spread use of cogeneration facilities in the industrial sector in Brazil.

The sugar and alcohol/pulp and paper industries share the characteristic of large amounts of solid wastes generated by their production processes. Sugar-cane bagasse and black liquor can be used respectively as heat sources and fuel in the sugar and alcohol/pulp and paper sectors. The cost of implementing the necessary technology in the sugar and alcohol sector varies from US$ 1,000-1,200 US$/kW.

Table 18. Cogeneration potential in Brazil (MW)

	Installed capacity	Market potential SPs(1)	IPPs(2)	Technical potential
Sector/Years	1998	2003	2003	
Sugar and alcohol	995	1,175	25	4,020
Chemicals	389	1,141	440	1,581
Oil refining	171	428	3,855	4,283
Steel	341	695	0	875
Pulp and paper	718	1,189	0	1,740
Total	2,614	4,628	4,320	12,499

Note: (1) SP: Self-production and
(2) IPP: Independent Power Producers

Source: Eletrobras (1999).

In the steel industry, the cogeneration potential varies, depending on the steel production technology. The Eletrobras study estimates that Brazil will follow the global trend towards more semi-integrated mills, using scrap and electricity as feedstock. This process is more efficient in energy terms, consuming less energy per finished product unit, and, consequently, cogeneration is not applicable here.

However, cogeneration is quite feasible in integrated coke-fired mills, as the coking plant, blast furnace and steel waste gases and the coke heat can be used together. The potential is even greater for charcoal-fired steel mills, particularly for the pig iron producers.[37] On average, this subsector uses only 60% of the gas generated in its furnaces to pre-heat the air injected into the furnaces themselves, with the remaining 40% not being used for energy purposes (Eletrobras, 1999).

For the oil refining sector, the basic model currently used consists of Petrobras participating in a consortium of companies supplying fuel and consuming electricity and steam. To set up this type of consortium, the companies must be located in an industrial hub.

Finally, it is worthwhile stressing that table 18 shows that installed capacity accounted for some 20% of the technical potential only in 1998. The independent power producers appear only as potential stakeholders, while the self-production projects stand out due to the fact that electricity consumption is guaranteed. These projects are frequently prepared by a consortium of companies through project financing that reduces risks. However, independent power production requires long-term supply contracts with the distributors or direct consumers. Within this context, a key factor providing leverage for cogeneration in Brazil would be the establishment of a setting that fosters partnerships between electricity regulators, generators, distributors and consumers.

In summary, because Brazil's industrial sector is dominated by energy-intensive industries (cement, iron and steel, ferroalloys, mining, non-ferrous and other metals, chemicals, foods and beverages, textiles, pulp and paper, etc), the relative importance of these industrial subsectors is growing (among other things because these subsectors contribute with an important share of the total exports of the country, which is increasingly in need of hard currency), there is a huge potential for energy efficiency improvements in most of these subsectors, and because renewable fuels, although already play an important role in total energy consumption in industry, still have a large potential to increase their share, a large potential for CDM projects do exist in the country in the areas of process change, energy efficiency and fuel substitution in industry.

37 It is interesting to notice that wider penetration of non-integrated charcoal-based technology would pay double dividends: on the one hand it would replace coke while on the other it would reduce electricity consumption through cogeneration.

4 Current state of CDM project development in Brazil

This chapter presents the current state of CDM project development in Brazil, excluding those projects related to afforestation and/or reforestation only. Due to confidentiality matters, several projects may present missing information about their location or even the identity of their proponents.

The data is organized according to the following structure:

- The Project (objective or description of the project);
- Project Sponsor (stakeholders involved);
- GHG Offset (abatement or sequestration perspectives);
- Sustainability Issues (other benefits such as employment creation, regional development, environmental positive externalities, government support for policy);
- Current Status (under consideration, in preparation, ready to be submitted as a CDM project). The current status ready to be submitted as a CDM project is used for the most advanced projects that could already be considered as standard CDM projects, approved or under approval from National authorities, according to actual criteria in Brazil.

United States-Brazil ASPEN Global Forum CDM projects (May 20-22, 1999)

The ASPEN document (Goldemberg et al, 1999) was prepared through a joint effort of the Lawrence Berkeley National Laboratory and the University of São Paulo. The authors, José Goldemberg, José Roberto Moreira, Steve Meyers and Jayant Sathaye, produced a list of 14 projects that deserve to be considered under the CDM regime. The projects cover essentially two mechanisms for CO_2 abatement: use of renewable energy or energy efficiency measures to displace energy obtained from fossil fuels, and carbon sequestration through biomass plantation. In addition, one project reduces emissions by replacement of CO_2 in industrial processing. For an overview of the projects, two summary tables present the energy projects and the carbon sequestration ones.

According to the ASPEN document (Goldenberg et al., 1999), some of the projects were economically feasible even without gains obtained through the value of carbon credits. Nevertheless, these projects seem to have a small chance of being implemented due to the high cost of money in Brazil and the lack of capital guarantees that can be provided by the project sponsor alone. The major interest of the sponsors is to find investors that are interested in carbon credits and that can also be partners in the ventures. Another group of projects seem to be able of being implemented by the project sponsors alone, should actors be found that are willing to acquire carbon credits. Finally, other projects are listed that are economically feasible, but the project sponsors want to discuss the possibility to qualify them for carbon credits.

Small hydro in the state of Goiás

THE PROJECT

The state of Goiás, situated in the centre/west part of Brazil, has several regions which are short in electrical energy supply. This project plans to offer 10 MW of installed power to the existing utility owned grid. The energy would be supplied by a small hydroelectric plant, Mambai II, which would be installed in Sitio D'Abadia and will be operated by the natural flow of a river that is part of the Rio Tocantins basin, without the necessity of a water reservoir.

Project sponsor

CPE — Consórcio de Produtores de Energia is the main sponsor. CPE is a civil engineering company and is working at this moment to establish the basis for a Power Purchase Agreement (PPA) with CELG, which is the utility that has the responsibility for supplying electrical energy to the consumers of the region.

GHG offset

When connected to the grid, Mambai II will be part of the integrated south/south-east/centre west electric system, which already has a small share of the electricity generated by coal and oil plants. The short term future expansion will include several natural gas based thermal plants. If we consider that usually this type of plant runs with a capacity factor of 80%, and assuming the expected capacity factor of 70% for this small hydro plant, one can assume the displacement of a 8.75 MW natural gas plant, avoiding the emission of 13,000 tC per year.

Sustainability issues

Government looks positively to expansion based on small hydro generation, because it is a clean energy source that will provide energy that would otherwise have to be generated by fossil fuels. As the project will not need a water reservoir, there will be no land flooding and therefore it will not affect the local landscape and the people settled nearby.

Current status

Under consideration.

40 MW wind project in north-east brazil

The project

The project consists of two wind farms of 30 MW and 10 MW to be built near industrial centres of Macao and Araripina in the north-east Brazilian states of Rio Grande do Norte and Pernambuco, respectively. Electricity from the wind farms will be sold to the state electric utilities, which have preliminarily agreed to purchase the electricity at a tariff equivalent to the tariff at which they buy natural gas-generated electricity.

Project sponsor

The project sponsor is a consortium of private companies currently in the process of being formed. The consortium, coordinated by EOLICA (the Brazilian Wind Energy Centre, incorporated as a private foundation), consists of two European wind turbine manufacturers, a British design firm, two Brazilian electric utilities, a Brazilian engineering firm, and EOLICA itself.

GHG offset

Due to the differences between their capacity factors (30% for wind generation plants and 80% for natural gas plants) and assuming 30% thermal efficiency for the natural gas plant, avoided carbon emissions are estimated at 22,000 tC/year.

Sustainability considerations

Installation of the wind farm in north-east Brazil is a way to avoid consumption of fossil fuels. Hydroelectric expansion in the north-east is limited and must include thermal generation. According to one of ELETROBRÁS latest plans, which forecasts supply and demand of electricity in the 1998-2007 period, the planned expansion will be based on hydroelectricity (72.7%), interconnection with south-south-east/centre-west system (18%), and thermoelectricity (8.9%). Present installed capacity in the north-east is 14.7 GW and ELETROBRÁS plans foresee 24 GW by the end of 2007. The demand, according to the same ELETROBRÁS plan, will grow at an annual rate of 6.3%/year, requiring 25.5 GW of installed power by the end of 2007. Therefore, there are good chances to have an energy shortage and any increase in supply will be welcome.

Government looks positively to wind generation. Besides helping to reduce possible energy shortage, it is a clean energy source, will open technology transfer possibilities, and will displace electricity that would otherwise be generated by fossil fuels.

Current status

Under consideration.

Hydroelectricity generation for the state of Amapá

The project

In the state of Amapá most of the electricity is consumed in the cities of Macapá and Santana, which are 20 km apart. The hydro capacity in the area cannot be expanded, since large land areas would have to be flooded, and the gas turbines in operation are at the end of their lifetime. In the border of the state of Amapá there is a convenient site for a 100 MW run-of-river hydro facility. The project foresees the installation of 3 units of 33 MW, which can be built at different phases. The run of river plant has the capacity to generate 60 MW year around. The remaining 40 MW is not available during 4 months due to seasonability variations (this means that one possibility is to install two units instead of three). The remaining power could be delivered to Macapá/Santana cities, requiring the construction of a 200 km long transmission line.

Project sponsor

The major interested partner is JARI CELULOSE. The company has been operational for more than 20 years but has had financial problems during its existence, and is in continuous negotiation with banks for managing its debts. JARI is presently approved by ANEEL as an Independent Power Producer, and is selling part of its generation to consumers located in the neighbourhood of the pulp and paper facility. It is looking for a partner, possibly to form a new company which would be in charge of the new hydrogeneration facility and the transmission lines.

GHG offset

The hydroelectricity produced will mostly displace fuel oil and diesel oil. With a capacity factor of 70%, the hydro plant could displace 57.75 MW oil based thermal generation, which usually operates with a capacity factor of 80%, avoiding thereby the emission of 109,000 tC/year, totalling 3.2 million tC after 30 years of operation.

Sustainability issues

The hydro facility does not require a dam, avoiding flooding land, and will not interfere with the present river landscape. Local pollution (in Macapá and in the JARI factory) is expected to be reduced.

Current status

In preparation.

Water cleaning for hydroelectric facility near São Paulo

The project

In the neighbourhood of São Paulo city, which is located at an altitude of 750 m, there is a 1000 MW hydroelectric facility (installed almost at sea level), which after several decades of operation remains in standby for more than 95% of the time due to water shortage. Up to 1970 water pumped from the Pinheiros River (which crosses the city) was used to drive the electric plant. Due to severe water pollution, environmental initiatives forbid the storage of such water in reservoirs near the city and consequently the operation of the hydroelectric plant. A possible solution to the water pollution problem is being proposed through the use of an energy-intensive water cleaning mechanism. Through water cooling and production of micron ice crystals it is possible to clean water. Energy for the cleaning facility will be supplied by electricity generated by the hydroelectric plant. The full operation of the 1,000 MW hydro plant requires a water flow of 147 m^3/s, from which 95% must be pumped from the dirty river. A demonstration project should be able to treat some few per cent of this amount, in order that a 10 fold larger facility will allow the commercial operation of part of the 1,000 MW hydro plant. It is necessary to prove the technical and economic feasibility of the proposal. Gaining financial resources for this phase would be easier if the full project receives interest of potential investors. The operation of the hydro plant will offset fossil fuel used in thermal plants. Availability of CERs to foreign investors is a way of increasing the number of interested partners and improving the economic feasibility of the project.

Project sponsor

CO DEVELOP LIMITED is an engineering company based in Maryland, USA, involved with development of projects in Brazil mainly through the BRASILINVEST GROUP. The sponsor identified a technology offered by MAYEKAWA MFG CO. in Japan which can be used for the proposed project. CO DEVELOP LIMITED intends to involve electric utilities from the state of São Paulo as partners for the complete project implementation.

GHG offset

Assuming the hydro facility operates as described above and displaces electricity generation using natural gas, the estimated GHG reduction would be 385,000 tC/year.

Sustainability issues

The existence of a standby hydro facility is a cost for the country. Its operation will save fossil fuel, and reduce air pollution. In addition, the availability of water for the industries located at sea level and near the power plant should reduce their energy consumption since wet cooling towers can be used. There is also the potential to reduce salt water penetration into the underground water of the region, which is assumed to be caused by the absence of water flowing in the direction of the ocean.

Current status

In preparation.

Village electricity generation using palm oil

The project

This project intends to make an installation of a bio-electricity system providing 50 kW in one village. Along with the installation of an electric generator it is also necessary to build a local electricity distribution network, which would include a step-up and step-down transformer. Electricity will be sold to the houses. It is expected that commercial activities triggered by the availability of electricity will help the village development. There would be a future need for a nearby palm oil plantation to easily obtain the fuel. EMBRAPA, a federal owned agricultural company, has 500 ha of oil palm plantation, which is only useful for the operation of an Elsbett type motor-generator set of 100 HP. The company is unable to sell palm oil due to difficulties imposed by federal regulation and due the 70 km of bad road connection. The state government of Amazonas has negotiated with EMBRAPA and villagers will be allowed to exploit the existing plantation for some time without cost. Near the EMBRAPA plantation are several villages which can be involved in the future in similar projects. Considering the small size of the installation, the electric plant must be locally administered. With proper training to the local community it is possible to qualify people for the operation of the plant. Maintenance service must be provided by a qualified organization.

Project sponsor

The PROMAK INDÚSTRIAS MECÂNICAS Ltda. already installed an electric system using palm oil in Boa Esperança village. PROMAK received grants from the Federal Government to cover the installation costs. Boa Esperança village has received electricity from an Esbelt type diesel engine for a year. The electric motor set has accumulated more than 2,000 hrs of operation without any major issue. Maintenance is being carried with parts acquired in the city of Belém, since most of the parts are common to diesel engines largely used in trucks. The service is provided by PROMAK for a fee.

GHG offset

In the absence of the vegetable oil, diesel oil (at a rate of 0.25 l/kWh) would have to be consumed, yielding emissions of 240 kg C/MWh or 88 tC/year.

Sustainability issues

Government should look favourably on this project because it is an opportunity to supply clean electricity to areas that would otherwise have diesel oil as the only alternative. Furthermore, with electricity locally generated with fuel also locally produced, the currency involved with these activities will stay in the area. Added to the income from the palm oil plantation for food products, it will provide the village inhabitants with improvement in their life standard, making them less interested in the sale of native wood, reducing the pressure on the forest.

Current status

Under preparation.

Lighting efficiency improvement in buildings

The project

The basic concept of this project is to cut 50% to 60% of electricity consumptions for lighting in a chain of commercial stores and/or a private university via utilization of efficient lighting technologies. As lighting can represent around 40% of the total electricity consumption, this means a reduction on the electricity bill of around 20%. Several small-scale projects already implemented by the sponsor in supermarket stores show that the utilization of specular reflectors with tri-phosphor fluorescent lamps maintains the level of lighting while cutting to half the number of fluorescent lamps in use. The reflector is especially designed and produced in each case to suit the light fixture and at the same time provide an efficient light distribution. Illuminance is kept on the original level and the power demand of the light fixtures is cut by 50%. By cutting to half the quantity of lamps, half of the ballasts are deactivated and can be used for further maintenance. With only half of the lamps and ballasts in use, there is an additional saving from reduction of maintenance costs. In case the facility uses air conditioning, an additional reduction on the power demand is obtained via reduction of the thermal load.

PROJECT SPONSOR

The sponsor of this project is NEGAWATT- PROJETOS, ENGENHARIA E COMÉRCIO LTDA., a Brazilian private company acting since 1992 in several energy-related projects. A main area of business is in lighting projects, which can include all related activities from design to final installation. Main customer of these projects is CBD, the second biggest supermarket chain in São Paulo, which has more than 300 stores. NEGAWATT is presently working to convince two potential customers to sign a contract. One of them is CBD, where lighting retrofit would be applied to 20-30 stores. After appraisal of the results on this first batch of stores, the project could be replicated to other CBD stores or to other customers. One is a private university, where a good potential for electricity savings was already detected and the same idea could be applied. NEGAWATT is seeking a partner to help with the necessary investments. It is ready to discuss destination of CERs and to collaborate in supplying engineering capacity, a significant share of the material to be used, and administrative services.

GHG OFFSET

The 20 store-project could avoid the emission of 1,000 to 2,000 tC/year, and the University project could avoid emission of 500 to 1,000 tC/year, if the saved electricity is assumed to substitute electricity that would be generated by thermal power plants. This is the expected situation in the near future since expansion of electricity generation in the south-south-east integrated system will be obtained, in part, from natural gas based power plants.

SUSTAINABILITY ISSUES

Energy conservation is an important issue for the government. Since 1985 and 1992 two national programmes on electricity savings (PROCEL) and oil savings (CONPET) have been established. These programmes have financial resources to promote conservation and PROCEL has invested time and money in the creation of an association of Energy Service Company (ESCOs) to strengthen the electricity conservation practice. This project will help promote the ESCO concept.

CURRENT STATUS

In preparation.

Charcoal from forest plantation for a pig iron industry — PLANTAR

THE PROJECT

Pig iron — a semi-industrialized raw material used in the production of steel — is produced in the state of Minas Gerais by independent producers who traditionally use charcoal as both fuel and feedstock. The project intends to produce charcoal for use in the pig iron industry. Investments are required for a plantation of 9,600 ha and for the transformation of wood into charcoal. The present high cost of creating a forest plantation in Brazil, compared to the low cost of coal, has slowed down the reforestation process, increasing pressure on the native forests or inducing charcoal-based industries to adapt their blast furnaces to the use of coal. It is expected that through the value of carbon offsets, it will be possible to commercialize charcoal at a competitive price.

PROJECT SPONSOR

PLANTAR S/A. — REFLORESTAMENTOS is a Brazilian company based in Belo Horizonte, Minas Gerais. It has been operational in the area of reforestation since 1967. The company has done projects for many clients in the pulp and paper sector and in the pig iron/steel sector. Projects already implemented cover a planted area of 380,000 ha. PLANTAR owns 103,000 ha in forests, another 281,000 ha in rural real estate, as well as agricultural machinery and vehicles.

GHG OFFSET

The project intends to produce charcoal to be used as substitute for coal. If coal is used for pig iron production, the carbon emission for the production of one ton of pig iron would be 513.9 kg. When using biomass, carbon emission for the production of one ton of pig iron is 705.3 kg. There is also storage of 303.7 kg of carbon in the iron. Thus, the use of charcoal avoids the emission of 513.9 kg of C from coal, and stores 303.7 kg of carbon in the iron. This means that each ton of pig iron produced with charcoal avoids 817 kg of carbon. The proposed project should produce 3,650,000 m^3 for each plantation cycle, yielding 1,140,000 t of pig iron and avoiding the emission of 931,380 tC over 14 years of operation.

SUSTAINABILITY ISSUES

An important aspect is the creation of job opportunities for rural workers with low cultural level. The charcoal based pig iron industry in Brazil employs 120,000 workers, from which 73,000 in forestry and charcoal production sectors. Annual production of pig iron is 1.3 million t, which yields 56,000 jobs/million t of pig iron. For this particular project, 1,900 job opportunities will be created.

CURRENT STATUS

Ready to be submitted as a CDM project.

Toyota hybrid motor automobile

THE PROJECT

Toyota has developed and commercialized a hybrid electric/gasoline vehicle (called PRIUS) in Japan with a low fuel consumption. The widespread use of hybrid cars could substantially reduce gasoline consumption, and reduce local and global pollution. The PRIUS is being sold in the Japanese market at a competitive price through a subsidy provided by the government. There are many reasons other than environmental concern to justify the governmental subsidy. It is a new technology and probably costs will decline as more vehicles are produced. Also, it may be a strategy to obtain a segment of the automobile market in other countries.

PROJECT SPONSOR

TOYOTA DO BRASIL is considering to sell the PRIOS in Brazil. It is interested in having this car qualified to receive CERs as a way to promote car sales. TOYOTA DO BRASIL would be the owner of CERs.

GHG OFFSET

Information unavailable.

SUSTAINABILITY ISSUES

The Brazilian Government sponsors, since 1991, an energy conservation programme for oil called CONPET. Brazil imports 15% of its oil needs and better energy efficiency means a reduction in the need for oil imports, with a positive impact in the country's trade balance. Local air pollution is significant in large cities, requiring sometimes a forced control over the operational fleet. With more fuel efficiency, local pollution will be reduced. Considering all the above aspects it is quite likely that the hybrid car would be welcomed by the Brazilian government.

CURRENT STATUS

Under consideration.

South-South-North CDM projects

According to the report provided by SSN (SSN, 2002), an NGO working with CENTRO CLIMA at COPPE,[38] projects that cater for improving energy efficiency and that lead to replacing the use of fossil fuels are clearly on the top of the country's policy priorities (albeit for the sake of economic efficiency rather than for climate change concerns). Most promising opportunities in this field can be found in the end-uses of gasoline and diesel oil in the transport sector, and of fuel oil in industry.

The initial list of CDM project candidates, drawn from the analysis of the Brazilian climate change and institutional context, was reached at the end of phase 2.1 of the SSN project. In Brazil, this first list was produced at the general level of 30 "project ideas", including GHG/sector/end-use/description. The potential stakeholders to discuss them were also identified in phase 2.1. During phase 2.2 of the SSN project in Brazil, 18 of these 30 "project ideas" have materialized in the form of "project concepts" through a process of information collection and discussion with selected stakeholders. Each CDM project concept was, then, reviewed against the sustainable development criteria and indicators developed by the SSN project (Thorne and La Rovere, 1999) and adapted to the Brazilian context. Moreover, the interviews with the stakeholders have also allowed for identifying barriers and opportunities for the con-

[38] See chapter I.

crete implementation of these projects. Taking into account the eligibility criteria (including additionality filters), sustainability indicators and operational barriers and opportunities, the preliminary selection of a short list of four priority CDM project concepts was made. During phase 2.3 these four selected candidates were further detailed through discussions with the stakeholders, refining the analysis in order to confirm the feasibility of starting CDM projects in Brazil. The final selection includes the four top-ranking CDM project proposals (the first two projects presented were selected and the other two are still under contingency) to be implemented in phase 3, as described below.[39]

Fueling garbage trucks with biodiesel produced from used vegetable (cooking) oils in Rio de Janeiro — HIDROVEG

THE PROJECT

This project is designed to replace fossil fuel (diesel oil) used by the transportation sector with the use of biodiesel (methyl ester) made from residual plant oils burned for cooking purposes. This project is designed to measure the technical, economic and environmental feasibility of processing used plant oils that are available on the market. In addition to environmental benefits, this project also offers economic advantages, as biodiesel would not be as sensitive to variations on the international market, even helping out Brazil's trade balance. This project will be located at the Hidroveg plant, which will handle the transesterization stage. The biodiesel will initially be used for mechanical trials in a Government-run fleet of vehicles. The city of Rio de Janeiro was selected for these trials. Without any project activities, part of the used vegetable (cooking) oils would be dumped on sanitary landfills. As this oil decomposes, it generates methane and these emissions might consequently be included in the baseline accounting, which would increase the emissions avoided by the Project activities.

PROJECT SPONSOR

The project participants and beneficiaries are IVIG, COMLURB, McDonald's and HIDROVEG. The facilitating institution is the International Virtual Institute for Climate Change (IVIG — Instituto Virtual Internacional de Mudanças Globais), COPPE/UFRJ, which is in charge of technological development, partner selection, technology transfers and product quality control. The trucks operated by the Rio de Janeiro Urban Cleaning Company (COMLURB — Companhia Municipal de Limpeza Urbana do Rio de Janeiro) will run on biodiesel produced through this Project. The McDonald's fast-food chain will provide part of the used vegetable (cooking) oil free of charge, which will be recycled as feedstock to produce biodiesel. The project owner is HIDROVEG Indústria Química Ltda., which runs the biodiesel processing plant and is also responsible for collecting the used vegetable (cooking) oil as feedstock, as well as for technological developments, jointly with IVIG/COPPE/UFRJ. The owner is also the project investor, although other investors entrance is open.

GHG OFFSET

Both COMLURB's and HIDROVEG's trucks are fuelled by diesel oil. The diesel used in two COMLURB trucks and the HIDROVEG trucks will be replaced by all the biodiesel produced — 153,000 litres per month — through the proposed project activities. HIDROVEG's fleet uses 70,000 litres of diesel per month, which will be replaced by 77,000 litres of biodiesel. In addition, two COMLURB trucks will also run on biodiesel instead of diesel, each consuming 1,500 litres per month. The consumption of the remaining 70,000 litres per month will be left to other official vehicles such as police trucks, etc. The transformation of vegetable oil used into biodiesel is 98% efficient in volume and 220 ml of methanol (CH_3OH) is consumed. Thus, to obtain one litre of biodiesel it is necessary to have 1.02 litres of oil and 224.5 ml of methanol. During the combustion of 1 litre of biodiesel, which uses 224.5 ml of methanol in its production, 244.5 g of CO_2 are generated. It is expected that in the first six months of the year 2003, only 90 m^3 of biodiesel will be produced a month, to supply the HIDROVEG and COMLURB trucks. From then on, production will achieve 150 m^3 a month, and other consumers will start to use it. In these first six months of 2003, 90 m^3 of biodiesel will be replacing 81 m^3 of diesel every month. From then on, 150 m^3 of biodiesel will come to replace 135 m^3 of diesel a month. Total avoided emissions without methane: 38,521.59 tons CO_2 and

[39] Additionally, SSN and the Centro Clima are developing, with the support of the Brazilian National Fund for the Environment (FNMA) of the Ministry of Environment, the Project Design Documents required to submit to the International Executive Board another 2 potential CDM. In these projects the project owners had no assistance from the Official Development Assistance (ODA), since the investments to implement the project were carried out with the owner's own resources. These projects are described through item F. FNMA projects, in page 123 and were designated by the technical team of the Centro Clima as FNMA project 1 and FNMA project 2.

with methane 59,865.99 tons of CO_2 equivalent, under a crediting period of 10 years and a mitigation cost of US$ 14 to 54 /ton CO_2.

Sustainability issues

The generation of new jobs in the metropolitan region is proportional to the increase in the collected used oil, going from 500 cubic metres a month to 628 cubic metres. The project is expected to be replicable in other large cities. It may encourage the expansion in the area of action of cooperatives, increasing the number of used oil collectors.

Current status

Ready to be submitted as a CDM project.

Power generation through biogas and biodiesel at the Jardim Gramacho Landfill, Rio de Janeiro — GRAMACHO

The project

The installation of a 200 kVA power generator driven by biofuel ensures the self-sufficiency of the Jardim Gramacho Sanitary Landfill, managed by the Rio de Janeiro Urban Cleaning Company (Companhia Municipal de Limpeza Urbana do Rio de Janeiro (COMLURB)). The electricity produced partially from fossil sources in the local distribution network will be replaced by electricity generated from biogas tapped from the landfill itself, supplemented by biodiesel. Through this power generation process, the biogas (CH_4) will be turned into CO_2, reducing its greenhouse gas effects.

Project sponsor

The project participants and beneficiaries are IVIG/COPPE/UFRJ, COMLURB and HIDROVEG. The coordinating institution is IVIG/COPPE/UFRJ, which is in charge of technological development, partner selection, technology transfer and product quality control. The project owner is the Rio de Janeiro Urban Cleaning Company (COMLURB), which manages the Jardim Gramacho Sanitary Landfill and will be responsible for ensuring the feasibility of the Project in the field, providing the generator, the plantation area, the biogas tapping system and the methane flare. The biodiesel will be provided by HIDROVEG Indústria Química Ltda. At the moment, the project owner is also the Project investor, but partnership stakes with other investors are being negotiated.

GHG offset

The project baseline is established on the fact that all the electricity currently acquired by COMLURB from the local distribution company will be replaced by electricity produced in the Project, fueled with approximately 70% of biogas and 30% of biodiesel. According to the business-as-usual scenario, the methane fuel from the landfill biogas that will be used to generate power under the project activity would be emitted into the atmosphere without burning, meaning it would not be turned into CO_2. The total avoided emissions are expected to vary from 42,496.40 tons CO_2 to 51,374.22 tons CO_2, under a crediting period of 10 years.

Sustainability issues

As far as environmental sustainability is concerned, there is a reduction of effluents and of the risk of uncontrolled explosion and improved operation of the Wastewater Treatment Station. Moreover, since all the equipment for this type of process is produced in Brazil, there will be neither payment of royalties nor remittance of profits abroad. It also reduces the impact of the original baseline scenario, which makes use of about 30% of imported equipment. Energy generation from wastes will encourage the production and commercialization of domestic equipment, reducing royalties for electricity generating equipment, particularly turbines.

Current status

Ready to be submitted as a CDM project.

Energy generation through the use of urban solid wastes from the Ilha do Fundão campus of the Federal University of Rio de Janeiro — USINA VERDE

The project

Construction of a power plant fuelled by urban solid wastes produced in the Ilha do Fundão campus of the Federal University of Rio de Janeiro. The benefits are: electricity generation for the campus and reduced amount of garbage that the University sends to sanitary landfills. The proposed plant will consume 30 tons of garbage a day, with the potential, at the conclusion of project implementation, for 1MW of installed capacity.

Since it is a pilot project within a research centre in the University, there will be a system to monitor the temperature and the product being incinerated for later use as inputs to new studies about this project. Since there will be replacement of energy supplied by the distribution utility in the University, some fossil fuels that produce electrical energy in the grid will be displaced. Also, the diesel used to transport the garbage produced by the University to the Caju Transfer Station and then further to the Controlled Landfill of Jardim Gramacho will no longer be used. Furthermore, the garbage will no longer emit CH_4 since it will not be disposed in a landfill for decomposition.

PROJECT SPONSOR

The project participants and beneficiaries are IVIG/COPPE/UFRJ, COMLURB, and USINA VERDE. IVIG/COPPE/UFRJ is responsible for identifying partners, technology transfer and monitoring emissions. COMLURB is responsible for providing the raw material, collecting the garbage on campus and taking it to the plant facilities. USINA VERDE S/A is the owner and is responsible for providing the technology, maintenance and operation of the power plant, as well as for the investment in the adaptation of the existing site and the commercialization of the energy.

GHG OFFSET

The electrical energy used by the University is purchased from the local distribution company considered in the project baseline. This electrical energy will be replaced by the power produced by the generator fuelled by the incineration of garbage produced on campus. The distance considered in the baseline would be that of the Caju Transfer Station to the Controlled Landfill of Jardim Gramacho, 25 km. For each 1MW generated, 30 tons of wastes are consumed, and thus the formation of approximately 2,700 m³ CH_4 (or 2.57 tons of CH_4) are avoided, which are considered in the baseline. Also, it is taken into account the percentage of the electrical energy produced in thermal plants in the state, provided by the utilities, for the same amount of energy that would be consumed in the unit. The total amount of CO_2 equivalent avoided is 364,275.72 tons, under a crediting period of 10 years.

SUSTAINABILITY ISSUES

Energy generation from wastes will encourage the production and commercialization of domestic equipment. Reductions of royalties for electricity generating equipment, particularly turbines.

CURRENT STATUS

Ready to be submitted as a CDM project.

Processing of urban solid wastes through the DRANCO — Dry Anaerobic Composting — system to produce electrical energy and carbon sequestration — NTA

THE PROJECT

Construction of a garbage processing facility for 90 tons/day, in the Caju Transfer Station, using semi-dry anaerobic composting — DRANCO, which allows the production, starting from organic wastes — humid garbage — both of methane gas and organic compounds for agricultural input. The digestion occurs by thermophilic fermentation (55° C), pasteurizing the organic fraction, and thus, the pathogens of the resulting compound. In addition to the compound, the product of anaerobic digestion is methane (CH_4), which is then used as fuel for thermal power generation, displacing fossil fuels. The construction of the DRANCO facility in the Caju Transfer Station will allow treatment of part of the garbage that would be transferred to the Controlled Landfill of Jardim Gramacho, thus avoiding the use of trucks that consume diesel oil during the transport. Furthermore, since the garbage will no longer be disposed in a landfill, it will not emit methane in its decomposition. With the implementation of the plant, electrical energy will be generated for the Caju Transfer Station, thus displacing the fuels used by thermopower stations that provide electrical energy to the distribution utilities.

PROJECT SPONSOR

The project participants and beneficiaries are IVIG/COPPE/UFRJ, the Interdisciplinary Environment Laboratory (LIMA/COPPE/UFRJ), COMLURB, and NTA Tecnologia Ambiental. LIMA and IVIG are responsible for identifying partners, technology transfer and monitoring emissions. COMLURB is responsible for providing the raw material and its screening. NTA Tecnologia Ambiental is the owner responsible for providing the technology, maintenance and operation of the DRANCO plant, as well as for the investment in the adaptation of the existing site and the commercialization of the energy.

GHG OFFSET

The electrical energy used by the COMLURB Caju Transfer Station purchased from the local distribution company is considered in the project baseline. This electrical energy will be replaced by the power produced by the generator fuelled by the DRANCO system. The distance travelled considered in the baseline is that from the Caju Transfer Station to the Controlled Landfill of Jardim Gramacho, 25 km. The baseline would be the transport of 90 tons of garbage by four trucks with a performance of 1km/l, that is, a consumption of approximately 25 litres of diesel per truck. As each litre of diesel emits about 2.69 kg of CO_2, emission would be 269 kg of CO_2 per trip. In the case of the DRANCO system, there would still be accounting of the carbon dioxide that will be sequestered by the absorption of lime in the transformation into calcium carbonate.

SUSTAINABILITY ISSUES

Implementation of the plant in the Caju Transfer Station would also generate direct jobs in the process and indirect jobs because of the need to set up a selective collection process. Increase in the useful life of sanitary landfills, reduction of effluents and of the risk of uncontrolled explosions. Energy generation from wastes will encourage the production and commercialization of domestic equipment. Negotiation of the use of the patent will determine how the technology is to be transferred.

CURRENT STATUS

Ready to be submitted as a CDM project.

Projects carried on by DRSAMBBAA law firm

This law firm has been dealing with climate change carbon trade issues since 1996/1997, as the Brazilian arm of International Ernst & Young Law Practice Network and was invited to be part of the official Brazilian Government Delegation at The Hague, Bonn and Marrakech Conferences of Parties (COP6, I-II, COP7). It is also a member of the Environmental Committee of São Paulo American Chamber (AMCHAM), its Climate Change Group and Renewable Energies Task-Force, and of the Brazilian Environmental and International Law Association (SBDIMA), at University of São Paulo. De Rosa, Siqueira, Almeida, Mello, Barros Barreto e Advogados Associados are performing services in the climate change area, both in aforestation/reforestation projects and in the energy field, offering legal advisory and general management assistance. Since most projects are still being negotiated, for confidentiality matters they can only be presented broadly.

Use of renewable energy in a wood industry

THE PROJECT

Fuel switching project through the use of wood chips instead of diesel and natural gas in a thermal power plant in Lajes, Santa Catarina. Carbon sequestration and avoided emissions through the planting of Pinus. The wood chips are used as a source of energy, produced from a renewable pines forest and is used in substitution of diesel and natural gas in the thermal power plant.

PROJECT SPONSOR

Information unavailable (confidential).

GHG OFFSET

Abatement and sequestration of CO_2.

SUSTAINABILITY ISSUES

Information unavailable.

CURRENT STATUS

In preparation.

Cogeneration with sugar cane bagasse

THE PROJECT

Information unavailable.

PROJECT SPONSOR

Information unavailable.

GHG OFFSET

Abatement of CO_2.

SUSTAINABILITY ISSUES

Information unavailable.

Current status

In preparation.

Fuel switching and carbon sequestration in a pulp and paper industry

The project:

Carbon sequestration through aforestation and reforestation (Pinus planting) and use of charcoal instead of other sources (diesel and natural gas) to generate energy in a paper and pulp industry in Paraná and Rio Grande do Sul states, south region of Brazil.

Project sponsor

Information unavailable.

GHG offset

CO_2 sequestration.

Sustainability issues

Information unavailable.

Current status

In preparation.

Fuel switching for cars

The project:

Use of natural gas as a substitute for gasoline for cars in the state of Rio de Janeiro.

Project sponsor

Information unavailable.

GHG offset

Abatement of CO_2.

Sustainability issues

Information unavailable.

Current status

In preparation.

Projects carried on by Ecoinvest

Ecoinvest is an advisory firm based in Brazil that offers investors in the United States and Europe a portfolio of environmentally friendly investments in Brazil that will provide competitive rates of return and at the same time are likely to generate CERs. Ecoinvest has been in contact with businesses in Brazil that are considering making investments in new plants or equipment that reduce emissions of greenhouse gases. They are learning about the possibility of getting financial reward through the generation of CER credits which will have a financial value once the Kyoto Protocol comes into force.

Ecoinvest assists investors with:

- Project identification;
- Project formulation (including feasibility studies);
- Portfolio building;
- Fund management.

BK Energia Itacoatiara Biomass Project

Project location

Itacoatiara, state of Amazonas.

Project sponsor

BK Energia Participacoes Ltda.

BK Energia Participações Ltda. is a special purpose company (a "Grupo Brennand" and "Koblitz Energia S.A." joint venture) set to look into small renewable energy power potential (thermo and hydro) in Brazil.

CDM project developer

Ecoinvest. Contact person: Mr. Ricardo Esparta, phone: +55(11)3063-9068, e-mail: esparta@ecoinv.com

Objectives of the project

BK Energia Itacoatiara Ltda. is a special purpose company set to explore renewable energy cogeneration potential from biomass (residues from wood processing companies) in the city of Itacoatiara, Brazil, while substituting diesel as primary energy source in the region.

PROJECT DESCRIPTION

As wood processing complexes become more integrated and environmental legislation more stringent, there is a need for better management of wood residue. For environmental and economical reasons traditionally dumped or simply incinerated in open air wood residue are being now increasingly seen as an alternative fuel. Large quantities of the residue, plentiful in some areas in Brazil, can be used in power plants as a fuel for boiler furnace to raise steam, which is then expanded through a turbine to drive a generator and create electricity. The wood processing industry is the major economic activity as wood residue disposal is the main environmental concern in the city of Itacoatiara. The thermoelectric central of Itacoatiara, Amazonas state, north-west of Brazil, will be installed within the major wood processing industry of the region, the "Mil Madeireira Itacoatiara Ltda.", a company of the Swiss group Precious Woods, working in the native forest within a project of sustained management in an area of 80,000 ha, with 25 years exploitation cycles, and producing around 60,000 tons of saw-mill residue per year. The industry's whole production is destined for the European market. It is the only Brazilian company in the segment certified with a "green seal" from "Imaflora" (Forest and Agricultural Management Institute), an institute accredited by The Forest Stewardship Council. The electrical power produced will be sold and delivered to "Mil Madeireira Itacoatiara Ltda." and to CEAM, the regional power utility, substituting diesel power plants that provide electricity to the entire city. The plant has the following configuration: rankine cycle steam turbine with a high-pressure boiler (50 tons of steam/hour, 42kgf/cm^2, 420 °C), multiple stage steam turbine and a 9 MW generator.

INVESTMENT COST

R$22, 750.000 (US$6,500,000).

CURRENT STATUS

In operation since November 2002.

MEANS OF REDUCTION OF GHG

Substitution of installed capacity electricity generation using diesel oil — baseline = 879 kgCO_2/MWh — which refers to 99% fuel oxidation and 30% thermodynamic conversion efficiency.

AMOUNT OF CO_2 EQUIVALENT OFFERED

Around 554,403 tons of CO_2 (10-year contract).

LIFE OF PROJECT

Twenty years.

SUSTAINABILITY ISSUES (POSITION OF THE HOST COUNTRY REGARDING THE KYOTO PROTOCOL)

The Kyoto Protocol was signed into Brazilian law on 23 July 2002. The ratification process under the UNFCCC was concluded on 23 August 2002. The Government has indicated its willingness to provide a letter of approval upon successful validation of the project and entry-into-force of the Kyoto Protocol.

Catanduva sugar cane mill, biomass power plant expansion

PROJECT LOCATION

Catanduva, state of São Paulo.

PROJECT SPONSOR

"Virgolino de Oliveira Group" (GVO, from the Portuguese Grupo Virgolino de Oliviera). GVO owns two mills (Catanduva Mill and Nossa Senhora Aparecida Mill). The parent company was founded in the 1920s and is fully owned by the Virgolino de Oliveira family. Both unities produce sugar and alcohol, each owning and operating a sugar mill and an alcohol distillery. In 2002 Catanduva Mill processed around 3,150,000 tons of sugar cane and produced roughly 3,900,000 sugar sacks (50 kg each), 57,700,000 litres of hydrated alcohol and 114,500,000 litres anhydrous alcohol. In the same season Nossa Senhora Aparecida Mill processed around 1,250,000 tons of sugar cane and produced roughly 1,850,000 sugar sacks and 51,000,000 litres of anhydrous alcohol.

CDM PROJECT DEVELOPER

Ecoinvest. Contact person: Mr. Ricardo Esparta, phone: +55(11)3063-9068, e-mail: esparta@ecoinv.com

Objective of the project

GVO envisions to set up a Special Purpose Company (SPC) to negotiate electricity generated by burning sugar cane bagasse and to fund the project on a project finance basis whereby the company's assets including long-term energy contract will be posted as collateral for the loan.

Project description

Sugar Mills in Brazil harvest sugar cane in order to produce sugar and alcohol (anhydrous, to be mixed with petrol, and hydrated, a final automobile fuel). The fibrous residue left in the production is the sugar cane bagasse. In Brazil, sugar mills typically have used their bagasse output in very low efficiency steam cycle to produce just enough electricity and steam needed to run their manufacturing process. As the sugar mills were not allowed to operate as power suppliers there was no incentive to operate in a more efficient way and any bagasse surplus has been used for cattle feeding or simply dumped in large piles for later incineration. More recently, with a more flexible legislation allowing independent energy producers, bagasse started to be recognized as a possible alternative source of renewable energy. For that reason sugar cane-processing companies began to see the possibility of setting up optimized cogeneration power plants fuelled by bagasse as an additional stream of revenues. The Virgolino de Oliveira Group intends to purchase a new turbo-generator (25 MW) and a new boiler (66 kgf/cm^2) in order to retrofit the cogeneration plant and to optimize energy own use and power export. After the plant's reconfiguration there will be roughly 19 MW power surplus and the plant will be able to export around 93,000 MWh during the season (210 days of operation, May to November, assuming 95% capacity factor).

Investment cost

BR$35,000,000 (US$10,000,000).

Current status

Negotiating debt-financing and contracting stage.

Expected start date

Construction: September 2003
Operation: June 2004

Means of reduction of GHG

Substitution of new installed capacity electricity generation using natural gas — baseline = 447 $kgCO_2/MWh$ — which refers to natural gas with 99.5% fuel oxidation and 45% thermodynamic conversion efficiency.

Amount of CO_2 equivalent offered

Around 420,000 tons of CO_2 (10-year contract).

Life of project

Twenty years.

Sustainability issues (position of the host country regarding the Kyoto Protocol)

The Kyoto Protocol was signed into Brazilian law on 23 July 2002. The ratification process under the UNFCCC was concluded in 23 August 2002. The Government has indicated its willingness to provide a letter of approval upon successful validation of the project and entry-into-force of the Kyoto Protocol. Roughly two-thirds of the GHG emissions offset was negotiated under the CERUPT programme.

Gargau wind power project

Project location

São Francisco do Itabapoana, state of Rio de Janeiro.

Project sponsor: SeaWest do Brasil Ltda

SeaWest do Brasil (SWdoB) owns the site and is now performing the relevant studies and analysis to complete the project. The site is under wind resource assessment since March 2001. On 7 February 2003, SWdoB signed an agreement with the Spanish wind generator manufacturer and developer Gamesa Energia to co-develop the site. Both companies have experience in the Brazil market. SWdoB will be responsible for the financing and fund raising and Gamesa for the technical side of the project. Also, Gamesa is today the world fourth largest wind turbine manufacturer.

CDM project developer

Ecoinvest. Contact person: Ricardo Esparta: phone +55(11)3063-9068, e-mail esparta@ecoinv.com

Objectives of the project

SWdoB envisions to set up a Special Purpose Company (SPC) to negotiate electricity generated by the wind project and to fund the project on a project finance basis whereby the company's assets including long-term energy contract will be posted as collateral for the loan.

Project description

The wind turbines utilize a three bladed, horizontal axis variable pitch design, mounted on a tubular steel tower. The wind turbine generator converts mechanical energy to electrical energy. A control system is necessary, given the generator has to work with a power source (the wind turbine rotor), which supplies a very fluctuating mechanical power (torque). The electricity is sent through a transformer next to the wind turbine (or inside the tower) to raise the voltage depending on the standard in the local electrical grid. SwdoB intends to install 39.95 MW, which is supposed to generate roughly 42,000 MWh (assuming a 27% capacity factor and minus the electric, availability and wake effect losses). Project feasibility is contingent upon above market electricity prices as proposed in the renewable energy programme (PROINFA) established by the Brazilian government to foster clean electricity generation. The final rules for the programme will likely to be set by next May or June, and the first project calls by end-June.

Investment cost

BR$ 123,000,000 (US$ 35,000,000)

Current status

Project under wind measurement (since 30 March 2001), environmental impact assessment and interconnection study.

Expected start date

Construction: April 2004
Operation: April 2005.

Means of reduction of GHG

Substitution of new installed capacity electricity generation using natural gas (baseline = 447 kgCO_2/MWh; which refers to natural gas with 99.5% fuel oxidation and 45% thermodynamic conversion efficiency.

Amount of CO_2 equivalent offered

Around 185,000 tons of CO_2 (10-year contract).

Life of project

Twenty years.

Sustainability issues (position of the host country regarding the Kyoto Protocol)

The Kyoto Protocol was signed into Brazilian law on 23 July 2002. The ratification process under the UNFCCC was concluded on 23 August 2002. The Government has indicated its willingness to provide a letter of approval upon successful validation of the project and entry-into-force of the Kyoto Protocol.

PCH Paraná I

Project location

State of Parana.

Project sponsor

Confidential.

CDM project developer

Ecoinvest. Contact person: Ricardo Esparta: phone +55(11)3063-9068, e-mail esparta@ecoinv.com

Objective of the project

To increase availability of reliable electricity supply in the region.

Project description

PCH Parana I (PCH, from the Portuguese "Pequena Central Hidrelétrica", small hydro facility) will be operational in September 2003, is a run-of-river facility (reservoir size: 0.61 km²), with 15 MW total installed capacity and yearly minimum energy output of around 73,500 MWh.

Investment cost

BR$35,000,000 (10,000,000).

Current state

In construction.

Means of reduction of GHG

Substitution of new installed capacity electricity generation using natural gas — baseline = 447 $kgCO_2$/MWh — which refers to natural gas with 99.5% fuel oxidation and 45% thermodynamic conversion efficiency.

Amount of CO_2 equivalent offered

Around 310,000 tons of CO_2 (10-year contract).

Life of Project

Thirty years.

Sustainability issues (position of host country regarding the Kyoto Protoco)

The Kyoto Protocol was signed into Brazilian law on 23 July 2002. The ratification process under the UNFCCC was concluded in 23 August 2002. The Government has indicated its willingness to provide a letter of approval upon successful validation of the project and entry-into-force of the Kyoto Protocol.

Dom Pedrito, C.G.D.e., Koblitz Energia S.A

Project location

Dom Pedrito, state of Rio Grande do Sul.

Project sponsor

C.G.D.e. — Companhia Geral de Distribuição Elétrica S. A.

The "Companhia Geral de Distribuição Elétrica," C.G.D.e., was founded in 1998 with the mission of developing, constructing, financing and operating power plants in Latin America, particularly in Brazil, with planned investments of around BR$ 400,000,000. C.G.D.e. main shareholder and managing partner is the Portuguese bank "Caixa Geral de Depósitos" (the largest Portuguese Bank, see http://www.cgd.pt/, with revenues in the first half of 2002 of €380M).

CDM project developer

Ecoinvest. Contact person: Ricardo Esparta: phone +55(11)3063-9068, e-mail esparta@ecoinv.com.

Objective of the project

To increase availability of reliable electricity supply in a region with energy deficit.

Project description

"Dom Pedrito, C.G.D.e., Koblitz Energia S.A" is a special purpose company (SPC) established to use residue from rice processing companies in the city of Dom Pedrito, in the state of Rio Grande do Sul, to generate electricity using a high pressure boiler (43 bar) and a multiple stage condensing steam turbine (output pressure 140 mbar) coupled with a 8 MW generator. For the expected electric energy output (around 56,000 MWh, assuming 80% capacity factor) there is a power purchase agreement (PPA) with the local power utility (CEEE).

Investment cost

BR$ 15,750,000 (US$4,500,000).

Current status

Under construction.

Expected start date

Construction: September 2002
Operation: January 2004

Means of reduction of GHG

Substitution of new installed capacity electricity generation using natural gas — baseline = 447 $kgCO_2$/MWh — which refers to natural gas with 99.5% fuel oxidation and 45% thermodynamic conversion efficiency.

Amount of CO_2 equivalent offered

Around 242,000 tons of CO_2 (10-year contract).

Life of project

Twenty years

Sustainability issues (position of host country regarding the Kyoto Protocol)

The Kyoto Protocol was signed into Brazilian law in 23 July 2002. The ratification process under the UNFCCC was concluded in 23 August 2002. The

Government has indicated its willingness to provide a letter of approval upon successful validation of the project and entry-into-force of the Kyoto Protocol.

Projects carried on by Ecosecurities

NovaGerar landfill gas-to-energy

THE PROJECT

The project is a landfill gas to energy project owned and managed by a newly formed company, NovaGerar. NovaGerar has been granted a 20 year concessional licence by Empresa Municipal de Limpeza Urbana (EMLURB) (Municipal Waste Collection Company, a government agency responsible for waste collection and disposal) in 2001 to explore the landfill gas potential of two landfill sites, Marambaia and Andrianopolis (officially called "Lixao de Marambaia" and "Aterro Sanitario de Andrianopolis") located in Nova Iguaçú, Rio de Janeiro state, Brazil. NovaGerar will be responsible for the decommissioning and rehabilitation of the Lixao Marambaia site, which has been operating since 1986 and was due to cease operation in October 2001. The Andrianopolis site commenced operation in 2002 and receives between 400-1,200 tons of municipal waste per day. The landfill gas to energy project will require investment in a comprehensive gas analysis and pumping trials, a gas collection system and a modular electricity generation plant (with final capacity 7MW, to be verified when further studies undertaken). The project will capture and combust landfill gas to generate electricity for the grid and reduce greenhouse gas emissions of over 3.5 million tons of CO_2 over the next 10 years (the total project lifetime is 20 years, and will result in emission reductions of over 7 million tons CO_2). In 2001, NovaGerar sought funding from IUEP to undertake further detailed studies to contribute towards the design and installation of a landfill gas collection system.

A social programme will be initiated in parallel, which will be based on the electrification of public buildings using electricity donated by the project. This project is based on two complementing activities: the collection and flaring of combustion of landfill gas, thus converting its methane content into CO_2, reducing its greenhouse gas effect; and the generation and supply of electricity to the regional grid, thus displacing a certain amount of fossil fuels used for electricity generation.

PROJECT SPONSOR

NovaGerar is a 50:50 joint venture between EcoSecurities, an environmental finance company which specializes in greenhouse gas (GHG) mitigation issues, with offices in Australia, Brazil, the Netherlands, United Kingdom and the United States, and S.A. Paulista a Brazilian civil engineering and construction firm based in the city of São Paulo, Brazil, with branches in several other states and counties. S.A. Paulista's core business is in traditional heavy construction sectors such as highways, railways, airports, ports, industries and sanitation. S.A. Paulista also manages the largest domestic waste transfer station in South America (Transbordo Ponte Pequena) responsible for 60% of all domestic waste from São Paulo, a city with a population of 8 million people.

GHG OFFSET

For the NovaGerar project, the project scenario is the collection and utilization of landfill gas for the generation of electricity. Utilization of the landfill gas will convert the methane content to less potent carbon dioxide. Use of the landfill gas will effectively result in the avoidance of approximately 300,000 tons of CO_2 emissions each year, and cumulative GHG emission reductions of over 3.5 million tons during the period 2002-2012. The project scenario also has the potential for further emission reductions as the electricity generated on site will displace use of electricity generated from other sources. At this stage it has been assumed that the Brazilian energy matrix is almost 100% hydropower, and displacing electricity generated from hydro does not result in appreciable greenhouse gas emission reductions. In reality, the Brazilian energy matrix is comprised of a majority of hydropower and small, but increasing, elements of natural gas and diesel.

SUSTAINABILITY ISSUES

The project is expected to conform to the Brazilian Government's expectations in relation to the CDM and sustainable development objectives. The main social and environmental impacts of this project will be a positive effect on health and amenity in the local area. The project is part of a large programme initiated by the municipality of Nova Iguaçú, of collection of urban waste in the municipality.

The project will also have a small, but positive impact on employment in the local area as a number of staff will need to be recruited to manage the landfill gas sites. Additionally, the joint venture also plans to donate 10% of the electricity generated on-site to the local municipal authority of Nova Iguaçu (where the project is located), to provide lighting for local schools, hospitals and other public buildings.

Economic benefits include the project acting as a clean technology demonstration project, encouraging less dependency on grid-supplied electricity and better management of landfills throughout Brazil, which could be replicated across the region. Moreover, it could attract additional foreign investment into the country, with a positive effect on the country's balance of payment; contributing towards a decrease in fuel imports.

CURRENT STATUS

Ready to be submitted as a CDM project.

Fuel switching in a hydroelectric plant in the north region (confidential)

THE PROJECT

The project is a hydroelectric plant, based primarily generating power from the flow of a river, but also involving shallow damming. The total installed capacity is 100 MW, with a capacity factor of 83%. The plant will be used to generate electricity that will feed into the isolated system of the north region, to the state of Amapá, and will also displace fuel oil consumption in the industrial sector. The hydroelectric plant is located between the two states of Amapá and Pará, which are intersected by the Jari river, in the northern region. The carbon mitigation potential arises through the displacement of diesel in the isolated grid of the north region and fuel oil used for industrial activities. The project should be operational from 2004 onwards.

PROJECT SPONSOR

A special purpose company was created to foster the carbon mitigation potential of this hydroelectric plant. This company's partner will be a major global player in manufacturing and operation of power systems, including hydroelectric plants.

GHG OFFSET

Electricity produced by the hydroelectric plant will be fed into an isolated grid in the northern region. This grid currently uses diesel for electricity generation. Diesel is the technology of choice for the next 10 years. Additionally, this hydroelectric project is said to have the capacity to generate emissions reduction of 3.88 million tons of CO_2 over a seven year crediting lifetime and 11.67 million tons of CO_2 over a 21 year credited lifetime.

SUSTAINABILITY ISSUES

Increased energy security; lower electricity prices, resulting in substantial savings in terms of expenditures on electricity consumption; reduction of the need for foreign exchange used for purchasing petroleum products, which improves the country's balance of payments. And last, but not least, this investment is likely to bring additional benefits, particularly in the rural area where the project is located.

CURRENT STATUS

In preparation.

Landfill gas collection in the state of Espírito Santo (confidential)

PROJECT DESCRIPTION

The objective of this project is to explore the landfill gas collection and utilization opportunities of a landfill in the state of Espírito Santo, in the south-east region. This will involve investing in a gas collection system and a modular electricity generation plant (with final capacity of 2 MW), in order to flare and/or produce electricity to supply to the grid and reduce emissions of 4.3 million tons of CO_2 over the next 21 years. This landfill has been operational since 1995 and over 780,000 tons of waste have been placed at the site. Many facilities at the site have fallen into disrepair and, in the absence of a gas collection system, landfill gas currently escapes to the atmosphere.

PROJECT SPONSOR

The sponsor firm currently owns and manages the landfill site, and, together with a company of specialists in landfill gas assessment, control and utilization, proposes to rehabilitate the landfill site with a view to collecting and utilizing the landfill gas generated. EcoSecurities is working with this firm to increase the financial viability of the project through securing carbon revenues.

GHG offset

The project has the capacity to generate 2.25 million tons of CO_2 credits over 10 years and 4.28 million tons of CO_2 credits over a 21-year baseline period.

Sustainability issues

The main social and environmental impacts of this project will be a positive effect on health and amenity in the local area. Contaminated leachate and surface run-off from landfills can affect down-gradient ground and surface water quality, impacting the local environment. The uncontrolled release of landfill gas can also impact negatively on the health of the local environment and the local population, and lead to risks of explosions in the local surroundings. By managing the landfill site properly the environmental health risks and the potential for explosions is greatly reduced.

The project should also have a small, but positive, impact on employment in the local area as a number of staff will need to be recruited to manage the landfill gas sites. Economic benefits are said to be: the project acting as a clean technology demonstration project, encouraging less dependency on grid-supplied electricity and better management of landfills throughout Brazil, which could be replicated across the region; the attraction of additional foreign investment into the country, with a positive effect on Brazil's balance of payment; additional benefits such as increased employment opportunities, in the area where the project is located; diversity and security of electricity supply and a decrease in fuel imports.

Current status

In preparation.

Improvement of energy efficiency and cogeneration in a sugar cane industry in the state of São Paulo (confidential)

The project

The objective of this project is to boost efficiency in the process of sugar and alcohol production, combined with the implementation of cogeneration in order to become self sufficient in electricity and even sell the surplus power to the regional electric power grid. The purpose of these investments is to increase energy generation security and use natural resources more efficiently, while reducing national energy consumption from fossil fuels.

Project sponsor

The sponsor firm is currently one of the major alcohol and sugar producers in the world. EcoSecurities is working with this firm to increase the financial viability of the project helping secure carbon revenues, and helping the firm to look for other partners.

GHG offset

It is estimated that the project has the capacity to avoid nearly 10,000 tCO_2/year, and for the whole project (over a 21-year baseline period) the reduction should attain 207,567 tCO_2 through the use of a renewable energy sources to generate electricity.

Sustainability issues

Economic benefits are said to be: the project acting as a clean technology demonstration project, encouraging less dependency on grid-supplied electricity and better management of sugar and alcohol industries throughout Brazil, which could be replicated across the region; the attraction of additional foreign investment into the country, with a positive effect on Brazil's balance of payment; additional benefits such as increased employment opportunities in the area where the project is located; diversification and security of electricity supply; and a decrease in fuel imports.

Current status

In preparation.

Fuel switching for fuel oil boilers in the state of São Paulo (confidential)

The project

The aim of this project is the conversion of fuel oil to biomass used in boilers in a pulp and paper industry in the state of São Paulo. As a second step, the industry is planning to use urban waste as a fuel to generate energy as well. The biomass fuel will come from planted forests belonging to the industry, that will also be sequestrating carbon.

Project sponsor

The paper and pulp industry where the project will take place is working with Ecosecurities, and is looking for other partners to finance it. It is a Brazilian firm, operating both in the international and national markets.

GHG OFFSET

According to the estimates presented by Ecosecurities, with the fuel switching (fuel oil to biomass) in two of the four existing boilers the company will be avoiding near 116,000 tCO_2/year.

SUSTAINABILITY ISSUES

There should be no expenses in foreign currencies, since either the fuel or the equipment required (national boilers) are available domestically in country. This could contribute towards a decrease in fuel and equipment imports.

CURRENT STATUS

In preparation.

Emission reductions in industrial activities of V&M do Brasil

THE PROJECT

The V&M project consists of investments to enable the maintenance of charcoal-based production of steel in Minas Gerais, Brasil, funded through the sale of carbon credits in the context of the clean development mechanism (CDM). The extra income derived from the sale of carbon credits will increase the profitability of charcoal-based steel production avoiding the decline of this industry, which would lead to the abandonment of its forestry activities and the absorption of this market share by coal-based steel mills. The project involves the avoidance of use of coke for the production of steel, by using charcoal from sustainably managed (certified to the Forest Stewardship Council standards) tree plantations. Associated with that, the project plans to adapt its existing approximately 1,600 carbonization kilns to incorporate a better design that avoids the emissions of methane and particulates.

PROJECT SPONSOR

With the structuring assistance of EcoSecurities, V&M do Brasil has signed a letter of intent with the IFC-Netherlands Carbon Facility securing long term support for the project through the sale of 5 million tons of CO_2e emissions reductions for a total value of €15 million. At the same time, a contract for the sale of an additional volume of CO_2e was signed with Toyota Tsusho Corporation during the launch ceremony. V&M do Brasil is a subsidiary of Vallourec & Mannesmann Tubes (V&M Tubes), a joint venture between the German company Mannesmannröhren-Werke (45%) and the French company Vallourec (55%). Created in October 1999, the joint venture incorporated Mannesmann do Brasil, a Brazilian subsidiary of Mannesmann, a manufacturer of seamless steel tubes. V&M Tubes is the largest producer of seamless tubes in the world, and is the only completely "carbon neutral" producer in the world. Toyota Tsusho Corporation is a member of Toyota Motor Group, undertaking a wide range of activities from trading, manufacturing and processing to retail and services throughout the world. Toyota Tsusho Corporation aims to be an eco-friendly company, and is developing CDM projects in various parts of the developing world. INCaF, the IFC-Netherlands Carbon Facility is an arrangement under which the International Finance Corporation (IFC) will purchase greenhouse gas (GHG) emission reductions for the benefit of the Government of the Netherlands using the "clean development mechanism" (CDM) of the Kyoto Protocol. The Netherlands has allocated €44 million (about US$40 million) for this Facility over the next three years. The Facility will provide additional revenues to eligible projects that generate emission reductions in developing countries.

GHG OFFSET

It is estimated that the project has the capacity to generate 21.3 million tons of CO_2 emission reduction equivalents over a 21-year timeframe. This is broken down as 17.3 million tons CO_2 from fuel switch for the industrial activities (use of charcoal as opposed to coke), and 4 million tons CO_2 from the capture of methane in carbonization activities.

SUSTAINABILITY ISSUES

Using sustainably produced charcoal as a reducing agent for steel production, the company is able to produce their "green tubes" for the international market. The company has demonstrated great dedication in the pursuit of social and environmental excellence, and has secured a series of quality certificates as a recognition of that, such as Forest Stewardship Council (FSC) certification for its forests, ISO14,000 and ISO9000. Since the V&M plantations are certified by the FSC, biodiversity maintenance in forestry operations are insured. Local employment should be created as a large share of the firm employees work in forestry activities. Should the baseline scenario take place (coal), these jobs would be threatened. Additionally, the substitution of kilns should lead to the creation of further jobs.

CURRENT STATUS

In preparation.

FNMA projects

In 22 March 2002, the FNMA Deliberative Council approved 28 projects to be financed with resources of its R$3.1 million fund, under three editals launched at the end of 2001. Specifically for Climate Change, 12 projects received the financial support from the FNMA. Since several of these projects refer to reforestation, which is beyond the scope of this work, and although all the 12 projects will be presented here, only two will fully be described below, and thus will appear separately from the list.

List of projects financed by FNMA funds:

- Viability study for the implementation of reforestation models for carbon sinks in rural Amazon, from the Brazilian Institute for Environmental Research and Studies — Pró-Natura;
- Viability study for "Social Carbon" projects in the Pontal of Paranapanema, São Paulo, from the Ecological Research Institute (IPÊ);
- Improvement of the production process of structural ceramics with mitigation actions for the additional reduction or stability of greenhouse gas emissions, from the University of Amazon;
- Project for carbon sinks and biodiversity conservation in the rural area of the Agronomy School of the Federal University of Bahia — Cruz das Almas, from the Centre for Sustainable Development of Sapucaia;
- Viability study for the creation of carbon sink forests: case study of the south of Paraná state, from the Ecoplan Institute;
- Viability study for the project of clean development mechanism in the area of the *Leontopithecus rosalia* monkey (Mico-Leão Dourado), from the Mico-Leão Dourado Association;
- Renewable energy production production from forest residues in Jaguaraíva, from the Luiz de Queiroz Agrarian Studies Foundation;
- Mangrove reforestation and the value of carbon sinks, from the Association for Coastal Ecoystems Protection;
- Viability study for the implementation and operation of residential solar systems in non-electrified rural communities in Bahia, from the University of Salvador — UNIFACS.

Following are the description of the two projects approved by FNMA that the Centro Clima team will try to develop in parallel with the selected SSN projects.

The use of rice husks for electrical energy generation and the current mitigation of gases that contribute to the greenhouse effect as a clean development mechanism

THE PROJECT

The project consisting of a 3 MW power plant fueled by rice husks implemented by the Urbano Agroindustrial company at Jaguará do Sul in Santa Catarina state will generate some 15,768 MWh/year of electricity. As this location is supplied by a system interconnected to the CELESC and GERASUL grid, the calculations for greenhouse gases emissions reduction were based on the contribution of natural gas-fired thermal power plants to this system.

PROJECT SPONSOR

Participants of the project are LIMA/COPPE/UFRJ, IVIG/COPPE/UFRJ, and Urbano Agro Industrial. Urbano Agro Industrial occupies an area of 605,000 m^2, with 40,500 m^2 of built-up areas, with four units in Jaraguá do Sul-Santa Catarina, in São Gabriel-Rio Grande do Sul, in Meleiro-Santa Catarina and Sinop, in Mato Grosso (under construction).

GHG OFFSET

A reduction of carbon emissions is estimated associated with the use of rice husks for power generation as a substitute for diesel oil burned in power generators. Also methane emissions are expected to be avoided due to the non-disposal of the husks in open landfills.

SUSTAINABILITY ISSUES

The power generation from natural gas baseline scenario implies in CO_2 emissions, while the alternative scenario for burning renewable biomass posts no emissions, according to the IPCC methodology. This project helps reduce greenhouse gases emissions and makes a significant contribution to local environmental sustainability, because some agricultural wastes are harmful to human health, usually dumped on vacant plots of land. Additionally, there are no final disposal procedures for rice husks as a waste material, as they are generally burned in the open air. This type of project sets an example under a policy of seeking solutions for the final disposal of solid wastes. Moreover, within a context of uncertainty in terms of power supplies in Brazil, power self-sufficiency is being sought in many sectors of the Brazilian economy, as are efforts at boosting productivity through a steady supply of uninterrupted electricity

CURRENT STATUS

In preparation.

Energy production through thermal power generation using biomass to operate jointly with a small-scale hydroelectric power plant located in the state of Rondônia

THE PROJECT

The project consists in the study of the technical, economic and environmental feasibility of a CDM project of a thermal power plant of 4 MW, that will be used to give support to a small-scale hydroelectric power plant. This thermal power plant will utilize as fuel, first the wood from the flooded area to be created by the reservoir in the construction of the Rondon II hydropower plant and later the wood from reforestation of degraded areas in the site. It is expected that the project will contribute to promote a significant reduction of greenhouse gas emissions and in the local ambient pollution caused by burning of diesel oil in generators that operate during the dry time. Besides, a CO_2 sink will be created during the development of the planted forests.

PROJECT SPONSOR

Participants of the project are: IVIG/COPPE/UFRJ, LIMA/COPPE/UFRJ, the University of Salvador (UNIFACS), the Ministry of Environment (MMA) and ELETROGOES S.A, responsible for carrying out the works. The University of Salvador is complementing the LIMA and IVIG technical team in this project. The project received the support of FNMA through the Ministry of Environment to help prepare its PDD. ELETROGOES S.A. is a company that owns power plants in the region. It is both financing and operating the project.

GHG OFFSET

Credits generated by the project will be the baseline minus the emissions of the thermal power plant with the use of renewable fuels plus the sinks related to reforestation. Total carbon emissions reductions plus the carbon sink that is expected to be created amount to some 415 $MtCO_2$ over a 21-year period.

SUSTAINABILITY ISSUES

The project aims at supplying additional electricity to the city of Vilhena with zero carbon emissions, plus the creation of a forest.

CURRENT STATUS

In preparation.

Other projects

Bioenergia cogeradora's sugar cane bagasse cogeneration project

THE PROJECT:

This project involves a high private investment in biomass power generation. It is a fuel switching project to use sugar cane bagasse cogeneration to increase overall efficiency as compared to "business as usual" power generation.

Project sponsor

The private company Bioenergia Cogeradora signed a memorandum of understanding that initiates an innovative cooperation in climate change, under funds of the United Nations Foundation (UNF), under the project "Engaging the Private Sector in Clean Development Mechanism Activities under UNFCCC/Kyoto Protocol — EPS/CDM", which is a collaborative effort undertaken by UNIDO, UNCTAD, WBCSD, UNFCCC, UNOPS and UNDP.[40] Bioenergia Cogeradora is a special purpose company that has Grupo Balbo as the main shareholder, which is a full Brazilian multi-purpose company producing sugar, alcohol, and cane-based products and is among the world leaders in organic sugar cane products. Both are located in São Paulo and Grupo Balbo is also advanced in developing and implementing industrial processes to produce environmental friendly biodegradable-plastic from sugar cane residues (bagasse). FIESP (Industry Association of São Paulo) and UNICA (São Paulo Sugar Cane Agro-Industry Union) presidents give their support by signing the memorandum of understanding.

GHG offset

Reduces GHG emissions by supplying additional electricity to the grid, thus replacing CO_2 emissions upstream and reducing the operation of fossil fuel based electricity generators.

Sustainability issues

This investment is said to satisfy the criteria of reducing local pollution, significantly reducing emissions of greenhouse gases, and seems to be consistent with the national development plans and priorities of the Government of Brazil. By switching the fuel source it improves the thermal efficiency of the combustion process end reduces residues of the sugarcane industry, contributing to local sustainability.

Current status

Ready to be submitted as a CDM project.

[40] See "Explanatory notes" for listed acronyms.

PRODEEM rural solar project

The project

The objective of this project is to promote the supply of solar energy to poor communities in non-electrified rural areas in the north-east of Brazil. The community-based applications are: community buildings (schools, health and community centres), water pumping (human and animal consumption and irrigation) and public lighting. The project aims at delivering electricity for lighting, televisions, computers and refrigeration for food. Moreover, the project seeks to provide input to illustrate member companies' proactive stance on climate change.

Project sponsor

This project is carried on through a private partnership under the scope of the National Pilot Programme for Sustainable Energy — PRODEEM, coordinated by the National Energy Development Programme within the Brazilian Ministry of Mines and Energy (MME). Policy guidance is provided by the Brazilian Government, through its Climate Change Advisory Unit (MME), and responsibilities are shared between British Petroleum (BP) (implementation of projects in Brazil and link between project implementers and CDM project team), CEBDS[41] (management of political relationships and links with the Brazilian Government, as well as raising awareness on CDM issues within the business community), PricewaterhouseCoopers (PwC) and BP (definition of international and domestic requirements, and technical definitions), and WBCSD (management of learning to WBCSD[42] member companies).

GHG offset

A total of 100 photovoltaic solar panels each of 75 watts will be installed, avoiding the carbon emission from diesel generators.

Sustainability issues

This investment is expected to satisfy the criteria of significantly reducing emissions of greenhouse gases, and is consistent with the national development plans and priorities of the Government of Brazil. Light enables children

[41] Brazilian Business Council for Sustainable Development.
[42] World Business Council for Sustainable Development.

and adults to continue their education during the evening, television provides access to educational programmes, news and entertainment, and refrigeration help ensure children receive at least one balanced meal a day.

CURRENT STATUS

Ready to be submitted as a CDM project.

Rural electrification in remote semi-arid north-east region of Caatinga of Brazil — BP Solar

THE PROJECT

The objective of this project is to introduce sustainable solar energy in nearly 2,000 schools in the poor region of Caatinga, north-east region of Brazil, affecting some 60,000 school children. The concept is simple: to install a solar energy package in 1,852 schools. The package consists of six solar panels, a battery installation, lights, a refrigerator, a television, a satellite dish and a video. The project will displace emissions from diffuse, indirect sources.

PROJECT SPONSOR

BP Solar and Brazil's government PRODEEM programme are working together as partners in this project, which is a CDM case study funded by the World Business Council for Sustainable Development (WBCSD).

GHG OFFSET

In the absence of the project, local electricity needs would continue to be met by existing diesel generators. The baseline is therefore calculated from carbon emissions per diesel generator, scaled up to the same level of electricity output as a remote area power supply unit. The additionality benefits of this project are the avoided CO_2 emissions from the displaced diesel generators. Some 2,000 tons of CO_2 emissions are expected to be avoided per year with the project.

SUSTAINABILITY ISSUES

The main sustainability benefits identified are: energy supply and security (the project should expand the provision of electricity supply to a 24 hour period allowing children and adults education in the evening), training of local communities, expansion of local goods and services and reduction of local air pollutants.

CURRENT STATUS

Ready to be submitted as a CDM project

Final considerations

In summary, because Brazil is seen by the international business community as one of the most promising countries to host future CDM projects, various CDM project activities and types, at various stages of development, are already underway in the country, some of which, hopefully, may be eligible for validation, provided they follow the first four of the five stages (project development-screening, project development-design, national approval, project registration, and project implementation) of the CDM project cycle and are registered by 31 December 2005.

5 Conclusions

As discussed in this report, Brazil played an active role in establishing the CDM under the Kyoto Protocol, and is now conducting a variety of ongoing efforts in this area. In our view, Brazil's institutional infrastructure for climate change is well prepared to deal with CDM projects.

With respect to CDM opportunities in the energy sector, because Brazil's energy structure is already dominated by renewable energy but a vast potential for further projects (hydropower, wood, sugar cane and other biomass resources, wind) in this area still exists (although the business-as-usual scenario for the power sector points to some expansion in power capacity with natural gas-fuel power plants), energy demand is growing fast, and like any developing country Brazil also has readily available energy efficiency opportunities, a great potential for CDM projects does exist in the areas of fuel substitution and energy efficiency.

With respect to CDM opportunities in the industrial sector, because Brazil's industrial sector is dominated by energy-intensive industries (cement, iron and steel, ferro-alloys, mining, non-ferrous and other metals, chemicals, foods and beverages, textiles, pulp and paper, etc), the relative importance of these industrial subsectors is growing (among other things because these subsectors contribute with an important share of the total exports of the country, which is increasingly in need of hard currency), there is a huge potential for energy efficiency improvements in most of these subsectors, and because renewable fuels, although already play an important role in total energy consumption in industry, still have a large potential to increase their share, a large potential for CDM projects do exist in the areas of process change, energy efficiency and fuel substitution in industry.

Finally, because Brazil is seen by the international business community as one of the most promising countries to host future CDM projects, various CDM project activities and types, at various stages of development, are already underway in the country, some of which, hopefully, may be eligible for validation, provided they follow the first four of the five stages (project development-screening, project development-design, national approval, project registration, and project implementation) of the CDM project cycle and are registered by 31 December 2005.

In summary, Brazil is fully aware of the many technical and political issues that surround CDM formulation and implementation. And a high potential for CDM does exist in various sectors of the Brazilian economy, in particular in the energy and industrial sectors as outlined here. As a matter of fact, the Brazilian scientific and technical expertise to deal with the climate change and the Kyoto Protocol issues is probably unique among developing countries. However, such expertise is held by a relatively small group of governmental and university officials, with high level decision-makers, both at the governmental and private sectors, normally showing little familiarity with the various and complexes issues involved in the global climate change discussions in general, and in the CDM processes in particular. As a consequence, effort should be made, both domestically and internationally, for further capacity development for CDM in Brazil.

Annex I. Some national policies and national legislation relevant to climate change*

- Art. 225 of the Brazilian Federal Constitution, chapter VI on the Environment; Law No. 6.938 of 17 January 1981, make provisions regarding the National Environmental Policy, its purposes, and formulation and employment mechanisms and makes other provisions;
- Conama Resolution No. 1 of 23 January 1986, makes provisions regarding the responsibilities, basic criteria and other general guidelines for the use and implementation of the Environmental Impact Assessment;
- Law No. 6.902 of 27 April 1981, creates the "Ecological Stations" and the "Environmental Protection Areas";
- Law No. 7.735 of 22 February 1989, creates the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA);
- Law No. 9.605 of 12 February 1998, known as the "Law of Environmental Crimes", rearranges the Brazilian environmental legislation with regard to infractions and penalties;
- Resolution No. 1, of 12 December 2002, of the Interministerial Commission on Climate Change, makes provisions regarding the approval of CDM project activities in Brazil.

Resolutions on atmospheric pollution

- Resolution No. 18, of 6 May 1986, creates the PROCONVE — Motor Vehicle Air Pollution Control Programme;
- Resolution No. 4, of 15 June 1988, makes provisions regarding emissions of crankcase gases by diesel-cycle engines;
- Resolution No. 3, of 15 July 1989, makes provisions regarding emissions of aldehydes;
- Resolution No. 4, of 15 June 1989, makes provisions regarding evaporative emissions from ethanol-fuelled vehicles;
- Resolution No. 5, of 15 June 1989, establishes the PRONAR — National Programme for Air Quality Control;
- Resolution No. 10, of 14 September 1989, makes provisions regarding gas emissions from diesel-cycle motor vehicles and establishes specifications for diesel oil;
- Resolution No. 15, of 7 December 1989, makes provisions regarding methanol use;
- Resolution No. 6, of 31 August 1993, makes provisions regarding imported vehicles;
- Resolution No. 7, of 31 August 1993, defines the basic guidelines and emission standards for the establishment of Inspection and Maintenance Programmes for Motor Vehicles in Use — I/M — altered by Resolution No. 227/97;
- Resolution No. 8, of 31 August 1993, updates PROCONVE with regard to heavy vehicles and gives other provisions — altered by Resolution No. 27/94 and complemented by Resolution No. 16/95;
- Resolution No. 16, of 17 December 1993, amends and alters deadlines and limits for emissions from light and heavy vehicles;
- Resolution No. 9, of 4 May 1994, determines that manufacturers of ethanol-fuelled light vehicle should declare the amounts of hydrocarbons and aldehydes emissions;
- Resolution No. 15, of 19 September 1994, makes provisions regarding the Plan for Controlling the Pollution of Vehicles in Use — PCPV;

National Policy, Planning and Legislation

- Decree Law No. 1,413 of 14 August 1975, makes provisions regarding the control of environmental pollution from industrial activities;
- Decree No. 76,389 of 3 October 1975, makes provisions regarding measures to prevent and control the industrial pollution referred to in Decree Law No. 1,413 of 14 August 1975;
- Law No. 6,803 of 2 July 1980, makes provisions regarding the basic guidelines for industrial zoning in critical pollution areas and makes other provisions;
- Conama Resolution No. 6 of 15 June 1988, makes provisions regarding the control of licenses to industrial activities that generate residues;

* Policies related to climate change issues, in industrial and energy sectors and excluding deforestation.

- Decree Law No. 1,413 of 14 August 1975, makes provisions regarding the control of environmental pollution from industrial activities;
- Decree No. 76,389 of 3 October 1975, makes provisions regarding measures to prevent and control the industrial pollution referred to in Decree Law No. 1,413 of 14 August 1975;
- Law No. 6,803 of 2 July 1980, makes provisions regarding the basic guidelines for industrial zoning in critical pollution areas and makes other provisions;
- Conama Resolution No. 6 of 15 June 1988, makes provisions regarding the control of licenses to industrial activities that generate residues.

Annex II. Some useful articles of the Kyoto Protocol to the United Nations framework convention on climate change (UNFCCC)

Article 4.1 of the Protocol (UNFCCC, 2002)

The commitments of the developing countries, including Brazil, described in Article 4.1 are:

- Develop, periodically update, publish and make available to the Conference of the Parties, inventories of anthropogenic emissions by sources and removals by sinks of all the greenhouse gases not controlled by the Montreal Protocol;
- Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change, as well as measures to facilitate adequate adaptation to climate change;
- Promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors;
- Promote and cooperate in scientific, technological, technical, socio economic and other research, systematic observation and development of data archives related to the climate system and intended to further the understanding and to reduce or eliminate the remaining uncertainties regarding the causes, effects, magnitude and timing of climate change and the economic and social consequences of various response strategies;
- Promote and cooperate in education, training and public awareness related to climate change and encourage the widest participation in this process, including that of non-governmental organizations.

Article 12 of the Protocol (UNFCCC,2002)

- A clean development mechanism is hereby defined.
- The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3.
    - Under the clean development mechanism:
    - Parties not included in Annex I will benefit from project activities resulting in certified emission reductions; and
    - Parties included in Annex I may use the certified emission reductions accruing from such project activities to contribute to compliance with part of their quantified emission limitation and reduction commitments under Article 3, as determined by the Conference of the Parties serving as the meeting of the Parties to this Protocol.
- The clean development mechanism shall be subject to the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Protocol and be supervised by an executive board of the clean development mechanism.
- Emission reductions resulting from each project activity shall be certified by operational entities to be designated by the Conference of the Parties serving as the meeting of the Parties to this Protocol, on the basis of:
    - Voluntary participation approved by each Party involved;
    - Real, measurable, and long-term benefits related to the mitigation of climate change; and
    - Reductions in emissions that are additional to any that would occur in the absence of the certified project activity.
- The clean development mechanism shall assist in arranging funding of certified project activities as necessary.
- The Conference of the Parties serving as the meeting of the Parties to this Protocol shall, at its first session, elaborate modalities and procedures with the objective of ensuring transparency, efficiency and accountability through independent auditing and verification of project activities.
- The Conference of the Parties serving as the meeting of the Parties to this Protocol shall ensure that a share of the proceeds from certified project activities is used to cover administrative expenses as well as to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation.

- Participation under the clean development mechanism, including in activities mentioned in paragraph 3*(a)* above and in the acquisition of certified emission reductions, may involve private and/or public entities, and is to be subject to whatever guidance may be provided by the executive board of the clean development mechanism.

- Certified emission reductions obtained during the period from the year 2000 up to the beginning of the first commitment period can be used to assist in achieving compliance in the first commitment period.

Decision 17/CP.7: Modalities and procedures for a clean development mechanism as defined in Article 12 of the Kyoto Protocol (UNFCCC, 2002)

The Conference of the Parties,

Recalling Article 12 of the Kyoto Protocol which that the purpose of the clean development mechanism shall be to assist Parties not included in Annex I to the Convention in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3 of the Kyoto Protocol,

Recalling also its decision 5/CP.6 containing the Bonn Agreements on the implementation of the Buenos Aires Plan of Action,

Aware of its decisions 2/CP.7, 11/CP.7, 15/CP.7, 16/CP.7, 18/CP.7, 19/CP.7, 20/CP.7, 21/CP.7, 22/CP.7, 23/CP.7, 24/CP.7 and 38/CP.7,

Affirming that it is the host Party's prerogative to confirm whether a clean development mechanism project activity assists it in achieving sustainable development,

Recognizing that Parties included in Annex I are to refrain from using certified emission reductions generated from nuclear facilities to meet their commitments under Article 3, paragraph 1,

Bearing in mind the need to promote equitable geographic distribution of clean development mechanism project activities at regional and subregional levels,

Emphasizing that public funding for clean development mechanism projects from Parties in Annex I is not to result in the diversion of official development assistance and is to be separate from and not counted towards the financial obligations of Parties included in Annex I,

Further emphasizing that clean development mechanism project activities should lead to the transfer of environmentally safe and sound technology and know-how in addition to that required under Article 4, paragraph 5, of the Convention and Article 10 of the Kyoto Protocol,

Recognizing the need for guidance for project participants and designated operational entities, in particular for establishing reliable, transparent and conservative baselines, to assess whether clean development mechanism project activities are in accordance with the additionality criterion in Article 12, paragraph 5*(c)*, of the Kyoto Protocol,

1. Decides to facilitate a prompt start for a clean development mechanism by adopting the modalities and procedures contained in the annex below;

2. Decides that, for the purposes of the present decision, the Conference of the Parties shall assume the responsibilities of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol as set out in the annex below on modalities and procedures;

3. Invites nominations for membership in the executive board:

   (a) For facilitating the prompt start of the clean development mechanism, from Parties to the Convention to be submitted to the President of the Conference of the Parties at its present session, with a view to the Conference of the Parties electing the members of the executive board at that session;

   (b) Upon the entry into force of the Kyoto Protocol, to replace any member of the executive board of the clean development mechanism whose country has not ratified or acceded to the Protocol. Such new members shall be nominated by the same constituencies and elected at the first session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol;

4. Decides that, prior to the first session of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol, the executive board and any designated operational entities shall operate in the same manner as the executive board and designated operational entities of the clean development mechanism as set out in the annex below;

5. Decides that the executive board shall convene its first meeting immediately upon the election of its members;

6. Decides that the executive board shall include in its work plan until the eighth session of the Conference of the Parties, inter alia, the following tasks:

   (a) To develop and agree on its rules of procedure and recommend them to the Conference of the Parties for adoption, applying draft rules until then;

(b) To accredit operational entities and designate them, on a provisional basis, pending the designation by the Conference of the Parties at its eighth session;

(c) To develop and recommend to the Conference of the Parties, at its eighth session, simplified modalities and procedures for the following small-scale clean development mechanism project activities:

(i) Renewable energy project activities with a maximum output capacity equivalent of up to 15 megawatts (or an appropriate equivalent);

(ii) Energy efficiency improvement project activities which reduce energy consumption, on the supply and/or demand side, by up to the equivalent of 15 gigawatt / hours per year;

(iii) Other project activities that both reduce anthropogenic emissions by sources and directly emit less than 15 kilotonnes of carbon dioxide equivalent annually;

(d) To prepare recommendations on any relevant matter, including on Appendix C to the annex below, for consideration by the Conference of the Parties at its eighth session;

(e) To identify modalities for seeking collaboration with the Subsidiary Body for Scientific and Technological Advice on methodological and scientific issues;

7. Decides:

(a) That the eligibility of land use, land-use change and forestry project activities under the clean development mechanism is limited to afforestation and reforestation;

(b) That for the first commitment period, the total of additions to a Party's assigned amount resulting from eligible land use, land-use change and forestry project activities under the clean development mechanism shall not exceed one per cent of base year emissions of that Party, times five;

(c) That the treatment of land use, land-use change and forestry project activities under the clean development mechanism in future commitment periods shall be decided as part of the negotiations on the second commitment period;

8. Requests the secretariat to organize a workshop before the sixteenth session of the Subsidiary Body for Scientific and Technological Advice with the aim of recommending terms of reference and an agenda for the work to be conducted under paragraph 10*(b)* below on the basis of, inter alia, submissions by Parties referred to in paragraph 9 below;

9. Invites Parties to provide submissions to the secretariat by 1 February 2002 on the organization of the workshop referred to in paragraph 8 above, and to express their views on the terms of reference and the agenda for the work to be conducted under paragraph 10*(b)* below;

10. Requests the Subsidiary Body for Scientific and Technological Advice:

(a) To develop at its sixteenth session terms of reference and an agenda for the work to be conducted under subparagraph *(b)* below, taking into consideration, inter alia, the outcome of the workshop mentioned in paragraph 8 above;

(b) To develop definitions and modalities for including afforestation and reforestation project activities under the clean development mechanism in the first commitment period, taking into account the issues of nonpermanence, additionality, leakage, uncertainties and socioeconomic and environmental impacts, including impacts on biodiversity and natural ecosystems, and being guided by the principles in the preamble to decision -/CMP.1 (Land use, land-use change and forestry) and the terms of reference referred to in subparagraph *(a)* above, with the aim of adopting a decision on these definitions and modalities at the ninth session of the Conference of the Parties, to be forwarded to the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol at its first session;

11. Decides that the decision by the Conference of the Parties at its ninth session, on definitions and modalities for inclusion of afforestation and reforestation project activities under the clean development mechanism, for the first commitment period, referred to in paragraph 10 *(b)* above, shall be in the form of an annex on modalities and procedures for afforestation and reforestation project activities for a clean development mechanism reflecting, mutatis mutandis, the annex to the present decision on modalities and procedures for a clean development mechanism;

12. Decides that certified emission reductions shall only be issued for a crediting period starting after the date of registration of a clean development mechanism project activity;

13. Further decides that a project activity starting as of the year 2000, and prior to the adoption of this decision, shall be eligible for validation and registration as a clean

development mechanism project activity if submitted for registration before 31 December 2005. If registered, the crediting period for such project activities may start prior to the date of its registration but not earlier than 1 January 2000;

14. Requests Parties included in Annex I to start implementing measures to assist Parties not included in Annex I, in particular the least developed and small island developing States among them, with building capacity in order to facilitate their participation in the clean development mechanism, taking into account relevant decisions by the Conference of the Parties on capacity-building and on the financial mechanism of the Convention;

15. Decides:

    (a) That the share of proceeds to assist developing country Parties that are particularly vulnerable to the adverse effects of climate change to meet the costs of adaptation, as referred to in Article 12, paragraph 8, of the Kyoto Protocol, shall be two per cent of the certified emission reductions issued for a clean development mechanism project activity;

    (b) That clean development mechanism project activities in least developed country Parties shall be exempt from the share of proceeds to assist with the costs of adaptation;

16. Decides that the level of the share of proceeds to cover administrative expenses of the clean development mechanism shall be determined by the Conference of the Parties upon the recommendation of the executive board;

17. Invites Parties to finance the administrative expenses for operating the clean development mechanism by making contributions to the UNFCCC Trust Fund for Supplementary Activities. Such contributions shall be reimbursed, if requested, in accordance with procedures and a timetable to be determined by the Conference of the Parties upon the recommendation of the executive board. Until the Conference of the Parties determines a percentage for the share of proceeds for the administrative expenses, the executive board shall charge a fee to recover any project related expenses;

18. Requests the secretariat to perform any functions assigned to it in the present decision and in the annex below;

19. Decides to assess progress made regarding the clean development mechanism and to take appropriate action, as necessary. Any revision of the decision shall not affect clean development mechanism project activities already registered;

20. Recommends that the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol, at its first session, adopt the draft decision below.

8th plenary meeting
10 November 2000

Glossary of terms related to carbon credits:

Since the early 1990's, a variety of terms has been used to refer to different project-level climate change mitigation mechanisms and their outputs. The meaning of these terms has changed gradually. Below are some of the definitions that have been used. Most bear some relation to stipulations of the United Nations Framework Convention on Climate Change (UNFCCC), signed in 1992, whose provisions are fleshed out by the Kyoto Protocol, signed in December 1997.

Carbon offsets and credits

- Carbon offsets — used in a variety of contexts, most commonly either to mean the output of carbon sequestration projects in the forestry sector, or more generally to refer to the output of any climate change mitigation project.

- Carbon credits — as for carbon offsets, though with added connotations of (1) being used as "credits" in companies' or countries' emission accounts to counter "debits" i.e. emissions, and (2) being tradable, or at least fungible with the emission permit trading system.

The Kyoto Protocol (KP)

In December 1997, the Kyoto Protocol was adopted during CoP3 of the UNFCCC. The most important aspect of the Kyoto Protocol are the binding commitments by 39 developed countries and economies in transition (the Annex B countries) to reduce their GHG emissions by an average of 5.2 per cent on 1990 levels by the commitment period, 2008 to 2012. The Protocol also approved the use of three 'flexibility mechanisms' (see below) for facilitating the achievement of GHG emission reduction targets. These are QUELRO (Quantified Emissions Limitations or Reduction Objectives) trading or simply 'emissions trading' (ET), Joint Implementation (JI), and the Clean Development Mechanism (CDM).

The Kyoto Protocol was opened for ratification on 16 March 1998 and becomes legally-binding 90 days after the 55th government ratifies it, assuming that those 55 countries account for at least 55 per cent of developed countries emissions in 1990.

Mechanisms (1) — Early pre-Kyoto definitions

Joint Implementation (JI)

The concept of joint implementation (JI) was introduced by Norway into pre-UNCED negotiations in 1991. This was reflected in Article 4.2(a) of the UNFCCC, which gives Annex I countries (see below) the option of contributing to the Convention's objectives by implementing policies and measures jointly with other countries. The investing participants in these projects could presumably claim emission reduction 'credits' for the activities financed, and these credits could then be used to lower greenhouse gas (GHG) related liabilities (e.g., carbon taxes, emission caps) in their home countries.

Activities Implemented Jointly (AIJ)

In the first Conference of the Parties (CoP 1) to the UNFCCC, held in 1995 in Berlin, developing country dissatisfaction with the JI model was voiced as a formal refusal of JI with crediting against objectives set by the Convention (see text for full discussion). Instead, a compromise was found in the form of a pilot phase, during which projects were called Activities Implemented Jointly (AIJ). During the AIJ Pilot Phase, projects were conducted with the objective of establishing protocols and experiences, but without allowing carbon credit transfer between developed and developing countries.

Mechanisms (2) — Post-Kyoto definitions

The Kyoto Protocol of the UNFCCC created three instruments, collectively known as the 'flexibility mechanisms', to facilitate accomplishment of the objectives of the Convention. A new terminology was adopted to refer to these mechanisms, as detailed below, but Joint Implementation prevailed. Note that because of the Kyoto Protocol's distinction between projects carried out in the developed and developing world, some AIJ projects may be reclassified as CDM or JI projects.

Joint Implementation (JI)

As mentioned before, JI was introduced into pre-UNCED negotiations in 1991. Then, it was set out in Article 6 of the Protocol, referring to climate change mitigation projects implemented between two Annex 1 countries (see below). Article 6 of the Kyoto Protocol defines Joint Implementation (JI) as the creation, acquisition and transfer of emission reduction units (ERUs) between Annex I parties (developed countries and economies in transition), that result from projects aimed at reducing emissions at sources or enhancing GHGs removals by sinks. While often considered a distinct commodity, in effect ERUs represent a form of Assigned Amounts and are directly related to an Annex 1 country's overall ability to meet its emission target. Credits from JI will only start accruing from the beginning of the first commitment period (2008-2012).

The Clean Development Mechanism (CDM)

The CDM was established by Article 12 of the Protocol and refers to climate change mitigation projects undertaken between Annex 1 countries and non-Annex 1 countries (see below). This new mechanism, whilst resembling JI, has important points of difference. In particular, project investments must contribute to the sustainable development of the non-Annex 1 host country, and must also be independently certified. As defined by the Protocol, the CDM's purpose is twofold: firstly, to assist developing countries (non-Annex I Parties) in making progress towards sustainable development and contributing to the UNFCCC's objectives; and secondly, to assist developed countries and economies in transition (Annex I Parties) in achieving their emission reduction targets. Non-Annex I Parties are supposed to gain the economic, developmental and environmental benefits from implemented projects that generate Certified Emission Reductions (CERs) for export.

An important facet of the CDM is that these CERs are bankable from 2000. This creates a strong incentive for those in a position to act now to engage in CDM projects as early as possible. Other features of the CDM include:

- Project activities must be additional to policy actions that give rise to the same outcomes;
- The CDM is open to participation by either private or public entities, or combinations of the two;
- Projects must have the approval of the host government;
- The CDM itself will act as an international body to oversee projects;
- CDM projects must be independently certified by Operational Entities accredited by the CDM Executive Board;

the CDM has a mandate to use a portion of its proceeds to assist those countries which are particularly vulnerable to climate change to adapt to those changes (the size of this Adaptation Charge is still undefined).

Emissions Trading (ET) or QUELRO trading (Quantified Emission Limitation and Reduction Obligations trading)

Article 17 of the Protocol allows for emissions-capped Annex B countries to transfer among themselves portions of their assigned amounts (AAs) of GHG emissions. Under this mechanism, countries that emit less than they are allowed under the Protocol (their AAs) can sell surplus allowances to those countries that have surpassed their AAs. Such transfers do not necessarily have to be directly linked to emission reductions from specific projects.

Which countries in which mechanisms?

Annex 1 countries

These are the 36 industrialized countries and economies in transition listed in Annex 1 of the UNFCCC. Their responsibilities under the Convention are various, and include a non-binding commitment to reducing their GHG emissions to 1990 levels by the year 2000.

Annex B countries

These are the 39 emissions-capped industrialized countries and economies in transition listed in Annex B of the Kyoto Protocol. Legally-binding emission reduction obligations for Annex B countries range from an 8% decrease (e.g., European Commission) to a 10% increase (Iceland) on 1990 levels by the first commitment period of the Protocol, 2008 — 2012.

Annex 1 or Annex B?

In practice, Annex 1 of the Convention and Annex B of the Protocol are used almost interchangeably. However, strictly speaking, it is the Annex 1 countries which can invest in JI/CDM projects as well as host JI projects, and non-Annex 1 countries which can host CDM projects, even though it is the Annex B countries which have the emission reduction obligations under the Protocol. Note that Belarussia and Turkey are listed in Annex 1 but not Annex B; and that Croatia, Liechtenstein, Monaco and Slovenia are listed in Annex B but not in Annex 1.

Annex III. The CDM project cycle

Because of the various regulatory requirements, the development of a CDM project necessarily has to follow a certain order. The description of a typical CDM project cycle, according to the latest proposals submitted by the Parties, is given below.

Project design

The project design phase is the process of conceiving the project concept, estimating the GHG mitigation potential of the project, undertaking the feasibility analysis, identifying the various project partners and developing a working plan. The output of this phase is usually a Project Design Document (PDD), that includes, at least:

- Parties involved in the project, addresses and contact directions;
- Description of project activities and background;
- Rationale for eligibility as a CDM project;
- Estimation of GHG mitigation potential, based on an analysis of project and baseline carbon flows;
- Estimated sustainable development objectives;
- Implementation workplan;
- Description of monitoring plan.

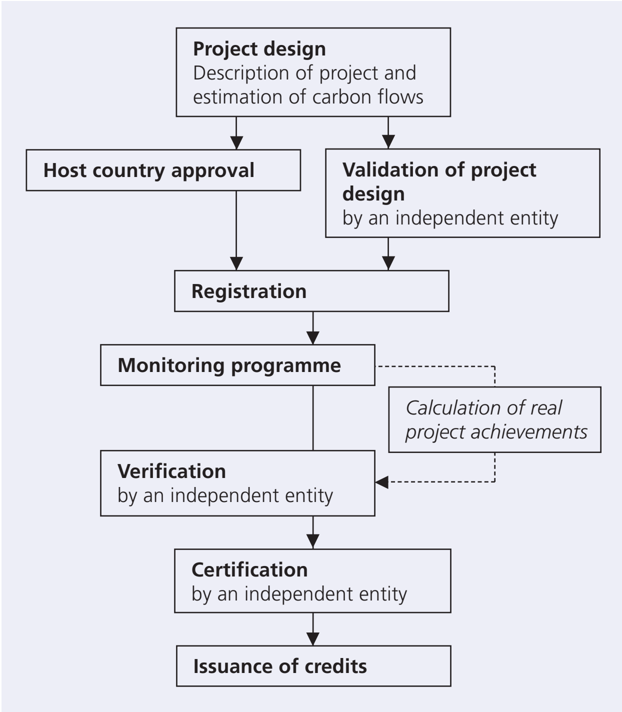
This document can then be sent to:

- Project investors — to attract investment;
- Host country authorities — to obtain host country approval;
- Certification bodies (or Operational Entities-OE, in the text of the CDM) — to have the project design 'validated' (see below);
- GHG regulatory bodies (or the CDM, when operational) — to obtain official project registration.

This activity is usually conducted by project developers, and may benefit from expert advice. The information contained in this report is essential to the PDD.

Host country approval and validation of project design

The next steps in the CDM/JI project cycle are to seek host country approval and validation of the project by an independent certification body.



All projects willing to participate in the CDM will have to have their Project Design Documents validated by an independent certification body. This process of validation will probably be conducted by Operational Agencies (certification companies) accredited by the CDM.

The process of validation usually addresses the following points:

- Whether the emission reductions or carbon sequestration are additional to the baseline scenario;
- Whether the project conforms to the sustainable development objectives of the host country and local stakeholders in question; whether the project is compatible with and supportive of national and developmental priorities;
- Whether it has a formal approval by the host country;
- Whether the project will result in real, measurable and long term environmental benefits related to the mitigation of climate change;
- How the project will monitor its GHG and sustainable development achievements (inspection of the monitoring plan);
- How the project will deal with GHG (leakage) and non-GHG externalities.

Given that host country approval is an essential requirement of the CDM, it is necessary that the Operational Entity have a letter of approval from the host country before it can finish the process of validation of the project. The process of host country approval will vary from country to country, given that different countries may have different internal procedures and agencies responsible for dealing with climate change issues. In general, however, it is expected that government agencies would like to analyse the project proposal prior to releasing a letter of support, and, often, they may need a letter from the Operational Entity stating that the project has already been analysed and seem to conform to the requirement of the Kyoto Protocol and the host country. For this reason, it is expected that both processes are likely to happen in parallel.

Registration of the project with the CDM Executive Board

After the project has been successfully validated and approved by the host country, it will have to be registered with the CDM Executive Board, which will give it a unique registration number.

Verification, certification and issuance of credits

Carbon offset projects under the CDM will need to be independently verified by an Operational Entity (OE) accredited by the CDM ex post delivery before any carbon credits can be issued for trading. While official guidelines for project verification still do not exist, experience with carbon offset project approval to date suggests that project verification will need to ascertain the following (amongst other criteria):

- That the project has followed the implementation plan described in the validated Project Design Document (PDD);
- The validity of the carbon claims of the project and the calculation procedures used for producing these claims;
- The quality of the data and the procedures used for data collection;
- That the sustainable development indicators proposed in the Project Design Document (PDD) have been monitored and meet the project's targets.

The successful output of the verification process is the certification of the project. Certification consists of issuing a statement indicating that the project has successfully created a given amount of carbon credits in accordance with the rules of the Kyoto Protocol and the UNFCCC. Based on this certificate, the CDM Executive Board can then issue credits for the project. The CDM will deduct from the project's gains two per cent of the credits generated, to support countries likely to be most affected by climate change (the Adaptation Levy. The levy to cover administrative costs is yet to be decided).

Annex IV. Project eligibility

For projects to qualify as valid mitigation activities in the context of the Kyoto Protocol, they have to fulfil a series of eligibility criteria. Under the proposed CDM system, a GHG mitigation project has to be acceptable and approved by the host country government under their respective sustainable development criteria (social, economic, environmental). Efforts are being made at the international level to have standardized and transparent investment criteria for clear and informed decision making by investors. It is important to emphasize that some form of host government approval for credit transaction will be required, and, as mentioned in this report, Brazil is elaborating its own criteria, although the investor country regulatory role may eventually be taken over by the CDM Executive Board at the international level.

GHG Baselines and Additionality

Baselines

In the context of the Clean Development Mechanism (CDM), Emission Reduction Units (ERUs, often referred to as 'carbon credits') are based on the difference in greenhouse gas (GHG) emissions (or CO_2 sequestration) between projected or business-as-usual practices (known as the baseline or reference scenario) and practices occurring due to project activities (known as the project scenario). This behavioural difference in GHG emissions or CO_2 sequestration is called 'additionality'. Additionality is, perhaps, the most important criterion dictating the eligibility of mitigation activities in the context of the Kyoto Protocol.

Determination of baselines can be divided into two steps:

- Determination of a future scenario in the absence of project activities. Essentially: what is likely to happen in the absence of the project?
- Determination of the carbon emissions that would take place in this future scenario. This is done using all the assumptions appropriate to this future scenario chosen. Given that baselines are, by definition, counterfactual, it is often the case that measurements and/or data may need to be collected in from other companies and/or proxy areas.

After the baseline is determined, the emissions that take place as a consequence of the project need to be quantified (or estimated, at the onset of the project) in order to determine the emission reductions impact of the project.

Moreover, a requirement of the Kyoto Protocol is that, in addition to its GHG benefits, projects contribute to sustainable development of the countries were they take place.

According to the UNFCCC's Drafting Group on Technical Issues text on CDM (Mechanisms) (version 21/07/01, Paragraph 46), a project must select a baseline methodology relevant to the project activity.

Given the difficulties and uncertainties inherent to the process of baseline setting (particularly in relation to predicting the future scenario), recent text related to the CDM require that projects select a crediting period and define when baselines are to be re-assessed at some points in the future. The recently released Marrakech Accords state that project participants shall select a crediting period for a proposed project activity from one of the following alternative approaches:

- A maximum of seven years which may be renewed at most two times, provided that, for each renewal, a designated Operational Entity (OE) determines and informs the Executive Board that the original project baseline is still valid or has been updated taking account of new data where applicable; or
- A maximum of 10 years with no option of renewal.

Additionality

Carbon credits are based on the difference in GHG emissions between projected or business-as-usual practices (known as the baseline or reference scenario) and practices occurring due to project activities (known as the project scenario). This behavioural difference in GHG emissions is called "additionality".

Additionality is a requirement of both JI and CDM projects, as set out in Article 6(1*b*) and Article 12(5*c*) of the Kyoto Protocol respectively. It is designed to ensure that carbon credit projects result in real reductions in the current rate of GHG accumulation in the atmosphere. Not all projects that might appear to have positive GHG effects are additional. For example, renaming existing hydroelectric plants as "carbon credit projects" does not involve any active reduction of existing GHG emissions. Conversely, establishing new clean power plants to replace existing diesel generators might rightly be considered as generating additional carbon credits.

For carbon credits to be acceptable under the terms of the Kyoto Protocol, no project can claim GHG emission reductions unless project proponents can reasonably demonstrate that the project's practices are "additional" to the "business-as-usual" or baseline scenario. The baseline scenario is broadly described as the collective set of economic, financial, regulatory and political circumstances within which a particular project is implemented and will operate. The validity of any particular project rests upon the case made that environmental performance — in terms of achieving GHG reductions — exceeds historical precedents, legal requirements, likely future developments, or a combination of all three. Establishing the baseline scenario thus requires knowledge of long term trends in energy use in the project area, the local socio-economic context, macro-economic trends that may affect the conventional outputs of a project, and other relevant policy parameters. However, in setting the baseline, these past trends and current situations must be projected into the future. Consequently, baseline scenarios are necessarily counterfactual, based on a range of assumptions. As a result, baseline setting is still affected by uncertainty.

Sustainable development

Under the CDM there is a specific objective to assist developing countries in achieving sustainable development. While international initiatives are trying to develop common guidelines, no outputs have been produced to date. There is increasing agreement that country-level definitions will be adopted for the analysis of eligibility of CDM projects.

Annex V. List of useful contacts for CDM Investors

This annex lists institutions and organizations, including governmental and research organizations, that are involved in climate change and CDM activities in Brazil and that could be a useful source of information and contacts for CDM investors in CDM project development and approval.

Ministério de Ciência e Tecnologia (MCT)

The Ministry of Science and Technology is the Ministry that has prepared the response of the Brazilian government to CDM issues. Within the country, MCT is viewed as a steady but conservative influence on climate change issues

Contact: José Domingos Gonzalez Miguez — Manager of the Advance Brazil Programme Global Change General Coordinator
Ministry of Science and Technology (MCT)
Address: Esplanada dos Ministérios, Bloco E, sala 240, 70067-900 — Brasília — DF, Brazil.
Phone: (55-61) 317-7523 / 7923
Fax: (55-61) 317-7657
E-mail: miguez@mct.gov.br
www.mct.gov.br/clima/ingles

or Ivonice Aires dos Campos — Actions for Energy Development Coordinator
Address: Esplanada dos Ministérios, Bloco E, sala 240
70067-900 — Brasília, DF Brazil.
Phone: (55-61) 317-7921 / 7922

Ministério do Meio Ambiente (MMA)

Leonardo Ribeiro and Adriano Santhiago de Oliveira, at the Secretary of Environmental Quality (MMA/SQA) within the Ministry of Environment, can be identified as the useful contacts concerning CDM. As mentioned before, this Secretary is working on eligibility criteria for CDM projects in Brazil.

Contact: Leonardo da Silva Ribeiro
Member of the Climate Change Workgroup of the Secretary of Environmental Quality
leonardo.ribeiro@mma.gov.br
Phone: (55-61) 317-1027 / 322-0539
Fax: (55-61) 323 8318
www.mma.gov.br

South South North (SSN) Project and Centro Integrado de Estudos de Mudanças Climáticas e Meio-Ambiente — CENTROCLIMA

The South South North Project (SSN) is a public interest nonprofit NGO with International Funding and the necessary expertise to help develop confidence for all concerned to deal effectively with the Clean Development Mechanism (CDM), both in the public and the private spheres. SSN operates in Bangladesh, Brazil, Indonesia and South Africa. SSN fosters capacity by providing training, development facilitation and other information, as well as forging links between the countries in which it operates.

In Brazil, the SSN project has been carried out by the Centre for Integrated Studies on Climate Change and the Environment (CENTROCLIMA), a centre designed to generate and disseminate knowledge, strengthening national capacities in the field of climate change and the environment.

The Centre was created in 2000, on the initiative of the Brazilian Ministry of Environment and the "Instituto Alberto Luiz Coimbra — Coordenação de Programas de Pós-Graduação e Pesquisa em Engenharia" (Alberto Luiz Coimbra Institute for Research and Postgraduate Studies of Engineering) of the Federal University of Rio de Janeiro — COPPE/UFRJ. It has also established a partnership with the University of São Paulo (USP). One of the objectives of the Centre is to support the Brazilian Climate Change Forum, recently created and chaired by the President of the Republic, by enabling the participation of the country's various stakeholders. Dissemination of the knowledge generated by the Centre provides inputs for developing public policies and non-governmental initiatives that make use of the opportunities provided by the United Nations Framework Convention on Climate Change to promote sustainable development in Brazil.

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Programa de Planejamento Energético/Coordenação de Programas de Pós graduação em Engenharia da Universidade Federal do Rio de Janeiro (PPE/COPPE/UFRJ)

Since 1990, The Energy Planning Programme of the Post-graduate Studies in Engineering at the Federal University of Rio de Janeiro — PPE/COPPE/UFRJ has been carrying out several studies on environmental issues. On an international level, it participates in the preparation of the IPCC (Intergovernmental Panel on Climate Change) reports and in studies for the Secretariat of the Climate Convention. In Brazil, it has been providing support to the Climate Change Unit of the Ministry of Science and Technology, preparing the inventory of greenhouse gas emissions. In Rio de Janeiro, COPPE has participated, together with the state government, in the launching of the movement "Rio Clean Development", with the International Virtual Institute for Global Changes — IVIG, created in partnership with FAPERJ — Foundation to the Support and Assistance to Research of the State of Rio de Janeiro. At the local level, it has carried out, through COPPE's Interdisciplinary Environmental Laboratory — LIMA, an inventory of the greenhouse gas emissions in the city of Rio de Janeiro. Lately, IVIG has been playing an important role of evaluating several environmental projects that could become eligible for CDM, and gives support, through a team of researchers, to the tenure of conferences on the issue.

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Comissão Interministerial de Mudança Global do Clima

The final decision-making on climate change issues remains the responsibility of the Interministerial Commission on Global Climate Change, established in 1999. It is co-chaired by the Minister of Science and Technology and the Minister of Environment, gathering several other Ministries as well. The Interministerial Commission on Global Climate was formed to integrate the response of the Brazilian government to climate change issues. More importantly, this group has the authority to authorize individual projects as CDM projects, and thus make CERs available. This Interministerial Commission is formally housed within the MCT.

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Fórum Brasileiro de Mudanças Climáticas — FORUMCLIMA

The Brazilian Climate Change Forum was created in August 2000 with the President of the Republic at that time, Dr. Fernando Henrique Cardoso, as its chairman. This forum is intended to develop awareness on climate change issues throughout Brazilian society. This forum gathers all the stakeholders in the field of climate change, including key federal government institutions, the governors of all states of the country, the mayors of all capital cities, and representatives from the private sector, the scientific community and NGOs. It has no decision-making power. However, it certainly influences the decision-making process, as its participants include all the key stakeholders at the highest level including chairmanship by the president of the country himself. The discussion of CDM issues is a top priority in the agenda of the Forum as there is a lot of controversy in the country about eligibility criteria, and particularly about the inclusion of forest projects. The establishment of official eligibility criteria will require some time due to the intrinsically controversial nature of the issue and the length of the discussion period will also depend upon external factors such as COP outcomes. However, the discussion of eligibility criteria and sustainability indicators to support a framework for decision-making on this issue is a top priority in the national agenda. Within this context, experiments with potential CDM candidates can provide the basis for establishing the criteria to be adopted by the Interministerial Commission on Global Climate Change.

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Conselho Empresarial para o Desenvolvimento Sustentável (CEBDS)

Created in 1997, the Brazilian Entrepreneurial Council for Sustainable Development (CEBDS) is an organization of 51 firms with one main concern: the implementation of sustainable development in the country. It is the Brazilian branch of the World Business Council for Sustainable Development (WBCSD). CEBDS promotes seminars, workshops and works directly with State authorities, NGOs and University and research centres. There are several technical chambers inside CEBDS, working on specific subjects such as: environmental legislation, ecoefficiency, global changes, biodiversity and biotechnology, social communication, energy, corporate social responsibility, and cleaner output.

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Fundação Brasileira para o Desenvolvimento Sustentável (FBDS)

The Brazilian Foundation for Sustainable Development (FBDS) acts in the environmental field. It was selected by international funding agencies to organize the first demonstration centre for CDM in Brazil.

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Banco Nacional de Desenvolvimento Econômico e Social (BNDES)

The Brazilian National Development Bank — BNDES is the main development bank in the country. It provides funding for national projects and could be an important partner since it may channel resources brought through the financial mechanisms of the Climate Convention. Since 1998, BNDES is taking part in various meetings, giving support to the Brazilian representatives in the negotiations of the Climate Convention. Since then, BNDES has been asked to take part in events related to the development of financial mechanisms and instruments to raise funds according to the Kyoto Protocol rules.

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ASPEN Projects: contacts

Small hydro in the state of Goiás

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40 MW wind project in north-east Brazil

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Hydroelectricity generation for the state of Amapá

Contact: JARI ENERGÉTICA
Gilberto Francischetto
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Water cleaning for hydroelectric facility near São Paulo

Contact: CO DEVELOPMENT LIMITED
Fábio Chazym
Phone: (1-301) 984 2381

Village electricity generation using palm oil

Contact: PROMAK — Indústrias Mecânicas Ltda.
Franz Josef Kaltner
Phone : (55-11) 243-0759

Lighting efficiency improvement in buildings

Contact:
NEGAWATT — PROJETOS, ENGENHARIA E COMÉRCIO LTDA.
Victor Pulz Filho
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Charcoal from forest plantation for pig iron industry (PLANTAR)

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Toyota hybrid motor automobile

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SSN Projects: contacts

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Ecosecurities

EcoSecurities Ltd. is an established environmental finance company which specializes in advising on strategy regarding global warming issues. The company has advised United Nations Agencies, national Governments, project developers and major corporations on scientific, policy and commercial issues related to climate change, including the development of potential CDM projects. Incorporating policy, science, and finance in a single organization, EcoSecurities identifies financial opportunities and investments both at the domestic as well as international level. Ultimately, EcoSecurities serves as a bridge between public policy and business actions in the area of greenhouse gas emission regulations and advises clients on all aspects of greenhouse gas mitigation in the forestry, energy, corporate and policy-making sectors.

The services provided by EcoSecurities include identification of strategic business opportunities resulting from current environmental policy shifts in industrial and emerging countries, carbon sequestration quantification, emissions trading policy analysis and project development services, integrated project structures, investment evaluation and financial structuring using environmental commodities.

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Ecoinvest

Ecoinvest is an advisory firm based in Brazil providing a broad range of financial services that meet the needs of environmentally conscious investors, helping them manage their money ethically and wisely. It focuses currently on identifying investments in cleaner technologies in Brazil, which will reduce emissions of greenhouse gases and become eligible for certified emission reduction (CERs) credits under the Clean Development Mechanism of the Kyoto Protocol.

Contact: Ricardo Esparta, a director and founding partner of Ecoinvest. He coordinates the Climate Change task force at the American Chamber of Commerce in São Paulo and develops research associated with the University of Stuttgart.

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De Rosa, Siqueira, Almeida, Mello, Barros Barreto e Advogados Associados (DRSAMBBAA)

This law firm has been dealing with climate change e carbon trade issues since 1996/1997, as Brazilian arm of International Ernst & Young Law Practice Network and was invited to be part of official Brazilian Government Delegation at The Hague, Bonn and Marrakech Conferences of Parties (COP6, I-II, COP7). It is also member of the Environmental Committee of São Paulo American Chamber (AMCHAM), its Climate Change Group and Renewable Energies Task-Force, and of the Brazilian Environmental and International Law Association (SBDIMA), at University of São Paulo. De Rosa, Siqueira, Almeida, Mello, Barros Barreto e Advogados Associados is performing services in the climate change area, both in afforestation/reforestation projects and in the energy field, offering legal advisory and general management assistance.

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Bioenergia Cogeradora's Sugarcane Bagasse Co-generation project

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Bibliography

Abracave, Anuário da Abracave, Base year 2000, Belo Horizonte, 2000, available in: www.abracave.com.br/anuario.htm.

Almeida, Mauro A., Schaeffer, Roberto and La Rovère, Emilio, "The potential for electricity conservation and peak load reduction in the residential sector of Brazil", Energy, 26, pp. 413-429, 2001.

Andrade, Maria Lúcia A. et al., "Siderurgia no Mundo", BNDES setorial n° 5, Rio de Janeiro, March, 1997.

Andrade, Adnei, Andrade, Carlos and Bodinaud, Albert, "Biomass energy use in Latin America: focus in Brazil", in IEA/OECD, Biomass energy: data, analysis and trends, Paris, 23-24 March, pp. 87-95, 1998.

Anfavea, Anuário Estatístico da Indústria Automobilística Brasileira, São Paulo, 2000.

ANEEL, Relatório de Análise do Mecanismo de Desenvolvimento Limpo — MDL — Estudos de Caso, ANEEL/MCT/UNEP/IVIGFAPERJ, Rio de Janeiro, 2000.

ANEEL, Banco de Informações de Geração (BIG), Available in: http:///www.aneel.gov.br, as of 25 April 2002.

BNDES, "O Setor Elétrico — Desempenho 93/99", Informe Infra-Estrutura, No. 53, December, 2000, available in www.bndes.gov.br.

Coelho, Suani et al., "Levantamento do potencial real de cogeração de excedentes do setor sucro-alcooleiro", in : IX Congresso Brasileiro de Energia, Rio de Janeiro, May, 2002.

Costa, Ricardo, "Do model Structures Affect Findings ? Two Energy Consumption and CO_2 Emission Scenarios for Brazil in 2010", Energy Policy, 29, pp. 777-785, 2001.

Costa, Ricardo and La Rovere, Emilio, Les Indicateurs de Viabilité Energétique : Le Cas du Brésil, report prepared for the Sustainable Energy Watch, Helio International, Paris, September, 2001.

Eletrobras/PROCEL, Resultados do PROCEL 1997 — Economia de Energia e Redução na Ponta, Rio de Janeiro, 1998.

Eletrobras/PROCEL, Relatório Síntese dos Programas de Combate ao Desperdício de Energia Elétrica Ciclo 1998/1999, Rio de Janeiro, outubro, 1999.

Eletrobras, Estimativa do potencial de cogeração no Brasil, GCPS, Rio de Janeiro, 1999.

Eletrobras, Plano Decenal de Expansão 2000-2009, Rio de Janeiro, 2000.

Góes, Roberto and Schaeffer, Roberto, "A complementaridade entre a geração hidrelétrica e a geração a partir do bagaço e resíduos de cana em sistemas de cogeração", in: IX Congresso Brasileiro de Energia, Rio de Janeiro, May, 2002.

Goldemberg, J., Moreira, J., Aspen Project, 1999.

Henriques Jr, Mauricio, Uso de Energia na Indústria Energo-Intensiva Brasileira : Indicadores de Eficiência Energética, MSc. Thesis PPE/COPPE/UFRJ. Rio de Janeiro, December, 1995.

IEA — International Energy Agency, CO_2 Emissions from fossil fuel combustion 1971-1998, IEA Statistics, OECD, Paris, 2000.

IPCC, Greenhouse Gas Inventory Reporting Instructions — IPCC Guidelines for National Greenhouse Gas Inventories, Vol 1, 2, 3 — IPCC, IEA, OECD, 1996.

Kolshus, Hans, Vevatne, Jonas, Torvanger, A. and Aunan, Kristin, "Can Clean Development Mechanism attain both cost-effectiveness and sustainable development objectives?", CICERO Working Paper 2001:8, June, 2001.

La Rovère, Emilio L., Domestic Actions in Developing Countries to Advance Development Priorities While Slowing Down Climate Change, A Climate of Trust Report, September, 2000.

La Rovère, Emilio et al., Inventário de Emissões de Gases do Efeito Estufa do Município do Rio de Janeiro, SMAC project nº 63/99, Rio de Janeiro, 2000.

Leite, Antonio Dias, A Energia no Brasil, Ed. Nova Fronteira, Rio de Janeiro, 1997.

MCT, www.mct.gov.br/clima, 2002.

MME, Balanço Energético Nacional, Brasília, 1976.

MME, Balanço de Energia Útil. Modelo de Avaliação do Potencial de Economia de Energia, FDTE, Brasília, 1995.

MME, Balanço Energético Nacional, Brasília, 2001.

MME, Leis n0 8.987/95 e lei n0 9.074/95, Notícias 10/08/99, PCH, available in: www.mme.gov.br, as of April 20, 2002.

MME/Eletrobras/Cepel, Atlas do potencial eólico brasileiro, CD-ROM. Brasília. 2001.

Muylaert, Maria Silvia (coord.), Consumo de Energia e Aquecimento do Planeta, COPPE/UFRJ, Rio de Janeiro, 2001.

Nascimento, M. V. G., Fontes alternativas de energia em sistemas isolados: uma possível solução para o problema da CCC, Grupo técnico operacional da região Norte, CEPEL/ELETROBRÁS, Rio de Janeiro, 1998.

Novaes, E., La Rovere, E.L., Oliveira, A.S.de, Ribeiro, Proposta Revisada de Critérios e Indicadores de Elegibilidade para Avaliação de Projetos Candidatos ao Mecanismo de Desenvolvimento Limpo (MDL), MMA/SQA, Relatório Técnico, april 2002.

Oliveira, Luciano et al., "Aproveitamento Energético de Lixo Urbano", in: Análise Prospectiva de Introdução de Tecnologias Alternativas de Energia no Brasil, Rio de Janeiro, Agost, 2002.

Oliveira, Luciano and Rosa, Luiz P., "Usinas termelétricas híbridas: geração de energia com balanço nulo de emissões de gases de efeito estufa, usando combustível fóssil e biomassa residual", in: IX Congresso Brasileiro de Energia, Rio de Janeiro, May, 2002.

Pereira, O., "As energias solar e eólica", in: UFRJ/Eletrobrás/MME, Seminário de Desenvolvimento Energético Sustentável, pp. 171-181, Rio de Janeiro, 1998.

Raufer, R., Personal communication, 2002.

Ribeiro, C. M., Eletrificação rural com sistemas fotovoltaicos distribuídos no contexto da universalização do serviço de energia elétrica no Brasil, MSc. Thesis, COPPE/UFRJ, Rio de Janeiro, 2001.

Seroa da Motta, Ronaldo, Ferraz, Claudio, Young, Carlos, Austin, Duncan and Faeh, Paul, O Mecanismo de Desenvolvimento Limpo e o Financiamento do Desenvolvimento Sustentável no Brasil, IPEA Working Paper 761, Rio de Janeiro, September, 2000.

Schaeffer, Roberto, Logan, Jeffrey, Szklo, Alexandre, Chandler, Willian and Souza, João Carlos, Developing countries and global climate change: Electric power options in Brazil, Pew Centre on Global Climate Change, Arlington, VA, May, 2000.

SSN, www.southsouthnorth.org, 2002

Thorne, Steve e La Rovère, Emilio, Criteria and indicators for appraising Clean Development Mechanism (CDM) Projects, Helio International, Paris, 1999.

Tiago, G., Alguns aspectos do estado atual das PCHs no Brasil, CERPCH, 2001.

Tolmasquim, M. (coord.), Tendências da Eficiência Elétrica no Brasil : Indicadores de Eficiência Energética, COPPE/UFRJ, Rio de Janeiro, 1998.

Tolmasquim, Maurício, Szklo, Alexandre and Soares, Jeferson, "Potential Use for Alternative Energy Sources in Brazil", Technical Paper presented in the Annual Petrobras Conference at St. Antony's College, Oxford. 2002.

Tolmasquim, M. T. and Neto, V. C., Estímulo ao uso da cogeração a partir do bagaço de cana-de-açúcar, Working Paper, PPE/COPPE/UFRJ, Rio de Janeiro, 2002.

UNFCCC, www.unfccc.int, 2002.

U.S. Census Bureau, Statistical Abstract of the United States, 2001.

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