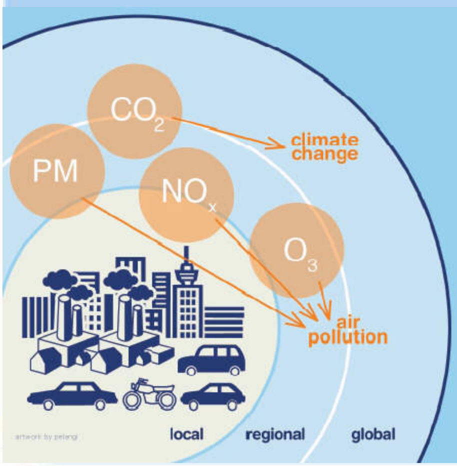
the clean development mechanism & urban air pollution

a handbook for policymakers



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"CURB-AIR: CDM and urban air pollution: partnerships enhancing synergies in urban air and health in Kyoto mechanisms"
an EU Asia Pro Eco co-funded project

The Clean Development Mechanism

and

Urban Air Pollution

A Handbook for Policymakers

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Preface

Urban air pollution is a serious health problem in large Asian cities. Often policymakers in those cities are not sufficiently equipped with budget or capacity to address urban air pollution. The clean development mechanism (CDM) could provide finance for air pollution reduction if the measures taken also reduce greenhouse gases. Indeed, there is room for synergy, as there is often a strong sectoral overlap between sources of air pollution and sources of greenhouse gases.

This handbook is based on the results an EU Asia Pro Eco co-funded project “CURB-AIR: CDM and urban air pollution: partnerships enhancing synergies in urban air and health in Kyoto mechanisms”. The CURB-AIR project intends to pave the way for projects that both improve air quality and reduce greenhouse gases emissions.

The handbook aims to be a guide for policymakers, civil servants and anyone who is interested in the issue of CDM, urban air pollution and climate change. The Handbook consists of five chapters. ***Chapter 1*** reviews the key issues of the synergy between air pollution, CDM, and climate change. ***Chapter 2*** provides an overview of the various steps which constitute the CDM process. ***Chapter 3*** examines the different types of CDM methodologies that could be applied to projects that contribute to improving urban air quality. ***Chapter 4*** presents four case studies that examine the CDM methodological issues of urban projects that both improve air quality and reduce greenhouse gases emissions. Finally, ***Chapter 5*** highlights the key conclusions with regard to the synergy between CDM and urban air pollution.

The CURB-AIR Project Team

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List of Abbreviations, Acronyms & Institutions

List of Abbreviations

€	Euro
GWh	Giga Watt Hour
MW	Mega Watt
USD	United States Dollar

List of Acronyms

ACMs	Approved Consolidated Methodologies
AM	Approved Methodology
AMS	Approved Small-scale Methodology
AQ	Air Quality
AQM	Air Quality Management
BC	Black Carbon
BGPG	Biomass Gasification For Power Generation
BRT	Bus Rapid Transit
CDM	Clean Development Mechanism
CERs	Certified Emission Reductions
CH_4	Methane
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CPA	CDM Programme Activity
DNA	Designated National Authority
DOE	Designated Operational Entity
EB	Executive Board
EDSA	Epifanio de los Santos Avenue
GHG	Greenhouse Gas
HFCs	Hydrofluorocarbons
HSU	Hartridge Smoke Unit
INV	Investment
IRR	Internal Rate Of Return
JBGPG	Jinan Biomass Gasification For Power Generation
Kmpl	Kilometres Per Litre
LPG	Liquefied Petroleum Gas
N_2O	Nitrous Oxide
NH_3	Ammonia
NM	New Methodology
NMVOC	Non-Methane Volatile Organic Compounds
NO	Nitric Oxide

NO_2	Nitrogen Dioxide
NOx	Nitrogen Oxides
O&M	Operation And Maintenance
O_3	Tropospheric Ozone
OC	Organic Carbon
PCN	Project Concept Note
PDD	Project Design Documents
PFCs	Perfluorocarbons
PIN	Project Idea Note
PM	Particulate Matter
PM_{10}	Particulate Matter 10 Microns
$PM_{2.5}$	Particulate Matter 2.5 Microns
PME-BDF	Palm Methyl Ester – Biodiesel Fuel
PoA	Programme Of Activities
RE	Renewable Energy
SF_6	Sulphur Hexafluoride
SO_2	Sulphur Dioxide
TC	Total Carbon
TSP	Total Suspended Particulate

List of Institutions

DEFRA	Department for Environment, Food and Rural Affairs (UK)
EU	European Union
IPCC	Intergovernmental Panel On Climate Change
KSRTC	Karnataka State Road Transport Corporation
SDERI	Energy Research Institute Of Shandong Academy Of Sciences
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	UN Framework Convention On Climate Change
US	United States Of America
USEPA	United States Environmental Protection Agency
WHO	World Health Organisation

Chapter 1: Urban Air Pollution and Climate Change

1.1 Introduction

Air pollution is a multi-pollutant, multi-effect, transboundary problem which poses a serious environmental risk in Asia. Many traditional urban air pollutants and greenhouse gas (GHG) emissions have similar sources. Ambient air pollutants generally stay in the atmosphere for a short period (e.g. days or weeks). In contrast, carbon dioxide (CO_2), a major GHG, has a lifetime of approximately 150 years and methane approximately 12 years (DEFRA, 2007). Emissions from different pollutant sources interact in the atmosphere and cause a variety of health and environmental impacts at the local, regional and global level. Air pollutants directly cause health and environmental impacts while GHGs contribute to climate change which has indirect effects on human health and the environment.

The benefit from urban air pollution control tends to be immediate, more certain and occur at the place where the control measure is taken (e.g. urban or regional scale). In contrast, the impact of control measures on climate change is long-term and global. These differences have been reflected in the current scientific and policy frameworks, which tend to address these problems separately (IPCC, 2007a) with policies to address urban air quality being in the form of local and regional measures. However, these can be adapted at low cost to also reduce GHG emissions. This is particularly important for developing countries in Asia, where economic and social development rather than climate change mitigation is a higher priority (Chandler et al., 2002). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (2007a) stated that:

> *"Integrating air pollution abatement and climate change mitigation policies offers potentially large cost reductions compared to treating those policies in isolation."*

This chapter will examine the issue of urban pollution management and climate change in Asia and potential co-benefits that could be achieved via the clean development mechanism (CDM). The CDM is an arrangement under the Kyoto Protocol allowing industrialised countries with a GHG reduction commitment (called Annex I countries) to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries.

1.2 Air Pollution and Development in Asia

Human activity has resulted in the emission of a wide range of gases and small particles into the atmosphere. These emissions affect the quality of the air we breathe which has an impact on human health and the environment. The main cause of urban air pollution is the use of fossil fuels (coal, oil and natural gas) in transport, power generation, industry, and domestic sectors. Emissions from these mobile (e.g. motor vehicles) and fixed sources (e.g. industrial unit) are directly linked to population growth, urbanisation, migration and industrialisation. These driving forces together with the high demand of individual mobility and economic development influence the emission of air pollutants. Polluting air emissions not only comprise noxious pollutants which are deleterious to human health but also GHG which contribute to global climate change. Emissions of air pollutants and GHG have direct (e.g. visual) and indirect (e.g. acidification, ozone depletion, climate change) effects on air quality with a wide range of impacts on human health, ecosystems, agriculture and materials. The IPCC (2007a or b) predicted that climate change will have a number of impacts in Asia. These include:

- a decrease in freshwater availability in Central, South, East and South-East Asia, particularly in large river basins by the 2050s;
- greater flood risk to coastal areas from the sea and, in some mega deltas, flooding from the rivers, especially in heavily-populated mega delta regions in South, East and South-East Asia;
- compounding of existing pressures on natural resources and the environment, associated with rapid urbanisation, industrialisation and economic development;
- Endemic morbidity and mortality due to diarrhoea primarily associated with floods and droughts are expected to rise in East, South and South-East Asia due to projected changes in the hydrological cycle (IPCC, 2007b).

Short-term and long-term exposure to air pollution adversely affects human health. Primary air pollutants include particulate matter (PM), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO) while secondary air pollutants include tropospheric ozone (O_3) and secondary PM such as sulphates and nitrates. PM levels are of particular concern as they regularly exceed national standards and World Health Organisation (WHO) recommended guidelines (Schwela et al., 2006; WHO, 2000a; 2000b; 2005).

Exposure to outdoor air pollution is responsible for an estimated 537,000 premature deaths annually, with exposure to indoor smoke from solid fuels being responsible for almost double this number of deaths (WHO, 2002). It is often the poor and socially marginalised who tend to suffer disproportionately from the effects of deteriorating air quality due to the fact that they are living near sources of pollution (Martins et al., 2004; Gouveia and Fletcher, 2000; Stern, 2003).

The severity of air pollution problems in Asian cities reflects the level and speed of their economic development (Seldon and Song, 1994; Shafik, 1994; Cole et al., 1997; Goklany, 1999; Gangadharan and Valenzuela, 2001; Harbaugh et al., 2002; Hill and Magnani, 2002; Cole, 2003). At the urban scale, as cities undergo economic development the environmental risks to human health generally decline both in absolute and relative terms with different types of risks tending to dominate each phase of development, moving from the household to the community and global scale (see Figure 1-1).

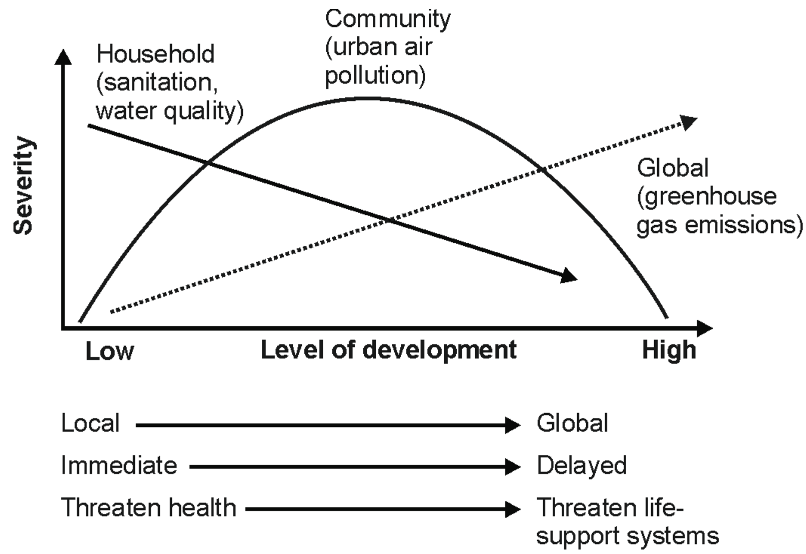

Figure 1-1: The Environmental Transition

Source: Schwela et al. (2006)

Many Asian governments have now recognised air pollution as a key environmental problem that needs to be addressed. Those cities which have been able to tackle air pollution early in their development path such as Hong Kong, Tokyo and Singapore have avoided high levels of key pollutants characteristic of cities that have no emission control measures or introduced them at a later stage. The earlier an integrated air quality management (AQM) system is introduced, the lower the maximum pollution levels that will occur (UNEP/WHO, 1992). Figure 1-2 relates the development of air pollution problems in cities to their development status. Many developed cities around the world generally follow this developmental path (Seldon and Song, 1994; Cole et al., 1997; Stern, 2004a).

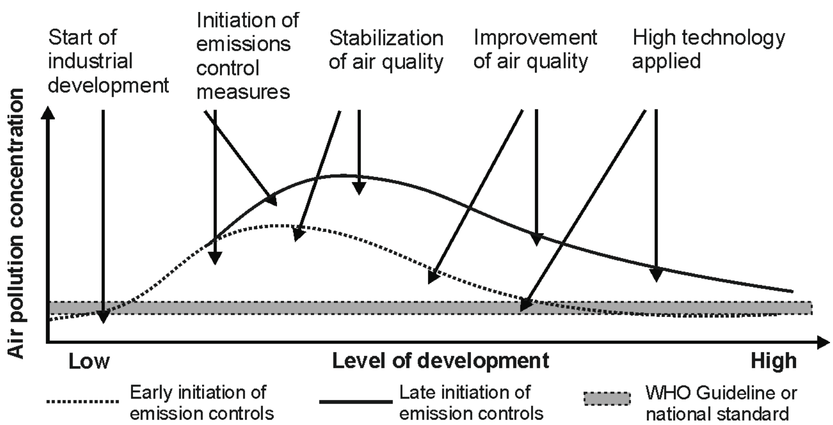

Figure 1-2: Development of air pollution problems in cities according to development

Source: Schwela et al. (2006)

In accordance with this 'environmental transition model' (Smith, 1997; McGranahan et al., 2001), SO_2 emissions in Asia have declined since the 1990s. This is mostly due to a reduction of SO_2 emissions in China (Sinton and Fridley, 2000; Stern, 2006; Streets and Waldoff, 2000). China has decreased its emissions of SO_2 from 23.8 million tons in 1995 to 20 million tons in 2000 due to a general reform of industry and power generation including a substantial decline in industrial high-sulphur coal use and an improvement in energy efficiency (Cofala et al., 2004). In contrast, the reduction of NO_x, primary and secondary PM, and O_3 has been slow in Asian countries due to an increase in the number of vehicles which offset the emission reductions achieved by improved vehicle technology.

1.3 Urban Air Pollution and Climate Change in Asia

Since the early 1980s a number of measures have been taken to address air pollution problems in Asia, which helped stabilise pollution levels and in some cases reverse air quality trends (Davis and Saldiva, 1999; WHO, 2001). However, considerable challenges still exist which need to be overcome before many Asian cities can achieve better air quality.

An assessment of air quality in 20 Asian cities shows that there has been a general improvement in ambient levels of total suspended particulate (TSP) and SO_2. However, there has been a limited decline in PM_{10} concentrations with many cities still exceeding the WHO annual average guideline of 20 $\mu g/m^3$. The average concentration of PM_{10} in the selected 20 Asian cities is approximately 80 $\mu g/m^3$. This has changed little since 1995, illustrating the challenge of reducing PM_{10} levels in Asia (CAI-Asia, 2006; Schwela et al., 2006).

Most Asian countries have adopted ambient air quality standards. However, such standards in Asia are not harmonised and vary considerably. Countries tend to follow WHO guidelines in setting the standards and in the case of $PM_{10,}$ the United States Environmental Protection Agency (USEPA) standards. Where standards deviate from WHO guideline values, European Union (EU) limit values and USEPA standards, Asian ambient standards tend to be more lenient. This is particularly the case for the 24-hour standards for PM_{10}, which are greater than the EU limit by a factor of 2 or more in Bangladesh, China, Hong Kong, Indonesia, Nepal, Philippines, Republic of Korea, Singapore, Taipei and Thailand

Although ambient standards have been established in most Asian countries, they are not necessarily used in all cities and implemented as part of an integrated AQM system comprising air quality monitoring, source identification, emissions inventories, emission control strategies, and health impact assessment. A number of opportunities exist where measures can be taken at the urban level which not only improve urban air quality but also reduces GHG emissions. Table 1-1 presents the most common urban air pollutants which have an effect on both air quality and climate change. Table 1-2 presents measures which are likely to lead to reductions in emissions of both air quality and GHG. Such measures could form part of an integrated strategy to address both urban air quality and global climate change.

Table 1-1: Urban air pollutants

Pollutant	Main sources	Major effects on air quality and climate change
Sulphur dioxide (SO_2)	Burning fossil fuels, e.g., domestic, industrial combustion, shipping, electricity generation.	1. Affects human health. 2. Forms secondary aerosol (sulphate), which affects health and causes cooling of the atmosphere. 3. Contributes to acidification of sensitive ecosystems.
Nitrogen oxides (NO_x) [nitric oxide, NO, and nitrogen dioxide, NO_2]	Burning fossil fuels, e.g., road transport, shipping, electricity generation.	1. Nitrogen dioxide affects human health. 2. Promotes formation of ozone, which affects human and ecosystem health and which is a greenhouse gas. 3. Forms secondary particulate matter (nitrate), which affects health and causes cooling of the atmosphere. 4. Contributes to acidification and eutrophication of sensitive ecosystems.
Nitrous oxide (N_2O)	Biomass burning, nitrogen fertilisers, sewage.	Greenhouse gas.
Ammonia (NH_3)	Agriculture, mainly from the production and management of manure and slurry in livestock farming.	1. Promotes the formation of secondary nitrate and sulphate aerosol, which affects human health and causes cooling of the atmosphere. 2. Contributes to acidification and eutrophication of sensitive ecosystems.
Particulate matter (PM)	Combustion processes from industries and transport, dust- and sandstorms	1. Affects human health 2. Some PMs' types provide negative contribution to radiative forcing
Ozone (O_3)	Chemical reactions in the atmosphere of nitrogen oxides and hydrocarbons	1. Affects human health and agriculture 2. Greenhouse gas
Carbon dioxide (CO_2)	All combustion processes	Greenhouse gas

Source: DEFRA (2007); WHO (2005); IPCC (2007a)

Table 1-2: Examples of measures to reduce emissions of air quality and climate active pollutants and their effects

Measure	Effect
Switching from coal to natural gas for power generation.	Reduces carbon dioxide emissions for each kilowatt generated. Emissions of sulphur dioxide and nitrogen oxides are also reduced.
Use of new technologies in road transport, e.g. (i) hybrid vehicles (ii) hydrogen from natural gas or from renewables (iii) lean burn petrol vehicles fitted with nitrogen oxide traps.	Reduces carbon dioxide emissions for each kilometre travelled and also emissions of nitrogen oxides and particulate matter. Essential that the whole fuel/ vehicle life cycle is analysed (e.g. the emissions associated with hydrogen generation).
Efficiency improvements in domestic appliances and industrial processes, e.g. through technical developments.	Reduces emissions of both types of pollutant, but efficiency measures sometimes result in increased demand, which must be avoided.
Energy conservation, e.g. through improved insulation of houses.	Reduces emissions of both types of pollutant.
Demand management/behavioural change: improved public transport coupled with disincentives for private car usage.	Reduces emissions of both types of pollutant.
Development of mass transit system in urban area (e.g. BRT)	Reduces emissions of both types of pollutant.
Switching to cleaner transport fuels (e.g. natural gas, biofuels)	Reduces emissions of both types of pollutant.

Source: DEFRA (2007), Authors

1.4 The Clean Development Mechanism

In 1997, the Kyoto Protocol was agreed by the UN Framework Convention on Climate Change (UNFCCC). The CDM is a means for developed countries to achieve part of their target under the Kyoto Protocol by purchasing Certified Emission Reductions (CERs) from GHG reduction projects in developing countries. A prerequisite for a CDM project is that it must contribute to sustainable development in the host country. It is up to each host country government to decide and define their criteria for sustainable development. A UNFCCC body called the CDM Executive Board (EB) decides on the validity of the methodology for generating CERs of each project.

The CDM aims to:

- contribute to the ultimate objective of the UNFCCC, i.e. preventing dangerous human interference with global climate system by reducing global GHG emissions
- help industrialised countries in achieving their GHG target under the Protocol; and
- assist developing countries in achieving sustainable development.

The CDM offers an incentive for developing countries to implement climate-friendly projects. Project developers can implement such projects and sell the generated CERs to governments or companies in industrialised countries that face a shortage in emission allowances. In addition to financial benefits, technology cooperation between western and developing countries is an important aspect. For example, biofuel processing equipment may be supplied by western companies. Using the CDM may help to lower other barriers such as reluctance to use a new technology, increase possibility to attract loans, and cooperation from local and national governments.

As of early 2008, nearly 3,000 CDM projects are in an advanced stage of development. These are expected to generate more than 2,400 million CERs up to 2012 or 430 million tonnes of CO_2-eq reduction annually across non-Annex I countries. More than 800 of these are registered with the CDM EB. Figure 1-3 presents a breakdown based on technology. Renewable energy projects (e.g. wind, hydro and biomass) account for more than half of the number of projects. However, in terms of CERs the non-CO_2 projects, notably hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and N_2O and methane destruction, dominate the current project portfolio.

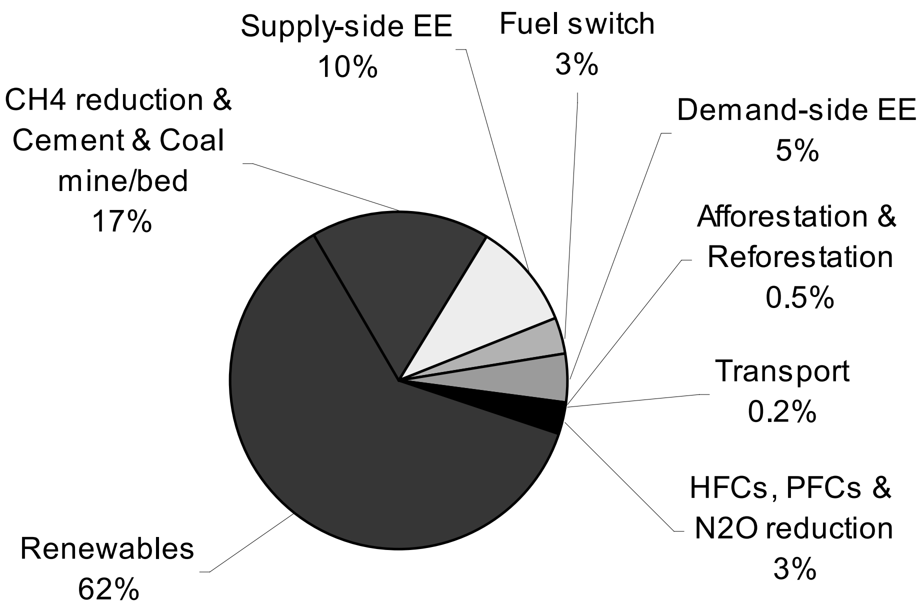

Figure 1-3: CDM project portfolio as of January 2008, number of validated projects technology-wise

Source: UNEP/Risø (2008)

1.5 Clean Development Mechanism and Sustainable Development

The IPCC third assessment report in 2001 projected that developing countries' GHG emissions are going to exceed industrialised countries' emissions some time between 2010 and 2020. China's CO_2 emissions already exceed those of the United States (WEO, 2007). At the same time, developing countries are struggling with immediate development concerns. This has two immediate implications for climate change policies. Firstly, if any large-scale reductions of GHG emissions are to be achieved in the long term, participation of both industrialised and developing countries is essential. Secondly, if developing countries are to participate in global climate policies, one of the ways forward is a stronger emphasis on integrating sustainable development within the climate change policies. The CDM is the first type of climate change mechanism to take into account these challenges and explores the potential for integrating climate change and sustainable development considerations in specific projects.

The Kyoto Protocol specifies that CDM activities have a dual purpose of assisting non-Annex I Parties in achieving sustainable development and Annex I countries in meeting their target of reducing GHG emissions. Thus, sustainable development is not just a requirement in CDM, but should be the main thrust for the developing countries to participate in CDM, as it will have other social, economic and environmental effects.

The World Commission on Environment and Development (1987) defined sustainable development has development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development can been seen as being composed of three inseparable and interrelated parts: economic development; environmental protection; and social advancement. In determining the sustainability of a particular policy, plan or programme three broad criteria can be used in the assessment:

- **Social:** improves the quality of life, alleviates poverty, and improves equity.
- **Economic:** provides financial returns to local entities, results in positive impact on balance of payments, and transfers new technology.
- **Environmental:** reduces GHG emissions and the use of fossil fuels, conserves local resources, reduces pressure on the local environments, provides health and other environmental benefits, and meets energy and environmental policies.

No guidance is given on how to determine the sustainability of CDM projects. Developing host countries are therefore free to determine their own criteria and assessment process on how CDM can contribute and maximise national development goals. The lack of a defined framework on sustainable development has resulted in ambiguity in choice of sustainability criteria to be used by a developing country in its assessment of a particular CDM project. While CDM provides a flexible mechanism to reduce GHG emissions it would be inappropriate for interventions designed to mitigate climate change to result in other environmental and social disbenefits for the host community

While the degree of freedom regarding sustainability requirements may be positive from a developing country perspective, since no limitations are imposed, it can also be viewed as a potential threat to the success of the CDM. Thorne and Raubenheimer (2001) note that since there is no clear guidance and no specific requirements regarding sustainability in the monitoring, verification, and certification texts, there is not a minimal standard for sustainability and nothing to prevent a "race to the bottom" among CDM host countries competing for investors.

In the current CDM legal framework sustainable development is given equal emphasis to GHG reduction. However, little emphasis is given to the potential sustainable development impacts that could be achieved from CDM projects without necessarily implying a heavy additional burden on project developers and investors. The sustainability dimension has been often viewed as an "add-on", rather than a main driver. However, a number of approaches and methodologies exist to assess impacts of different sector projects and plans. These have been routinely used in environmental impact assessment, strategic environmental assessment and social impact assessment and can be applied in the assessment of CDM projects. To facilitate sustainable development, various factors can be used in the process:

- provision of general guidance on selecting sustainability criteria and indicators as well as on the overall agreed assessment procedure;
- building capacity for CDM project evaluation; and
- balancing the need for simple, operational approach with the need for identifying projects that have the largest sustainable development impacts.

Project design documents (PDD) as well as the validation process by international consultants can assist in understanding the methodology for the projects, which will enable developing countries to meet their sustainable development objectives.

While the concept of sustainable development is a guiding principle for developing countries, it is not necessary for all the criteria and indicators to be fulfilled at the same time. All criteria should take into account the temporal and spatial boundaries of the project and should aim to measure comprehensively the project's impact. The basic principle of the CDM is that both developed and developing countries benefit from participating, because synergies between global carbon abatement goals and local sustainable development goals are exploited. From the developing country perspective, the benefits arise both from the increased investment flows and from the requirement that these investments should advance host country sustainable development objectives. More specifically, the CDM may contribute to several developing country development objectives, including:

- increased energy efficiency and conservation;
- transfer of technologies and financial resources;
- local environmental benefits, e.g. cleaner air and water;

- local environmental co-benefits, such as health benefits from reduced local air pollution;
- poverty alleviation and equity considerations through income and employment generation;
- sustainable energy production; and
- private and public sector capacity development.

CDM projects may have a number of additional benefits (or indirect benefits) on other national development objectives (e.g. related to rural development, energy access, capacity building, education and health). In contrast, a number of activities which have been undertaken without any reference to climate change mitigation or adaptation (e.g. price reform, agricultural soil protection, sustainable forestry and energy sector restructuring) can make a significant contribution to reducing GHG emissions. This suggests that it may often be possible to integrate development priorities that are vitally important to decision-makers in developing countries into environmental and climate considerations. It opens the potential for climate change policies not to be seen as a burden to be avoided but as a co-benefit of sustainable development policies.

1.6 Synergy between Air Quality Management and CDM

In principle all technologies that reduce GHG emissions are eligible under the CDM with the exception of nuclear power. Within the framework of the CURB-AIR project a sector-wise analysis of air pollution reduction options based on their ability to reduce GHG emissions was undertaken (Caldés et al., 2007; Kok and de Coninck, 2004). A selection of options available is discussed below.

Transportation

In most cities the transportation sector is a major contributor to air pollution. However, it also appears to be the most difficult to address with appropriate policies. In general, most measures, with the notable exception of tail-pipe emission abatement devices, also reduce GHGs. Most promising options include:

- fuel switch from petrol/diesel to CNG or LPG;
- fuel switch from petrol/diesel to (sustainable) biofuels (impact on air pollutants uncertain);
- public transportation policies, such as rapid bus systems;
- traffic management, such as fly-overs, separated traffic lanes, or improved roads;
- vehicle policies, such as scrap programmes and technical control programmes;
- vehicle efficiency improvements;
- fuel cell or hybrid/electric cars.

Industry and Power Production

One of the most effective measures to reduce urban air pollution from industry and power plants is relocation. However, this has little effect on GHG emissions. Also, flue gas treatment can reduce energy efficiency and thereby increase CO_2 emissions. Measures which can be applied to plants in or near urban areas exist, which also have co-benefits include:

- fuel switch from coal to gas;
- fuel switch from coal to biomass (reduces SO_2 emissions, and in case the baseline is open biomass burning close to city it also mitigates PM emissions);
- utilisation of other types of renewable energy;
- energy efficiency measures;
- cleaner coal technology, such as integrated gasification combined cycle or CO_2; capture and storage (where air pollutants are reduced in addition to CO_2).

Buildings Sector

In the residential and service sector several options with co-benefits for urban air pollution and GHG emissions exist. These include:

- fuel switch from coal to gas in building heating (including district heating);
- fuel switch from coal to (sustainable) biomass for heating/cooking;
- in case the baseline is unsustainable use of biomass : fuel switch from biomass to gas in cooking stoves or heating;
- improved cooking stoves;
- renewable electricity (e.g. solar home systems);
- energy efficiency measures such as efficient lighting.

The current CDM project portfolio (see Figure 1-3) contributes to urban air pollution reduction, but only to a limited extent. The large number of renewable energy and efficiency projects has a significant air pollution reduction impact only when they displace coal utilisation in or near urban areas. The same argument is valid for the fuel switching projects.

Several CDM barriers to the development of available synergetic options can be identified (see Table 1-3):

- baseline establishment: both emission factors and baseline scenario;
- limited financial contribution from CERs, compared to project investment;
- difficulty and/or high cost for monitoring;
- interaction with other policies (the perverse incentive of the CDM);
- proof of additionality (i.e. other aspects than the project intervention).

However, when an approved baseline and monitoring methodology for a proposed CDM project exists, many of these issues can be dealt with (see Chapter 3).

Table 1-3: Barriers to Air Quality and CDM projects

	Baseline	Low CER contribution	Monitoring	Other policy	Additionality
Fossil fuel switch	x		x	x	x
Biofuel	x	x	x	x	
Infrastructure	x	x	x	x	x
Vehicle programmes	x		x		x
Cleaner coal technology	x	x			x
Cooking stoves			x		x
E-efficiency programmes	x	x	x		
RE in buildings		x	x		

Source: Authors (2007)

CDM has the potential to contribute to both reducing GHG emissions and improving urban air quality. In particular, industry and transport sector projects may have high co-benefits in terms of reducing air pollutant emissions and associated impacts on human health and environment. Chapter 2 will further explore CDM and the various steps which constitute the CDM process.

Chapter 2: The Clean Development Mechanism

2.1 Introduction

CDM projects or project activities[1], as they are officially referred to in the Kyoto Protocol can be categorised in a number of ways. CDM projects may reduce GHG emissions (i.e. emission reduction projects) or absorb GHGs from the atmosphere and store them in a medium (i.e. sequestration projects). This chapter describes the different types of CDM projects and the CDM approval process.

2.2 Types of CDM Projects

A variety of projects are eligible under the CDM**.** The following list classifies the eligible CDM projects according to sectors and technologies, as well as specific activities (UNEP, 2005):

- Renewable energy technologies;
- Energy efficiency improvements (supply side and/or demand side);
- Fuel switching;
- Combined heat and power;
- Capture and destruction of methane emissions (e.g. from landfill sites, oil, gas and coal mining);
- Emissions reduction from industrial processes;
- Capture and destruction of GHGs other than methane (i.e. N_2O, HFCs, PFCs, and SF6);
- Emission reductions in the transport sector;
- Emission reductions in the agricultural sector;
- Afforestation and reforestation (also called sink projects);
- Modernisation of existing industrial units/equipment using less GHG-intensive practices/technologies (retrofitting);
- Expansion of existing plants using less GHG intensive practices/technologies (Brownfield projects);
- New construction using less GHG intensive practices/technologies (Greenfield projects).

CDM projects are also classified according to scale on the basis of their potential GHG emission reductions or GHG absorption. Small-scale CDM projects are separated from other, or large-scale, CDM projects and categorised into three types:

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[1] As opposed to project, a “project activity” is a measure, an operation, or an action that aims at reducing the concentration of GHGs in the atmosphere. Project and project activity will be used interchangeably in this chapter.

- Type I project activities: renewable energy project activities with a maximum output capacity equivalent to up to 15 MW (or an appropriate equivalent)
- Type II project activities: energy efficiency improvement project activities which reduce energy consumption, on the supply and/or demand side, by up to the equivalent of 60 GWh per year
- Type III project activities: other project activities that both reduce anthropogenic emissions by sources and directly emit less than 60 kilotonnes of carbon dioxide equivalent annually

In 2006, the UNFCCC allowed project activities under a programme of activities to be registered as a single CDM project activity. A Programme of Activities (PoA) is a voluntary coordinated action that leads to GHG emission reductions or GHG sequestration, via an unlimited number of CDM programme activities (CPA) coordinated by a public or private entity. The physical boundary of a PoA may extend to more than one host country as long as each participating non-Annex I country certifies that the PoA contributes to its sustainable development. To be registered as a CDM project and issued CERs, a PoA also requires the preparation, submission, and validation of a Programme of Activities Design Document (CDM-PoA-DD). All CPAs of a PoA shall use the same approved baseline and monitoring technology. A CPA can be included in a registered PoA at any time during the duration of the PoA.

2.3 CDM Project Cycle

Figure 2-1 presents the main activities in the CDM project cycle. It also highlights the actors responsible for each activity and the major official documents required for approval under the CDM. Each of these activities is discussed is discussed below:

Project Identification, Design and Formulation

Project identification is the first step in the CDM project cycle. Potential CDM projects must be able to deliver cost-effective CERs, provide adequate returns on investments to project proponents and investors, and satisfy national sustainable development criteria of the host country. To screen projects for their ability to generate cost-effective CERs, project proponents must have an understanding of:

- the types of technologies and project activities that can reduce GHG emissions;
- whether and how the project's emission reductions can be accurately measured and verified against a business-as-usual baseline;
- how many CERs the project is likely to generate and what would be the transaction cost; and
- the likelihood of project approval by the host country and the CDM Executive Board (UNDP, 2006).

After a project has been judged as potentially suitable to be developed under the CDM project, a project design document (PDD) should be prepared by the proponent. The PDD presents information on the essential technical and organisational aspects of the project activity and the approved baseline and monitoring methodology (see Chapter 3) applied to the project activity. It discusses and justifies the choice of baseline methodology and the applied monitoring concept, including monitoring data and calculation methods. The PDD also specifies the crediting period of the CDM project, which is the length of time during which the project will generate carbon credits, or the period for which reductions from the baseline are verified and certified by a designated operational entity for the purpose of issuance of certified emission reductions (CERs). Projects can choose between a 7-year period that can be renewed twice for a total of 21 years and a one-off 10-year period. The PDD, therefore, is a key input into the validation, registration, and verification of the project as required under the Kyoto Protocol. The present structure of the PDD is as follows:[2]

Main Contents

A. General description of project activity

B. Application of a baseline and monitoring methodology

C. Duration of the project activity / crediting period

D. Environmental impacts

E. Stakeholders' comments

Annexes

Annex 1: Contact information on participants in the project activity

Annex 2: Information regarding public funding

Annex 3: Baseline information

Annex 4: Monitoring plan

Some institutions and organisations that assist in the development of CDM projects or buy carbon credits (or CERs) have developed formats for project idea note (PIN) or project concept note (PCN) and require project proponents to prepare and submit one prior or as a preliminary step to the PDD. A PIN generally provides a brief overview of the project, including estimated emission reductions, baseline and monitoring methodologies to be employed, and estimated project investment costs. The PIN is also a useful means of presenting the project to prospective investors or host-country governments. Some host countries also require a PIN as an initial step in the project approval process and to enable preliminary screening against national CDM project criteria. The host Designated National Authority (DNA) may issue a 'letter of no objection' following the screening of a PIN, providing the project proponent with a greater level of assurance that the project will be approved by the host government when the full PDD is submitted and thereby reducing project risk.

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[2] PDD forms for different kinds of CDM projects can be downloaded from http://cdm.unfccc.int/Reference/PDDs_Forms/PDDs/index.html.

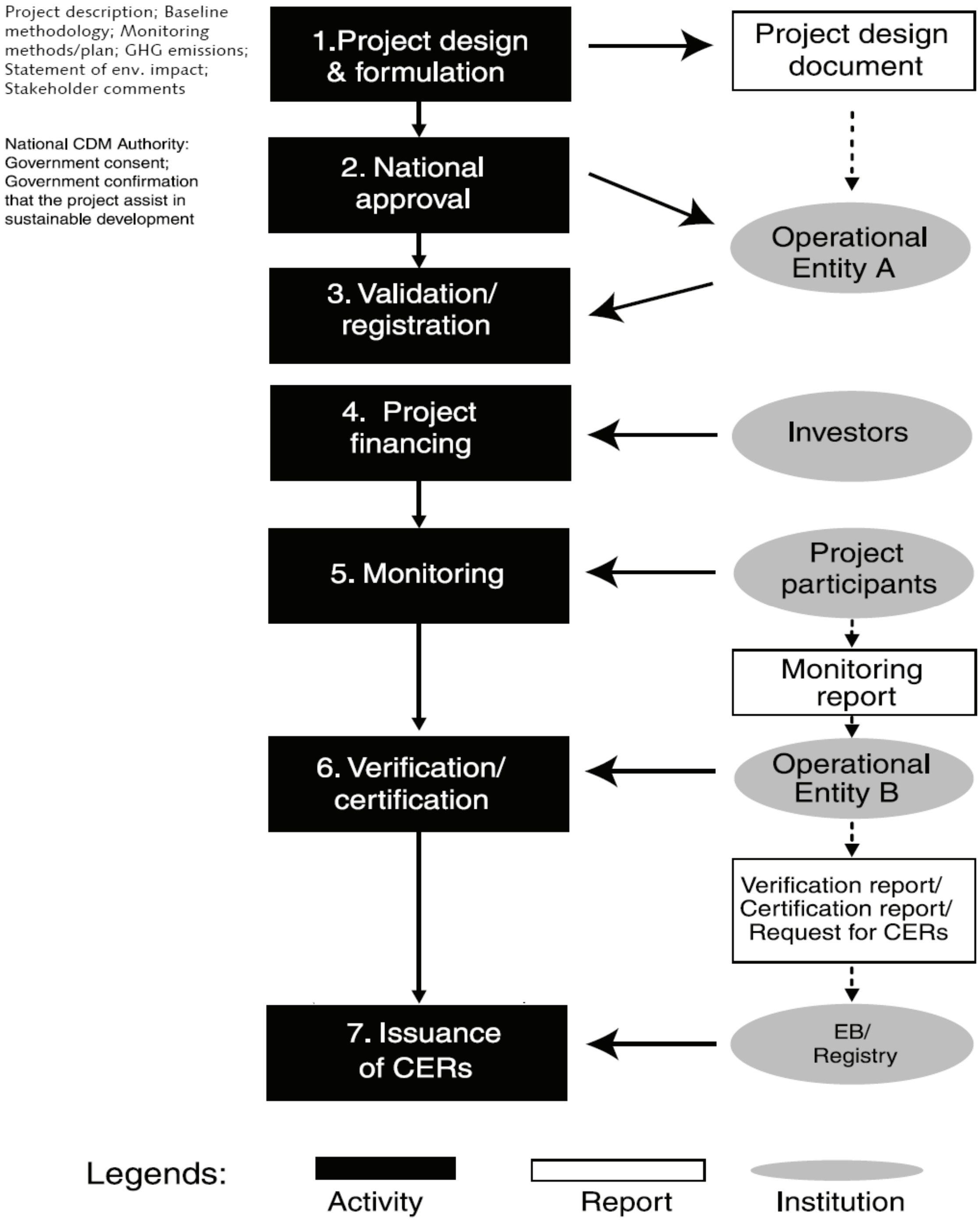

Figure 2-1: The CDM Project Cycle

Source: UNEP (2004), p. 30.

National Approval

One of the goals of CDM is to assist developing countries in achieving sustainable development. The national governments of most developing countries have established DNAs which decide whether a proposed CDM project satisfies this requirement. The

DNAs have developed a set of sustainability criteria and indicators to screen CDM projects according to national sustainable development goals (see Chapter 1.)

Validation and Registration

Validation is the process of independent evaluation of a project activity by a designated operational entity (DOE) against the requirements of the CDM. Validation consists of the review of the PDD and supporting documentation, including consideration of public inputs, by a DOE to confirm if:

1. The participation requirements are satisfied. One of these requirements is that CDM project participants are Parties to the Kyoto Protocol.
2. Comments by local stakeholders have been invited, a summary of the comments received has been provided, and a report to the DOE on how due account was taken of any comments which were received.
3. Project participants have submitted to the DOE documentation on the analysis of the environmental impacts of the project activity, including transboundary impacts and, if those impacts are considered significant by the project participants or the host Party, have undertaken an environmental impact assessment in accordance with procedures as required by the host Party.
4. The project activity is "additional." i.e. is additional if anthropogenic emissions of GHG by sources are reduced below those that which would have occurred in the absence of the registered CDM project activity.
5. The baseline and monitoring methodologies comply with requirements pertaining to: (i) methodologies previously approved by the EB; or (ii) modalities and procedures for establishing a new methodology.[3]
6. Provisions for monitoring, verification and reporting are in accordance with the CDM
7. The project activity conforms to all other requirements for CDM project activities.

The DOE should also receive from the DNA a written approval of voluntary participating in the project and confirmation that the CDM project assists the host Party in achieving sustainable development. The DOE must then make the validation report publicly available upon transmission to the EB.

Registration is the formal acceptance by the EB of a validated project as a CDM project activity. The EB must register the CDM project within 8 weeks (4 weeks for small-scale projects) of the date of receipt of the request.

[3] If the DOE determines that the project activity intends to use a new baseline or monitoring methodology, it shall, prior to a submission for registration of this project activity, forward the proposed methodology, together with the draft project design document, including a description of the project and identification of the project participants, to the Executive Board for review. (see Chapter 3)

Monitoring, Verification, Certification and CERs

Once the project is operational, participants must prepare a monitoring report, including an estimate of the CERs generated, and submit it for verification to an operational entity (different from the one that validated the project[4]).

Monitoring is a systematic surveillance of a project's performance by measuring and recording target indicators relevant to the objective of the project. The project's developers should prepare a monitoring plan based on an approved monitoring methodology. The monitoring plan needs to provide detailed information related to the collection and archiving of all relevant data necessary to:

- estimate GHG emissions occurring within the project boundary;
- determine the baseline GHG emissions;
- determine the leakage i.e. the net change of anthropogenic emissions by sources of GHG which occurs outside the project boundary, and which is measurable and attributable to the CDM project activity.

Verification is the periodic independent review and ex-post determination by the DOE of the monitored GHG emission reductions that have occurred as a result of a registered CDM projects during the verification period. It will include the periodic auditing of monitoring results, the assessment of achieved emission reductions and the assessment of the project's continued compliance with the monitoring plan. The DOE must ensure that the CERs have resulted according to the guidelines and conditions agreed upon in the initial validation of the project. Following a detailed review, the DOE will produce a verification report and then certify the amount of CERs generated by the CDM project.

Certification is a written assurance by the DOE that, during a specified time period, a project activity achieved the GHG emission reductions as verified. The DOE shall inform the project participants, parties involved and the EB of its certification decision in writing immediately upon completion of the certification process and make the certification report publicly available. The certification report shall constitute a request to the EB for issuance of CERs equal to the verified amount of reductions of anthropogenic emissions of GHGs. Unless a project participant or three Executive EB members request a review within 15 days, the EB will instruct the CDM registry to issue the CERs.

The EB must issue the CERs to the project partners within 15 days after the date of receipt of the request for issuance.

The CDM Registry keeps track of all issuances of CERs. When the EB has issued the CERs, they are placed in a pending account in the CDM Registry. From here the CERs will move to the Party's legal entity's account according to a split specified in the request from project participant.

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4 except for Small-Scale CDM projects and for single projects where the EB gives permission.

Costs Related to CDM Project Cycle

Costs arise from developing a project under the CDM framework. These costs are in addition to the general project development costs and are called CDM transaction costs. CDM transaction costs accrue in every stage of the CDM project cycle and are categorised into transaction costs that are incurred during the project preparation phase (stages 1-3 of the project cycle shown in Figure 2-1) and those incurred during project implementation (stages 5-7). The former are also called pre-registration costs and the latter, post-registration costs. Costs incurred during stage 4 (Project financing) are not included as transaction costs because these are incurred whether a project is eligible under CDM or not.

Table 2-1 shows that pre-registration transaction costs range from USD 40,000 to USD 130,000 for most projects. The pre-registration transaction costs for small-scale CDM projects are usually 20-40 per cent lower and range from USD 50,000 to USD 70,000 for most projects (UNDP, 2006). It also indicates that the largest transaction costs come from the preparation of the PDD, in fact, in terms of both time and money.

Table 2-1: CDM pre-registration transaction costs (USD)

Stage	Low	High
Pre-development	5,000	15,000
PDD	15,000	50,000
DNA Approval	0	5,000
Validation	10,000	40,000
Legal/Contracting	10,000	20,000
Total	40,000	130,000

Source: UNDP (2006).

Chapter 3: Air Quality related CDM Methodologies

3.1 Introduction

For a project to be registered by the CDM EB, it needs to utilise an approved baseline and monitoring methodology. This is an issue which has been at the centre stage of discussions relating to the CDM. This chapter aims to highlight the current state of affairs with regard to methodologies that are relevant for projects in the industry/power and transport sector which could be beneficial for improving urban air quality.

3.2 What are CDM Methodologies?

A key element of the CDM is that a project should lead to *real and measurable* emission reductions. In order to determine how much GHG emissions are reduced by the proposed project, it is necessary to know the level of emissions that would be produced without the project. This is referred to as the baseline emissions and corresponds to the situation what would have happened if the CDM project would have not been implemented (e.g. electricity would be produced by using coal rather than wind energy). The CDM project will reduce GHG emissions, and the emission reductions will correspond to the difference between the baseline emission and the CDM project's emissions (for example, in a biofuel project, emissions relate to the production of biofuel. The emission reductions of the CDM project are obtained by subtracting the project emissions from the baseline emissions over the crediting period(s) of the project (see Figure 3-1).

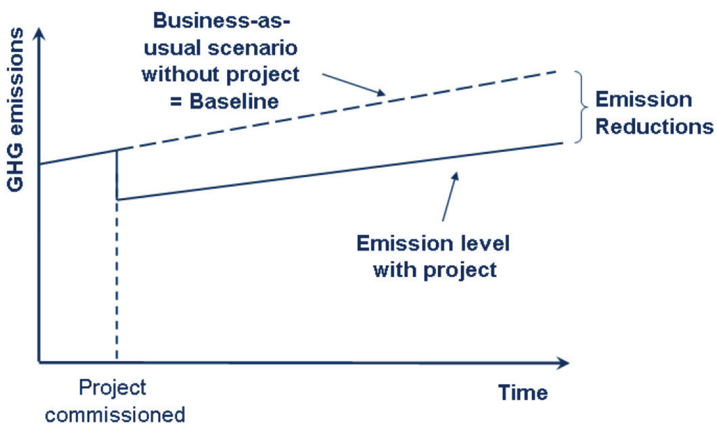

Figure 3-1. Baseline scenario and emission reductions of a CDM project

Source: Tyndall Centre, 2007

For a project to use an approved methodology (AM) two different ways exist:

- *Use an existing AM.* As of January 2008 more than 60 methodologies covering different project types have been approved for large-scale projects (see below), and 28 for small-scale projects. CDM projects with similar characteristics can use these baseline methodologies, provided they comply with applicability conditions specified in the AMs. Approved Consolidated Methodologies (ACMs) are those in which several AMs are integrated, broadening the scope and streamlining the methodology process. The latest versions of all AMs are available at *cdm.unfccc.int.*

- *Propose a new methodology (NM)*. If the proposed CDM project does not fall within the scope of any AM, a new baseline methodology can be proposed, together with a PDD. This NM should be submitted to the CDM EB, which is then scrutinised by experts from the Methodology Panel. These give a recommendation to the EB which then approves or reject the methodology. In most cases a rejected methodology can be resubmitted with the required changes. However the process of getting a NM approved can be long and difficult as proven in recent years.

Table 3-1: Key features of a CDM baseline and monitoring methodology:

Applicability	It must be clearly specified which kind of projects the AM can use. The scope of some AMs is broad (e.g. ACM0002 can be applied to several types of grid-connected renewable electricity projects), while for other the AM is very specific (e.g. AM0020 can only be used for efficiency improvements of water pumping equipment).
General approach	One of the baseline approaches from paragraph 48 of the CDM modalities and procedures should be used, and a justification should be given: a) Existing actual or historical emissions, as applicable; b) Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment; c) The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performances are among the top 20 per cent of their category.
Project boundary	For the baseline as well as project emissions, it needs to be indicated and justified which sources of GHGs are included in the project boundary.
Leakage	If there are increases in GHG emissions that occur outside project boundary as a result of the project activity, this should be included in the assessment of leakage.
Selection of most likely baseline scenario and determination of additionality	All alternatives to the project activity are to be evaluated to determine the most likely baseline scenario. This should include at least: • Business as usual (e.g. using petrol in cars) • The proposed activity without CDM (e.g. biofuel without CER revenues) • Other alternatives (e.g. natural gas, diesel, other biofuels, electric cars, etc) Additionality of the proposed project is determined by evaluating these alternatives in a 5 step approach: 1) All alternatives that do not comply with mandatory laws and regulations may be disregarded;

	2) The remaining alternatives are evaluated using an investment analysis and/or barrier analysis 3) Analyse if the proposed project is 'common' practice, i.e. whether the proposed activity is already implemented widely in the host country or region without help of the CDM 4) Analyse the impact of registration of the project activity under the CDM (e.g. by proving that the CER revenues bring the IRR of the project above the threshold) In most AMs it is specified that the latest version of the 'tool for demonstration and assessment of 'additionality' of the EB should be used.
Monitoring	The monitoring methodology consists of: 1) Explanation and justification of the procedure to be followed. 2) A concise description and justification of which parameters are monitored and in what fashion (i.e. unit, data source, monitoring frequency, etc).

Source: UNFCCC (2007)

3.3 Current Status of Methodologies in the Industry/Power and Transport Sector

The following section describes the current status regarding methodologies in the industry/power and transport sectors.

Industry and Power Production

The industry and power sector together account for more than 50 per cent of GHG emissions in most countries. Coal is the dominant fuel in many world regions, the combustion of which is a major contributor to local air pollution as well, in particular when the installations are situated in or close to cities. CDM project and methodology development have been relatively successful in this field, with the sector accounting for more than 80 per cent of the registered projects as well as CER generation (UNEP/Risø, 2008). The most common project types are:

- renewable electricity (hydro, biomass, wind, geothermal);
- energy efficiency (waste heat utilisation, boiler replacement, fuel switch from coal or fuel oil to natural gas, combined heat and power); and
- non-CO_2 projects (HFC-23 and N_2O destruction, methane capture, all of which will be disregarded in this chapter due to low air quality benefits).

The success in developing methodologies for industry and power compared to other sectors can be explained by the fact that the projects are in general clearly spatially fixed, with a limited number of operations that need to be monitored. This simplifies the monitoring and reduces the possible alternatives to the project in the assessment of the likely baseline scenario. This does not mean however that proving additionality is straightforward. Due to the fact that savings from reduced consumption of fossil fuels are realized in energy efficiency projects, it is far from easy to demonstrate that the project only gets implemented due to CER revenues. In many cases therefore, only a barrier analysis is used in energy efficiency projects, which has led to doubts among experts about the additionality of those projects (e.g. see Bakker et al (2007)). In 2007 the EB consistently has rejected cement blending projects. It is expected that the application of the barrier analysis will be restricted and thereby proving additionality more difficult.

Table 3-2 outlines the broad set of AMs for industry and power projects available as of October 2007. It is also indicated how many projects in validation or in a more advanced stages use each methodology, with the total number of (large + small-scale) projects being 2,883. Only the large-scale methodologies are included; for small-scale projects the simplified baseline methodologies for these sectoral scopes are also available.

Table 3-2: Approved large-scale methodologies in the power and industry sector

Method. number	Scope	No. of projects
	Zero emission renewables	
ACM2 (v7)	Grid-connected electricity generation for renewable sources (no biomass)	780
ACM3 (v7)	Emission reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture	15
ACM6 (v6)	Grid-connected electricity from biomass residues (includes AM4 & AM15)	160
AM19 (v2)	Renewable energy project replacing the electricity of one single fossil plant (excl. biomass)	0
AM7	Switch from coal/lignite to seasonal agro-biomass power	0
AM27 (v2.1)	Substitution of CO_2 from fossil or mineral origin by CO_2 from renewable resources in production of inorganic compounds	1
AM36 (v2)	Fuel switch from fossil fuels to biomass residues in boilers for heat generation	6
AM42	Grid-connected electricity generation using biomass from newly developed dedicated plantations	0
	Fossil fuel switch	
ACM9 (v3)	Industrial fuel switching from coal or petroleum fuels to natural gas	10
ACM3 (v5)	Emission reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture	1
ACM11 (v2)	Fuel switching from coal and/or petroleum fuels to natural gas in existing power plants for electricity generation	2
AM29	Grid connected electricity generation plants using natural gas	36
AM50	Feed switch in integrated ammonia-urea manufacturing industry	1

Cement		
ACM5 (v3)	Increasing the blend in cement production	36
AM33 (v2)	Use of non-carbonated calcium sources in the raw mix for cement processing	6
AM40 (v1.1)	Use of alternative raw materials that contain carbonates in clinker manufacturing in cement kilns	1
Energy efficiency, Supply side		
ACM13	new grid connected fossil fuel fired power plants using a less GHG intensive technology	0
ACM7 (v2)	Conversion from single cycle to combined cycle power generation	8
AM14 (v4)	Natural gas-based package cogeneration	40
AM48	New cogeneration facilities supplying electricity and/or steam to multiple customers and displacing grid/off-grid steam and electricity generation with more carbon-intensive fuels	0
AM52	Increased electricity generation from existing hydropower stations through Decision Support System optimisation	0
AM61	Rehabilitation and/or energy efficiency improvement in existing power plants	0
AM62	Energy efficiency improvement of a power plant through retrofitting turbines	0
Energy efficiency, own generation (of electricity)		
ACM12	GHG reductions for waste gas or waste heat or waste pressure based energy system	31
AM24	Waste gas recovery and utilisation for power generation at cement plant	11
AM49	Gas based energy generation in an industrial facility	0
AM55	Recovery and utilisation of waste gas in refinery facilities	0
Energy efficiency, Industry		
AM17 (v2)	Steam system efficiency improvement by replacing steam traps and returning condensate	0
AM18 (v1.1)	Baseline methodology for steam optimisation systems	14
AM38	Improved electrical energy efficiency of an existing submerged electric arc furnace used for the production of SiMn	1
AM44	Energy efficiency improvement projects: boiler rehabilitation or replacement in industrial and district heating sectors	0
AM54	Energy efficiency improvement of a boiler by introducing oil/water emulsion technology	0

AM56	Efficiency improvement by boiler replacement or rehabilitation and optional fuel switch in fossil fuel-fired steam boiler systems	0
AM60	Power saving through replacement by efficient chillers	0

Source: Based on UNEP/Risø (2008)

In addition to this extensive list of approved methodologies, there are several new methodologies within the power and industry sector under consideration by the CDM EB. The applicability of AMs therefore is consistently increasing.

Transport Sector

Fossil fuel consumption in the transport sector accounts for 18 per cent of global CO_2 emissions, and motor vehicles contribute 90 per cent of urban air pollution, (Earthtrends, 2007). This is particularly the case in developing countries where most of the vehicle fleet uses inefficient technologies and practices such as two stroke engines, with high average vehicle age, poor maintenance, and low-quality fuels. It is also a sector that is growing rapidly in all world regions, and in which implementing policies that would reduce fossil fuel consumption and CO_2 emissions has turned out to be a major challenge.

There is no single solution to promote sustainable urban transport. Instead, there is a wide range of possible options from which cities may be inclined to choose one or a combination of them depending on the particular situation of the city. Of course, achieving sustainable transportation solutions in megacities all around the world will require many years of collaborative work and cooperation between businesses, governments, civil society and public sector.

According to Grütter (2007), three possible ways to reduce GHG (and in addition other air pollutants) emissions in transport sector exist, and each of these objectives is related to specific transport measures and policies (See Table 3-3).

Table 3-3: GHG mitigation options in the transport sector.

Ways to reduce GHG in transport sector	Transport sector specific measures	
Projects reducing emissions per kilometre	Technology/vehicle change (more efficient vehicles)	
	Behavioural change including improved fleet management	
	Fuel switch	
Projects reducing emissions per unit transported	Passenger/freight transport	Mode switch
		Improved occupation rates
	Public transport sector	BRT projects
		Rail based public transport
Projects reducing the number of trips	Demand side management	

Source: Adapted from Grütter (2007)

In principle these measures could be developed under the CDM. To date, however, the CDM has not been very successful in the transport sector, with only 2 registered project and another 5 projects at validation (UNEP/Risø, 2008). One reason for this under representation is the low number of approved methodologies: 2 large-scale and 3 small-scale. General difficulties with regard to developing transport methodologies are related to:

- multitude of plausible baseline scenarios;
- proving additionality (e.g. CER revenues provide only a small part of the investment cost);
- requirements for monitoring; and
- possible double counting of emission reductions and life cycle emissions (biofuels);

Table 3-4 present the CDM methodologies available as of January 2008. Several other methodologies have been submitted to the EB but were rejected (i.e. 'C-cases') or withdrawn, including more than five biofuel methodologies. These are not shown here. In 2004 a methodology related to fuel switch from gasoline to LPG was submitted and rejected.

Table 3-4: Transport sector CDM methodologies as of January 2008.

	Bus rapid transit systems
AM31	Baseline Methodology for Bus Rapid Transit Project
NM229	Mexico City Insurgentes Avenue Bus Rapid Transit Pilot Project
	Biofuels
AM47 (v2)	Production of biodiesel based on waste oils and/or waste fats from biogenic origin for use as fuel
NM228	AGRENCO Biodiesel Project in Alta Araguaia
NM233	Palm Methyl Ester – Biodiesel Fuel (PME-BDF) production and use for transportation in Thailand
NM253	Destilmex fuel ethanol project
	Improving vehicle efficiency or modal shift
AMS-III.C	Emission reductions by low-greenhouse emission vehicles
AMS-III.S	Introduction of low-emission vehicles to commercial vehicles fleets
AMS-III.T	Plant oil production and use for transport applications
NM237	EDSA Bus Dispatch System, Manila, Philippines

Source: cdm.unfccc.int

Based on the experience with methodology development in the transport sector, a number of conclusions can be drawn. Approval of the Bogota methodology (AM31) has been a step forward for the development of bus rapid transit (BRT) projects, including two that are currently at validation stage of the CDM approval process. The AM31 methodology can also be applied to rapid bus systems (or expansions thereof) that are integrated in the city transport system. However, this needs extensive monitoring as well as concise baseline data. If NM229 is approved, the scope for BRT will be further extended towards rail-based public transport systems. However, this only covers part of a city's transport and GHG emission reductions are based on passenger-kilometre rather than passenger-trip. The application of AMs for BRTs may not be straightforward and may need to be assessed on a case-by-case basis.

Biofuels under the CDM has been an area of great debate over the past years, with approximately 10 methodologies submitted and most of them being rejected or withdrawn. Only one large-scale methodology has been approved, which is specifically for biodiesel production based on waste oils or fats. Apart from the small-scale methodology AMS-III.T, there are no crop-based biofuel methodologies that have been approved (as of November 2007), although NM228 is the first one to receive recommendation for approval by the Methodology Panel. This methodology is applicable to biodiesel production and consumption from oil seeds from plantations on degraded or under-utilised land. It can be assumed that in the coming years more biodiesel and ethanol methodologies will be approved, when concerns by the EB have been resolved. These include: proper accounting of life-cycle emissions related to the production of biofuel and leakage; avoidance of double counting by assuring that the biofuel is produced and consumed in the same geographical region (the EB has developed a tool to cover this); and that the production of the biofuel does not lead to increased deforestation.

With regard to other project types that could reduce GHG emissions in transport sector, the small-scale methodology AMS-III.C appears to be attractive. It is used by four (rather different) projects currently at validation stage. These include biofuel, modal shift for industrial transport, efficient metro-vehicle and a taxi retrofit project. The recent approval of AMS-III.T could further enhance opportunities for more efficient transport.

Chapter 4: Case Studies

4.1 Introduction

As extensively analysed in the framework of the CURB-AIR project, this chapter provides four projects examples which have been identified and selected as potentially attractive CDM projects. These include ethanol blending with diesel in Bangalore (India), BRT in Bangkok (Thailand) and Jakarta (Indonesia) and biomass gasification for power generation in Jinan (China). The four case studies consider the benefits and methodological issues associated with each type of project. More detailed information can be found at www.curb-air.org.

4.2 Ethanol Blending with Diesel in Bangalore

Introduction

Seventy two percent (72%) of air pollution in Indian cities is attributed to vehicles, 20% to industries and the rest to domestic sources[5]. Thus, the air pollution problem in the city of Bangalore is the result of the combination of forces – economic, administrative, social, legal and cultural. Also, industrial activities like fossil fuel combustion (petrol, diesel, kerosene) in heavy industrial vehicles and stationary engines, adulteration of fuels, re-suspended road dust, extensive construction activity, poor city maintenance (dusty roads, unpaved sidewalks, parks without green cover and uncovered playfields) and refuse burning are some of the major causes of air pollution in the city.

In India, the vehicular population has increased from 0.3 million in 1951 to 65 million in 2003. The road transport sector is the largest consumer of commercial fuel energy within the transportation system in India and accounts for nearly 35% of the total liquid commercial fuel consumption by all sectors. In India, on the total GHG emissions, 61% come from the energy sector and 15% from the transport sector. About 42% of liquid fuel emissions are from diesel. Emission estimates have revealed that nearly 27 Million tons of CO_2 were emitted in 1980, increasing to about 105 Million tons in 2000[6].

The government has initiated various measures to curb air pollution, with a particular focus on integrated traffic management, introduction of cleaner and alternate fuels like CNG, LPG, etc. and creating awareness among relevant stakeholders like national, provincial and local governments, civil society organisations, academic institutions, development agencies and the private sector. In 2002, Government of India came with a proposal of blending 5% of ethanol with petrol. Despite this mandatory blending of ethanol with petrol, the programme is yet to take off with full steam due to anomaly in supplies and prices of ethanol.

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[5] "IT Scenario Karnataka - IT Industries", Department of IT and Biotechnology, 2006, Government of Karnataka

[6] Singh A., Gangopadhyay S., Nanda PK., Bhattacharya S., Sharma C., Bhan C., Central Road Research Institute

Ethanol Scenario

On a world wide basis, out of a total annual production of 50.98 Billion liters of ethanol in 2006[7], 68% is used as automotive fuel, 21% is utilised for industrial purposes and the remaining 11% is used for beverages. India is the second largest producer of sugar cane in the world with a production level of about 315.5 Million tonnes per annum[8] while it stands fourth in the world in ethanol production with a production of about 2.3 Billion liters per annum[9]. The ethanol production in India is mainly from molasses, the by-product from sugar mills.

With the government's initiative of increasing biofuel usage, the Karnataka State Road Transport Corporation (KSRTC), Bangalore has initiated the use of ethanol diesel blend in the transport sector, especially its bus fleet. They have been provided with technical support on an initiative from Energenics Pte Ltd, Singapore, who introduced the ethanol-diesel blend as EnerDiesel™.

Project Description

The ethanol-diesel blend has a composition of 7.7% ethanol, 91.8% Diesel and 0.5% of a proprietary additive to provide a technically and commercially viable clear homogenous and stable fuel that can be utilised in unmodified engines and existing fuel delivery infrastructure. The blending of ethanol and diesel is done onsite with computerised state-of-the-art dosing equipment. The dosing units are microprocessor controlled and it delivers ethanol and the additive at precise quantities into the existing fuel line. This ensures hassle free and highly accurate blending operations. The initiative of using ethanol-diesel blend as an alternate fuel started on a trial basis for 126 buses and currently it is running in 450 buses. KSRTC is now planning to use it on all 4,000 buses. Since fuel economy is a major parameter to be considered in any alternate fuel trials, the blending of 10% or 15% ethanol with diesel have shown some percentage decrease in the mileage. But with the additive and an optimal percentage of 7.7% of ethanol in the blend, it has resulted in a 1.75 % increase in mileage.

The ethanol used for the project is produced from molasses, the by-product of the sugarcane industry, and is procured through tender by the KSRTC. The current ethanol production consists in only 37% of the total production capacity of the country[10]. Therefore, the supply of ethanol for the project is secured. In addition, the use of ethanol in the transport sector will largely benefit the agricultural sector, particularly the sugarcane industry, due to the growth of ethanol demand.

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[7] Renewable Fuels Association
[8] India in Business, Ministry of External Affairs, Government of India
[9] Ethanol India
[10] Ethanol India

Synthesis of Results

The trial runs - when extended to 4,000 buses - can be developed as a CDM activity. With the 7.7% ethanol blended diesel as the fuel, the CO_2 reductions from the lower use of diesel in the bus fleet are estimated to be approximately 18,000 tonnes annually.

The benefits of ethanol-diesel blend can be seen from the first fill-up in the buses and consecutively in the subsequent fill ups. Apart from CO_2 emission reduction, there has been a significant amount of reduction in various pollution parameters like particulate matter, oxides of nitrogen, smoke, etc. The percentage reduction of above parameters when emission checks on buses using the blend prior to their conversion is shown Table 4-1.

Parameter	% Reduction	
	Min	Max
PM	**20**	**46**
NO_X	1.8	6.0
CO	12	23
SMOKE	60	70

Table 4-1: Reduction of Pollutants

Smoke emission checks were performed on all buses. The average values of smoke measured was around 40 HSU[11]. The smoke emission tests within a week of use of the ethanol-diesel mix showed a reduction of around 30% and after 4 weeks the smoke levels have been reduced significantly by 60%. The smoke emissions are in the range of 15-20 HSU after continuous use of Enerdiesel™.

Baseline and Additionality

With an annual carbon reduction of 18,000 tonnes, the project can be qualified as a small-scale project (for which the upper limit is 60,000 tCO_2/yr) for CDM. Thus to prepare the baseline methodologies, the simplified procedures can be used.

The price of ethanol in India is lower than the price of diesel; however with the cost of additive as well as labour, handling, transport and other miscellaneous costs, the ethanol-diesel blend comes out to be more expensive than diesel. Therefore, diesel becomes the baseline fuel, and the main reasons are: (i) the limited resources and inadequate expertise for investment in production of CNG, LNG, etc. with the project developer; (ii) no appropriate technological standards being introduced with respect to ethanol which makes it difficult to reach to the consumers; (iii) approximately 27% of the alcohol produced from molasses is used for industrial purposes, 33% for human consumption use and approximately 3% for other purposes. Therefore, ethanol surplus is available for use in the transport sector. In addition, the market for ethanol is limited to local distribution, direct sale and purchase. Thus, the investment analysis would

[11] HSU is Hartridge Smoke Unit; it is the basic unit for auto emission.

discourage the use of ethanol-diesel blend as an investment. But with steep rises in the diesel prices compared to ethanol, this picture would change. The barrier analysis could also make a strong case for diesel as the baseline fuel, as the ethanol/diesel blend is a very new technology, therefore the use of ethanol-diesel blend is far from 'common practice'. Thus, as a CDM project, the project is likely to pass the additionality test. Also with the government of India making it mandatory for petrol companies to mix 5% ethanol with petrol, the regulation is yet to be implemented throughout the country and is unlikely to be strictly implemented in the coming years. The fact that the regulations are not enforced means that the CDM project is also additional to current policy.

However, the main obstacle for developing the project under the CDM is the non-existence of an approved (small-scale) baseline methodology for using ethanol in the transport sector. On the other hand, there are approved methodologies for plant-based oils (AMS-III-T), as well as for waste oils and/or waste fats from biogenic origin for use as fuel (AM0047), which can be used as an example. In addition, several large-scale methodologies for ethanol have been submitted in the past three years, all of which have been rejected or are under consideration by the CDM Executive Board. The key issues for rejections include:

- It must be assured that the project covers both production and consumption of ethanol in order to prevent possible double counting of emission reduction due to export to Annex I countries.
- Coverage of upstream emissions due to land-use and production of ethanol should be based on a thorough life cycle analysis.
- Biofuel production should not lead to increased deforestation.

Advantages

In addition to reduction of carbon content from the environment, the technical advantages of using ethanol-diesel blend over petro-diesel are as follows:

1. The lubricity of the combustion engine is enhanced by the use of ethanol.
2. It improves the cetane number of the vehicles.
3. It improves the corrosion resistance of the diesel vehicles.
4. It has outstanding static properties.
5. It has excellent response and power.
6. It helps in maintaining clean distribution system.
7. It maintains fuel economy.
8. No engine modifications are required for the use of ethanol diesel blend.
9. The engine and other components have also increased lifetime.
10. The life of the engine oil is increased.

Future Scope

The Indian market for diesel is large and more highly fragmented than that of petrol; virtually all heavy trucks and urban buses burn diesel fuel. Regulatory standards like emission norms, etc. for diesel engines are getting tougher and will push the ethanol-diesel market as one of the primary drivers. A cost-effective way to achieve these new standards is by using cleaner fuels. The ethanol-diesel blend is an attractive option to fleet operators because it offers an economical solution to bring fleet emissions within mandated levels without expensive hardware retrofits, major modifications to refuelling or fuel storage infrastructures or substantial retraining of maintenance staffs.

Conclusions

The ethanol-diesel blend can easily substitute diesel without any loss in fuel economy. The emissions profile for both, the particulate matter and NO_X emissions, promises to significantly improve air quality and meet the regulatory requirements for fleets operating on both new and older diesel engines in small-duty, medium-duty, and high-duty configurations. It will also help expand ethanol markets acting as a huge beneficiary to the agricultural sector.

The key issues generally raised during the methodology development stage should be appropriately accommodated for the blending of ethanol with diesel and its consumption in the transport sector. Development and approval of this methodology could take considerable time and resources, but when successful, the KSRTC project is likely to be implemented as a CDM project. More importantly the scope for replication to other regions in India and other countries is very large, thereby contributing to sustainable CDM projects and better air quality in these regions.

4.3 Bus Rapid Transit in Bangkok

Introduction

BRT is a bus-based mass transit system that delivers fast, comfortable, and cost effective urban mobility. A BRT system can reduce greenhouse gas emissions via:

- Improved fuel-use efficiency through new and larger buses. Mode switching due to the availability of a more efficient and attractive public transport system.
- Load increase by having a centrally managed organisation dispatching vehicles.
- A fuel switch to low carbon fuels.

BRT systems replace or complement conventional public transport systems. The new bus system transports passengers who, in absence of the project, would have used the conventional public transport system or other modes of transport such as passenger vehicles.

Learning from the successes of the Bus Rapid Transit (BRT) systems elsewhere in the world and wanting not to be left out in applying modern transportation schemes in solving its own transport problems, the Bangkok Metropolitan Administration (BMA) is constructing its first BRT project in Bangkok. Officially called the southern route, the first Bangkok BRT project spans a distance of 15.8 km and comprises three major segments: Mahai Sawan Road, Rama III Road, and Narathiwas Road. The project is expected to ease the traffic along this route, particularly the Rama III Road-Narathiwas Road segments, which in terms of vehicle per hour during peak hours increased by 10% in 2005-2006. Moreover, the Mahai Sawan segment includes a vital crossing of the Chao Phraya River, which is expected to ease the traffic along three alternative crossings of the Chao Phaya River in the vicinity of the project, namely, Rama III Bridge, Taksin Bridge, and Bangkok Bridge. The traffic along these bridges, measured in terms of passenger car units increased by 20% between December 2005 and January/February 2006.

From the point of view of CDM and urban air quality, the BRT project will reduce GHG emissions and air pollutant emissions by introducing in Thailand's capital city a more efficient mass transportation system than ordinary buses at less than 10% the cost of building (another) underground rail system[12]. The designated BRT buses are also designed to use compressed natural gas (CNG) (instead of clean diesel as originally planned) contributing further to reduced CO_2 (GHG) emissions and reduced NO_x and SO_x (air pollutants) emissions, compared to the emissions of normal buses, taxis, and cars even if many of them already use CNG.

Applicable methodology

The first approved baseline and monitoring methodology for transport CDM projects, "Methodology for Bus Rapid Transit Projects", in short called AM0031, is not applicable

[12] Bangkok opened its first underground rail system – called the blue line – in July 2003 and is planning to build three or four more lines until 2016.

to the first Bangkok BRT project. The reason is that AM0031 applies to a complete BRT system that partially or fully replaces an existing public or mass transport system in a particular city. The first Bangkok BRT project is a stretch of dedicated lane on an existing portion of a road network crossing the Chao Phaya River, which separates the big commercial areas of Metropolitan Bangkok from mostly residential areas. Even if the first BRT project is part of a planned network of 10 BRT routes extending over 157 km, it is not meant to replace an existing public transport system but rather complement it.

The more applicable methodology seems to be the disapproved “Methodology for Mass Rapid Transit Projects”, or NM229, which builds on AM0031 but, among other conditions, apply to “new infrastructure consisting either of segregated bus lanes or a rail-track system.” The first Bangkok BRT project also easily satisfies many of the applicability conditions of NM229 - that is, the project is for passenger transport only; it will use CNG as the eligible fuel; it is purely road-based; and it is being constructed in an area where public transport is available. However, it is difficult to say that the alternative baseline to the project is the continuation of the present situation, the last applicability condition of NM229 (in fact, as well as of AM0031).

Baseline and additionality

For the identification of baseline scenario and demonstration of additionality, both AM0031 and NM229 methodologies use the “Tool for the demonstration and assessment of additionality (version 4).” The Tool requires that the alternatives to the project include a continuation of the present situation and implementation of the project without CDM. Reliable sources involved in the development of the first BRT project in Bangkok identified the construction of at least one more bridge in the area as the nearest alternative to the BRT project, particularly in terms of its intended immediate benefit (that is, to alleviate the traffic across Chao Phraya River). Another possible alternative to the BRT project is construction of a monorail along the planned BRT route, including the crossing of the Chao Phraya River. The methodology specifies that the baseline scenario is that with the lowest possible emissions among feasible or possible alternatives. The local government of Bangkok confirms that “continuation of the present situation is not an option.” Moreover, the fact that the BRT project is going ahead even without the CDM option makes this the likely baseline scenario.

Notwithstanding, the first Bangkok BRT project seems to pass the additionality test of the methodology NM229. In the first place, all identified alternatives to the project would easily comply with legal and mandatory requirements. Secondly, a preliminary investment analysis based on limited available information shows that the project is unlikely to be the most financially attractive and, in fact, unlikely to be financially attractive. The feasibility study of the first phase Bangkok BRT (including the northern route in addition to the southern route) indicates that the project is an unprofitable venture. The earnings generated by the project will just be enough to cover operating and maintenance costs but not capital investment. The project would be subsidised by the local government of Bangkok at the rate of 5 baht per passenger over a period of 20 years. Thirdly, a preliminary analysis of the identified barriers – including political, financial, regulatory, and operational barriers – indicates that the alternatives to the BRT project are not prevented by any of these identified barriers. But an in-depth analysis of these barriers has to be made. Lastly, a preliminary analysis of similar, or "common practice", elsewhere suggests that the first Bangkok BRT project can claim distinguishing features from these similar projects. These features include the project's main purpose of alleviating the traffic across the Chao Phraya River – a portion of the BRT route – and its integration with other mass transit systems in the city, including the light rail and underground systems.

Baseline and project emissions and leakage

In principle, the baseline and project emissions are the emissions of the passengers using the BRT project that would have used other modes of transport in the absence of the project. Leakage emissions are those directly attributable to the project but occur outside the project boundary. The methodology, therefore, requires a clear definition of project boundary. NM299 also uses the term zone of influence as equivalent to project boundary, but is heavily criticised for the vague definitions of the two terms. The other major criticism of NM229 is the approach in determining the baseline emissions and leakage. The proposed approach is believed to be inadequate in obtaining accurate and reliable information needed to calculate baseline and leakage emissions. The methodology also requires the monitoring of a long list of data, some of which need to be clearly defined and distinguished from one another. On the other hand, the methodology for calculating project emissions is simpler and more straightforward.

Conclusions

The development of the first Bangkok BRT project as a CDM project therefore hinges on the development and approval of a more applicable methodology. The new methodology should consider the issues concerning NM229 as well as the specific circumstances of the Bangkok BRT development. In fact, the way BRT projects in Bangkok are being planned suggests that an approach could be through programmatic CDM. In any case, a lot of data will be needed or should be monitored to define the baseline scenario; perform the additionality tests; and determine the baseline, project, and leakage emissions.

The case study confirms the methodological difficulties with transport CDM projects. It confirms furthermore that BRT projects need new and suitable, or more applicable, methodologies. Meanwhile, transport projects should not be hindered by these difficulties. Transport is simply too important a sector in urban development to wait for CDM solutions. Notwithstanding, future BRT projects should not overlook the opportunity offered by CDM, particularly when new methodologies more applicable to the specific circumstances of BRT projects have been developed.

4.4 Phase 5 of TransJakarta Project

Introduction

The TransJakarta BRT project Phase V consists in the implementation of a busway system using corridors 11 to 13. Currently, phases I to III corresponding to corridors 1 to 7 are in operation, while phase IV corresponding to corridors 8 to 10 is still in its final stage of development. The whole TransJakarta BRT project has been designed to replace the un-coordinated and overlapping existing bus systems operating on above corridors. The submission of the TransJakarta project as an eligible CDM project is based on the approved methodology AM0031.

The methodology is applicable to project activities that reduce emissions through the construction and operation of a BRT system for urban road based transport. The methodology is also applicable for extensions or expansions of existing BRT systems (adding new routes and lines).

The following applicability conditions apply:

- The project has a clear plan to reduce existing public transport capacities either through scrapping, permit restrictions, economic instruments or other means and replacing them by a BRT system.
- Local regulations do not constrain the establishment or expansion of a BRT system.
- The fuel(s) used in the baseline and/or project case are unblended gasoline, diesel, LNG or CNG.
- The BRT system partially or fully replaces the existing public transport system in Jakarta which passes through the corridors.
- The methodology cannot be used for BRT systems in areas where currently no public transport is available.
- The methodology is applicable if the analysis of possible baseline scenario alternatives leads to the result that a continuation of the current public transport system is the scenario that reasonably represents the anthropogenic emissions by sources of GHG that would occur in the absence of the proposed project activity (i.e. the baseline scenario).
- The BRT system as well as the baseline public transport system and other public transport options are road-based (the methodology excludes rail, air and water-based systems from analysis).

This baseline methodology shall be used in conjunction with the approved monitoring methodology AM0031 (Monitoring methodology for Bus Rapid Transit project).

The project contributes to sustainable development in Indonesia context as it will meet with sustainable development criteria and indicators such as:

a. Improved environment through less GHG in the form of CO_2, and other air pollution emission such as PM and NO_x. This can be achieved through the implementation of a more efficient transport system.

b. Improved social well-being as a result of less time lost in congestion, less respiratory diseases due to less PM pollution and fewer accidents per passenger transported.
c. Economic benefits at the macro-economic level. Modern transit system is intended to reduce economic costs of congestion in Jakarta.
d. Job creation for more than 2,000 temporary constructions for unskilled workers for construction works of phase 5.

Baseline and additionality

The methodology AM0031 is applicable if the analysis of possible baseline scenario alternatives leads to the result that a continuation of the current public transport system is the scenario that reasonably represents the anthropogenic emissions by sources of greenhouse gases (GHG) that would occur in the absence of the proposed project activity (i.e. the baseline scenario).

The business as usual scenario of the existing public buses in the three corridors (11, 12 &13) with their future growth projections will be the baseline for this project. The baseline will use diesel to fuel the three corridors, while the project will use CNG. The use of new engines CNG fuels instead of diesel fuels in new fleets will reduce the emission of CO, particulate matters, SOx, NOx and hydrocarbon significantly. In addition, the expected modes shifting from private vehicles to BRT will reduce the number of private motorised vehicles operated and therefore will also reduce the total air pollutant emission

The proposed project will comply with both environmental and financial additionality criteria.

The environmental additionality will be the reduction of GHGs and air pollutants emissions. Such reduction happen due to: (i) restructuring of the existing overlapping bus routes with TransJakarta's routes; (ii) replacement of old bus fleets with the new ones; (iii) increase of passenger capacity per fleet; (iv) better operation conditions, and (v) modal shifting from private motorised vehicles.

Financial additionality is mainly due to the fact that the Regional Government of Jakarta has not enough funds to implement the project and to maintain its sustainable operation. By implementing these 3 corridors as CDM, there will be additional revenue to support maintenance and operations within the respective corridors.

Conclusions

Based on the analysis and comparison with the Transmilenio's case, to allow the use of AM00031, a number of activities and possibility of methodology revisions are needed:

- A thorough survey and analysis on basic data including number of old routes and buses to be eliminated and replaced, as well as detailed travel information of potential passengers

- A detailed feasibility study for the three corridors including the technical, investment and financial, as well as the environmental aspects.
- Combining TransJakarta Corridor 11-13 with Corridor 8-10 and Corridor 14-15 to get an annual emission reduction of more than 60,000 ton CO2 equiv. to allow the use of AM00031
- Possibility to develop Corridor 8-10, Corridor 11-13 and Corridor 14-15 as Programmatic CDM under the CDM Programme of Activities (PoA) and to develop a new methodology for CDM-PoA in the urban public transport sector or to develop simplified methodology for small scale CDM.

In addition, to ensure the effectiveness and maximum benefits of TransJakarta, not only for the proposed project but also for all the corridors, we recommended a number of actions to be taken:

- The increased of passengers is one of the success indicators of TransJakarta BRT implementation. Therefore, it is important to ensure such increase by improving the quality of services, increasing the frequency of buses by managing the headway and helping in improving the travel speed (travel time) as well as the comfort of the passengers.
- Transport demand management (TDM) measures play a key role and should be promoted especially in the central business districts of Jakarta.
- Pedestrian and NMT facilities and zones have to be an integrated part of the BRT corridors. They can also serve as feeder to the BRT corridors; and
- Providing park and ride facilities in every suburb terminal need to be considered to reduce and limit the use of private motorised vehicles into the city. Provision of bicycle parking close to bus stations would attract the utilisation of bicycles as feeder.

4.5 Biomass Gasification for Power Generation in Jinan

Introduction

The biomass gasification for power generation project (hereafter refers to as the BGPG project) is a biomass utilisation project which will mainly use local straw from wheat and corn for electricity generation. The final BGPG will be implemented on a local scale (2MW) and five units will be bundled into a small-scale CDM project. The technology employed is developed by Energy Research Institute of Shandong Academy of Sciences (SDERI).

The electricity generated by the Jinan BGPG (JBGPG) project will be sold to Shandong provincial power grid that is part of Central China Power Grid to replace the capacity of coal-fired power plants. Furthermore, the JBGPG project will achieve an extra benefit of GHG mitigation derived from a reduction of methane emissions from straw dumping or uncontrolled burning of biomass. The development of the JBGPG project will directly benefit the local region by creating new job and investment opportunities, stimulating economic development, improving the quality of local power supply and increasing tax revenues. The project will also generate additional on-line power capacity from a renewable energy source to meet the strong local electricity demand. The JBGPG project will not only reduce GHG emission and SO_2 emissions caused by local coal-fired boilers, but also to some extent abate air pollution, especially PM from the direct burning of biomass. The proposed project is consistent with China's national energy policy and sustainable development strategy.

BGPG is still at the development and demonstration stage with small-scale installed capacity in China. The BGPG technology consists of a combination of gasifier, internal combustion engine and generator installed in a power generation system. In order to guarantee the stable engine running, a new type of gasifier has been carefully developed, which can gasify straw and produce tar free gas by violent thermal cracking in the furnace. With waste heat recovered from the engine exhaust, the gasifier could work at a high efficiency of approximately 88 per cent. The total conversion efficiency from straw to electricity could reach 28 per cent. A 200kW demonstration project has been in operation since 2005. The feasibility and improvement of the technology has been developed by SDERI based on experimental results. In 2007 another BGPG 2MW demonstration project, was started in Huanghe village.

Methodology Applied and Monitoring Plan

The approved baseline methodology ACM0006 Version 3 can be applied - "Consolidated baseline methodology for grid-connected electricity generation from biomass residues". This consolidated baseline methodology is based on elements from AM0004, AM0015, NM0050, NM0081 and NM0098.

According to ACM0006 methodology, the Jinan project would qualify as a *Greenfield Power project* with the following classifications used for the baseline methodology:

- *for power generation :* **P4**, the generation of power in the grid
- *for the use of biomass residues:* **B3**, the biomass residues are burned in an uncontrolled manner without utilising it for energy purposes.

This combination leads to **scenario 2** classification in Table 2 of the ACM0006 (page 8/63). The major emission sources to be covered are (based on Table 3 in ACM0006):

- baseline grid electricity CO_2 emissions;
- CO_2 emissions from project related fuel and electricity consumption (biomass transportation and boiler starting);
- Optionally CH_4 from uncontrolled burning in the baseline, and if this option is chosen, also CH_4 from biomass residue combustion in the project.

The leakage issue can be easily resolved, following **L1**.

The biomass project meets all conditions of the monitoring methodology approved in ACM0006 because the final case consists of five BGPG stations bundled together. Monitoring methodology can therefore be duplicated from one to the others.

Estimated Amount of Emission Reductions covering GHG and Air Pollutants

The emission reduction can be calculated according to the equation:

$$ERy = ER_{electricty,y} + BE_{biomass,y} - PE_y - L_y$$

(*Equation (1) page 21/63 of ACM0006*).

Emission reductions are realised through the displacement of grid electricity and by avoiding open air burning of the biomass residues. The project could generate emissions through the transport of the biomass residues to the BGPG site and from the combustion itself. The difference between the reduced and generated emissions is the net emission reduction by the project - which can be claimed as CDM credits. Following the CDM guidelines in ACM0006, only CO_2 and CH_4 are taken into account.

The CO_2 reduction of a 2 MW BGPG would be 12,271 ton per year (or 12,694 ton CO_2-eq per year as illustrated below); or, if expressed in kWh delivered by the BGPG, 1,026 g CO_2 or 1,061 g CO_2-eq per kWh will be avoided.

The reduction of the pollutants based on the difference between emissions from open air burning and from transport and use of biomass and diesel in the BGPG, should be multiplied by five to obtain the final results for the overall project case (2MW×5).

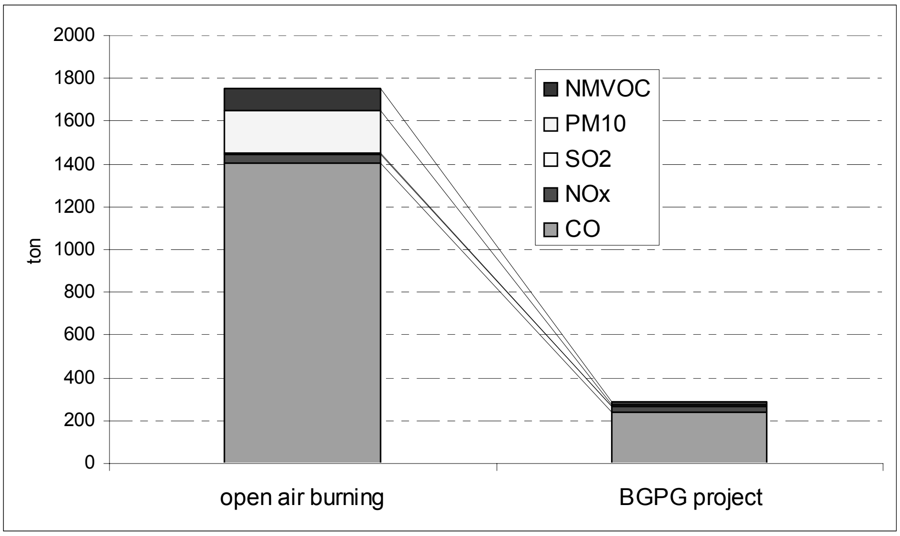

Figure 4-1: Emission of air pollutants related to open air burning of the same amount of biomass residue and from the BGPG project implementation

Additionality and Economics

The additionality check follows the tool for the demonstration and assessment of additionality. Despite rich biomass resources, the investment and technology barriers means that biomass combustion power generation is regarded as an unattractive technology by the Chinese power sector. The proposed project activity is not financially viable without the CER revenue. Therefore, the emission reductions to be achieved by this proposed project are additional.

The Jinan 2 MW BGPG project is just under economic feasibility with an IRR of 7.3 per cent, if we consider that the feasibility threshold is 8%. However, project investors may choose to use other thresholds values in order to justify internally this project. From a CDM point of view, the calculations show that the project is (marginally) additional since the IRR threshold level is not reached (7.3 per cent instead of 8 per cent). In addition, the sensitivity analysis shows that small deviations of main parameters of the project (e.g. a 5 per cent increase of biomass price, or a 5 per cent reduction in electricity tariff) cause considerable fall in IRR. Therefore, the project can be considered as financially additional.

Reduction of Other Pollutants

The Jinan BGPG project has a clear an impact on the local human and environmental health. Even if the methodology used has been developed for Europe and specific parameters in that methodology may differ for Jinan (e.g. dose response functions, damage costs) and even if the existing methodology still contains uncertainties, the outcome of the above analysis may still be valid for reference. The major outcome is that external damage would be reduced by 88 per cent following a simplified approach based on the ExternE derived damage costs per pollutant. If a more detailed analysis is followed using the on-line EcoSenseLight tool which calculates damage impacts on various elements, health damages would decrease by 96 per cent and material damages (on crops and building materials) by 80 per cent. As the EcoSense methodology covers various countries, therefore the calculations result in a range of effects (min-reference-max) which are illustrated below. In any case, the damage impact reduction remains in the same order of 96-98%.

According to both methodologies (ExternE and EcoSense) the largest share of damage reduction is caused by a significant reduction of PM emissions by switching from open air biomass residue burning to the BGPG project.

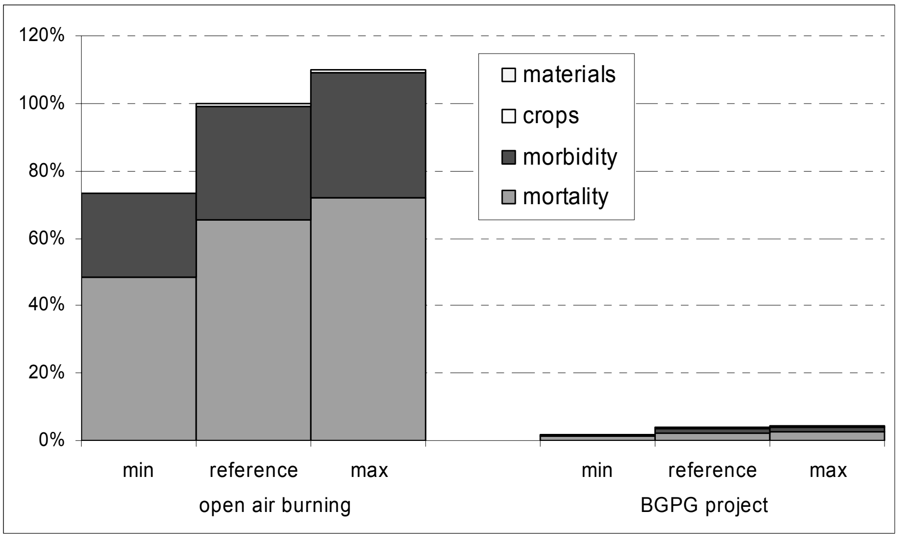

Figure 4.2: Comparison of damage impacts on different elements according to the EcoSense approach

Conclusions

The Jinan BGPG project has clearly an impact on the local human and environmental health. Even if the methodology used has been developed for Europe and specific parameters in that methodology - like dose response functions, damage costs,- may differ for Jinan and even if the existing methodology contains still uncertainties, the outcome of the above analysis may still be valid. The major outcome is that external damage would be reduced by at least 88% following the simplified approach. If a more detailed analysis is followed using the on-line EcoSenseLight tool, health damage would decrease by 96% and material damages (crops and building materials) by 80%. Total damage is 96% to 98% lower than the damages evaluated in the different countries studied with the EcoSense tool.

In both cases the largest share of damage reduction is caused by a significant reduction of particulate matter emissions (98%) when switching from open air biomass residues burning to the BGPG project. The total emissions of CO, NO_x, SO_2, PM and NMVOC - which are considered to be the highest contributors to local air pollution – are reduced by 84% when implementing the BGPG project.

Chapter 5: Summary and Conclusions

The following section highlight the main findings and conclusions reached in the framework of the Curb-Air project and which have been presented in separate detailed reports and also in preceding chapters of this handbook:

- Carbon finance can be used to improve air quality. This Handbook has shown that the Clean Development Mechanism under the Kyoto Protocol may provide a window of opportunity for technologies that reduce both greenhouse gas and air pollutant emissions.
- A multitude of policy options exhibiting strong co-benefits exist in different sectors. These include fossil fuel switch, biofuels, energy efficiency, and improved public transportation.
- A CDM project can only be registered if it uses an approved baseline methodology. Development of these methodologies has proven to be a key issue in the CDM process.
- Synergetic options in the industry and power sectors generally stand a good chance of being developed under the CDM. Renewable energy and energy efficiency projects currently dominate the CDM project portfolio
- The transport sector is underrepresented in the CDM. There are very few approved transport methodologies, and development of new methodologies has been proven difficult. The methodological issues revolve around baseline determination, proving additionality, and monitoring emission reductions. Several methodologies, however, are under development and prospects for biofuels, mass transit systems, and energy efficiency in transport are likely to increase in the future.
- Air quality benefits of CDM projects may actually outweigh the carbon benefits. However these local benefits cannot be valued financially in current international mechanisms.

We recommend urban and national policymakers to explicitly look at the Clean Development Mechanism to provide financing for options to improve air quality in Asian cities. Initial experiences in the realm of bus rapid transit systems and different types of biofuels have been gained recently, and these should be taken forward by decision makers, CDM consultants, NGOs, and project developers.

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cdm & urban air pollution: partnerships enchancing synergies in urban air quality and kyoto mechanisms

About CURB-AIR

CURB-AIR is a partnership between 7 Asian and European research institutions, coordinated by the Energy research Centre of the Netherlands. It is co-funded by the Asia Pro Eco Programme of the European Commission, and was completed in January 2008.

Objectives

The CURB-AIR project aims to contribute to improving air quality in Asian mega cities while contributing to climate change mitigation by using the Clean Development Mechanism (CDM).

The project seeds to perform partnerships with local and international stakeholders to promote CDM initiatives that change mitigation.

Outputs

The 2 year project focused on research and capacity building on air quality, CDM and co-benefits. The main reports published include:

- Air quality review of the four Asian cities
- Best practices for synergetic options in the transport sector
- Policy report on air quality - CDM measures
- CDM viability report of the four case studies
- Handbook for urban policymakers in Asia

> All of these reports, as well as additional resources and links, are available on our website:

www.curb-air.org

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